Town of
Garrett Park

Town of Garrett Park
Comprehensive Arboretum Plan
Part I: History, Policies, and Current Collection

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Table of Contents

Table of Contents 2
Executive Summary 4
- The Goals 4
- The Challenges 4
- State of the Current Collection and Town Tree Practices 4
- Key Actions 5
- Vision Statement 6

Overview 7
- An Overview of Garrett Park's Tree History and Arboretum 7
- Threats to Urban Forests 9
- Benefits of Urban Forests 12

The Comprehensive Arboretum Plan 15
- The Purpose of the Comprehensive Plan 15
- Implementation and Review of the CAP 15
- Objectives and Goals for the Tree Collection 15
- Summary of the Current Collection 16
- Regulations and Permitting Regarding Tree Planting, Maintenance, and Removal 28
- Summary of Permits for Homeowners and Contractors Related to Tree Planting, Maintenance, and Removal 30

Recommendations - Goals and Strategies 31
- Tree Selection and Planting 31
- Care and Maintenance of the Collection 34
- Regulations and Permitting 36
- Public Education and Outreach 40
- Long Term Goals and Plans 41
- Summary of Goals and Strategies 42
- Urban Forest Criteria and Performance Indicators Matrix 43

References 54

CONTENTS

Glossary 55
Appendix A. List of Species from 2018 Inventory.....57
Appendix B. List of Genera from 2018 Inventory.....64
Appendix C. i-Tree Report 67
Appendix D. Invasive Plant Species 103
Appendix E. Voluntary Codes of Conduct for Botanic Gardens and Arboreta 105
Appendix F. Grant Opportunities.....106
Appendix G. Sample Tree Protection Ordinances 108

Executive Summary

The Goals

The Garrett Park Arboretum, established in 1977, comprises all of the trees and other plantings on town-owned and town-managed property. The mission of the Arboretum is **"To support and evolve Garrett Park as a green oasis of healthy, beautiful trees, sustainably managed, and appreciated by town residents, now and far into the future."** To accomplish this mission, this comprehensive plan establishes standards to:

- Increase the urban forest's health and resiliency by expanding tree taxa diversity while planning for climate change's effects and challenges.
- Maintain the Arboretum's healthy and resilient tree canopy through a commitment to planting and best management practices.
- Restore natural forest areas with native plantings and manage invasive plants, deer browsing, and erosion.
- Engage the citizens of Garrett Park in understanding the value of their urban forest, and also the value of caring for it.

The Challenges

Garrett Park currently has a diverse, healthy tree canopy. Every urban tree faces significant challenges due to air pollution, stormwater runoff, soil compaction, confined root areas, exposure to wind, pests, and diseases, and other factors. Trees are impacted by power lines, underground utilities, and construction. The Town has a dedicated Arboretum Committee to advise the Town on tree care, removal, and planting, as well as a Consulting Town Arborist, but 1500 trees are a lot to look after. Engaging the community in tree care is essential to the continued well-being of the Town's trees.

State of the Current Collection and Town Tree Practices

The 2018 inventory found 1509 trees representing more than 183 species of trees and 78 genera. A complete list of species can be found in **Appendix A**. Garrett Park has an extraordinarily high tree canopy coverage—82.9%. Canopy coverage that high is quite rare in a developed area like metropolitan Washington, DC. As part of the inventory, each inventoried tree was examined for structural defects and health concerns; only a few trees were found to be in need of immediate attention. The tree collection also shows a diversity of tree ages and sizes. The inventory included trees located in the Town's Right of Way (ROW) based on the Town's 2017 ROW maps and town-managed properties.

The Town's natural areas, such as Porcupine Woods and Cambria Park, have a diversity of native tree species, but are also heavily invaded by non-native plants and are impacted by deer and erosion.

The Town manages trees within planting strips including pruning, removal, and planting.

EXECUTIVE SUMMARY

Key Actions

1. **Establish a tree selection process**. The Town Arborist and Arboretum Committee are responsible for selecting the tree species to be planted. The process of tree selection involves consideration of both the site and the species. The main goals for enhancing the diversity of the collection are to select species that:
   - *Increase tree diversity and forest resilience* - Aim to have diversity in genera such that no one genus constitutes more than 5% of the total intensively managed trees. New trees should be adapted to a warming climate with variable (and sometimes intense) weather events. Species and varieties should also be selected to take into account their structural potential and insect and disease resistance.
   - *Are non-invasive* – The Town should follow the Invasive Plant Species Codes of Conduct endorsed by the American Public Gardens Association. The Town should consider an ordinance that forbids planting invasive species—at least on Town property, and perhaps also on private property.
   - *Increase habitat for wildlife* - To as great an extent as possible, Garrett Park's Arboretum should include native plants with value to wildlife.
   - *Help to interpret Garrett Park's natural and historical heritage* - The tree collection should have representatives of the many beautiful and ecologically important trees of the mid-Atlantic Piedmont region. In the spirit of horticultural display, Garrett Park's tree collection should include taxa new to the Horticulture industry, but only if they are not invasive.
   - *Create education potential* - Trees can provide many great lessons on botany, horticulture, ecology, history, and philosophy. Selecting a diversity of tree species will provide many opportunities for education.
2. **Plant canopy trees where the site is appropriate**. Plant smaller-statured trees where soil volume is limited, or where there is an infrastructure conflict.
3. **Dedicate funding for tree planting, pruning, and periodic tree risk assessment,** as well as for a on-going position for a contracted Town Consulting Arborist.
4. **Utilize best management practices when planting new trees.** Provide for aftercare and structural pruning, as well as deer and invasive plant protection, so that trees establish well and thrive. The Town should adopt the American National Standards Institute (ANSI) *American National Standard for Tree Care Operations - Tree, Shrub, and Other Woody Plant Management - Standard Practices (Pruning)* standards as well as the Z133 Safety Standards and International Society for Arboriculture (ISA) Best Management Practices.
5. **Conduct a Level Two Basic Tree Risk Assessment every five years** for intensively managed trees. Adopt guidelines for tree risk assessment for all trees.
6. **Adopt a Tree Protection Plan** for trees on public property. The objectives of a Tree Protection Plan are to minimize the impact of construction activities on trees. A further step would be to require residents who are seeking a building permit from the town to develop a Tree Protection Plan and take tree protection measures prior to being issued a permit and commencing work.
7. **Increase the scope of tree ordinances** to preserve trees and plant new trees, especially with respect to construction and development in the Town. The tree ordinances could extend to covering trees on private property.
8. **Establish an on-going relationship with external entities** – utilities such as PEPCO, WSSC, and Washington Gas; other infrastructure companies; and State and County agencies—whose work may impact trees. Engage the consulting arborist from these entities to ensure proper treatment of the trees.

9. **Document all tree tasks in the inventory** so that it is kept current. Commit to the maintenance of accurate, up-to-date, and pertinent records on its accessioned living collections. Conduct new inventory every 10 years.
10. **Tag any new trees** with round aluminum numbered tags and enter their identification, location, source, size, and planting date in the inventory; contract with a third party to place the new tree's location in the online ArcGIS database.
11. **Educate residents** about the need for diverse taxa in their home landscapes, how stormwater management affects trees, and what effects climate change will have on the health of their home landscapes. Provide education to the public about tree care issues, including tree pests and diseases and their management.
12. **Engage volunteers** to help with care and maintenance and to record natural history observations.
13. **Become a TreeCity USA** through the Arbor Day Foundation, an accredited Arboretum through ArbNet, and a member of the American Public Gardens Association.

Vision Statement

Garrett Park envisions a forest that enhances the community's aesthetic and ecological appeal for generations to come. We envision restoring the Town's natural areas to provide a diversity of wildlife habitat and ***ecosystem services***[1]*. We seek to engage citizens in stewardship activities through education and open dialogue. This plan provides for regular maintenance and coordination among public agencies, residents and Town management.*

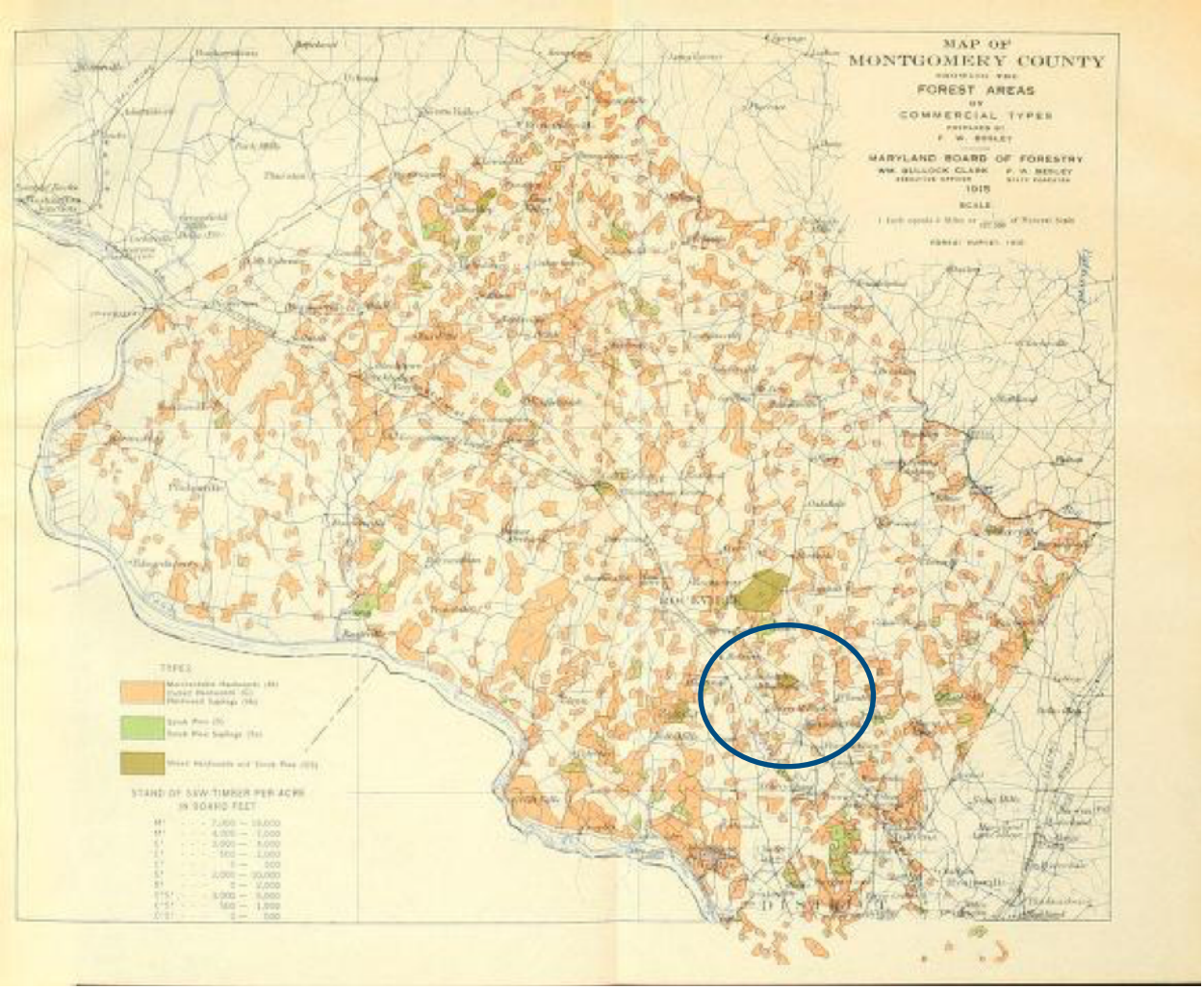
[1] Terms that appear in boldface italics are defined in the Glossary, page 55.

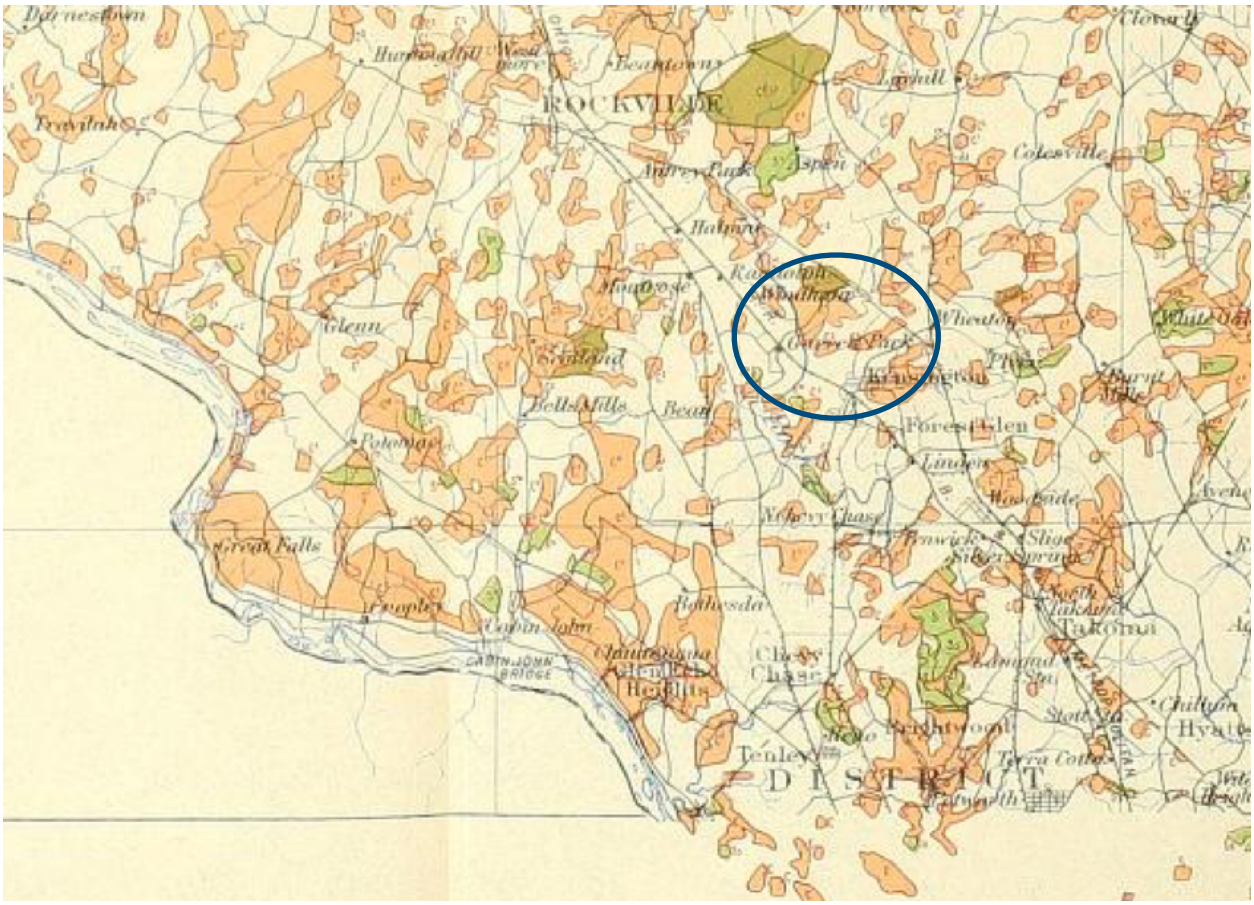
Overview

An Overview of Garrett Park's Tree History and Arboretum

Businessman Henry W. Copp envisioned Garrett Park as an English village serving as a suburb of Washington, DC when he purchased land in 1886 and formed the Metropolitan Investment and Building Company. The layout of the town was designed by horticulturist Prof. William Saunders, Superintendent of Grounds of the USDA (Almy, 1974). Saunders was known for introduction of many exotic plant species that typically graced landscapes at the turn of the century. The 154-acre town of Garrett Park was incorporated in 1898, five years after the Baltimore and Ohio Railroad built a station in town.

One of the first ordinances adopted by the Town gave legal protection to tree and shrub plantings. A small building boom occurred during the 1890s, and as new houses were built their inhabitants planted trees, including tulip trees, elms, and sugar maples, to beautify and shade the new community. A 1916 map of forests greater than 5 acres in Montgomery County shows just a few small forest remnants around Garrett Park (Besley, 1916).





FIGURES 1&2. 1915 MAP OF FORESTED AREAS IN MONTGOMERY COUNTY (HTTPS://WWW.BIODIVERSITYLIBRARY.ORG/ITEM/161588#PAGE/181/MODE/1UP)

A second round of building occurred in the 1920s and a third round after 1945. The town occupies about 0.26 square miles and had a population of 992 people in the 2010 census.

In 1977, Garrett Park declared itself an Arboretum to avoid the limits on tree species choices imposed by Montgomery County. In 1994, the establishment of the Arboretum was formalized by adoption of Section 717 of the Town's Code of Ordinances. The Arboretum includes all plants on all town-owned or town-managed land.

Garrett Park is in the Rock Creek watershed, and Glendarragh Stream originates in and runs through Garrett Park to Rock Creek. Glendarragh would roughly translate as "dark oak stream." The Rock Creek watershed lies within the Piedmont Uplands ecoregion. Piedmont Uplands vegetation is characterized by mixed mesic and dry-mesic hardwood forests and floodplain forests, with some successional areas of meadow and pine forests.

Garrett Park is set in a suburban/urban matrix within Montgomery County. It is bordered by the ribbon of Rock Creek Park to the south and east. To the northwest is an urbanized shopping district.

FIGURE 3. MAP OF GLENDARRAGH STREAM FROM [HTTP://DEP.MAPS.ARCGIS.COM/](http://dep.maps.arcgis.com/)

Threats to Urban Forests

The ***urban forest*** today is vastly different from pre-Colonial forests and from the fragments left behind by agriculture.

In this document, the urban forest is the sum total of all trees that are growing in the town of Garrett Park, both privately owned and publicly owned. **Publicly owned trees** are further broken down into two categories: **intensively managed trees** and **natural area trees**. Intensively managed trees are those trees in the Right of Way (ROW) as well as some of the trees in natural areas or parks. Some of the natural areas or parks contain a feature such as a ball field or playground that elevates the need for the Town to actively manage the surrounding trees for risk. (For example, a large dead limb would be removed if it were an intensively managed tree, but allowed to rot and fall if it were a natural area tree.)

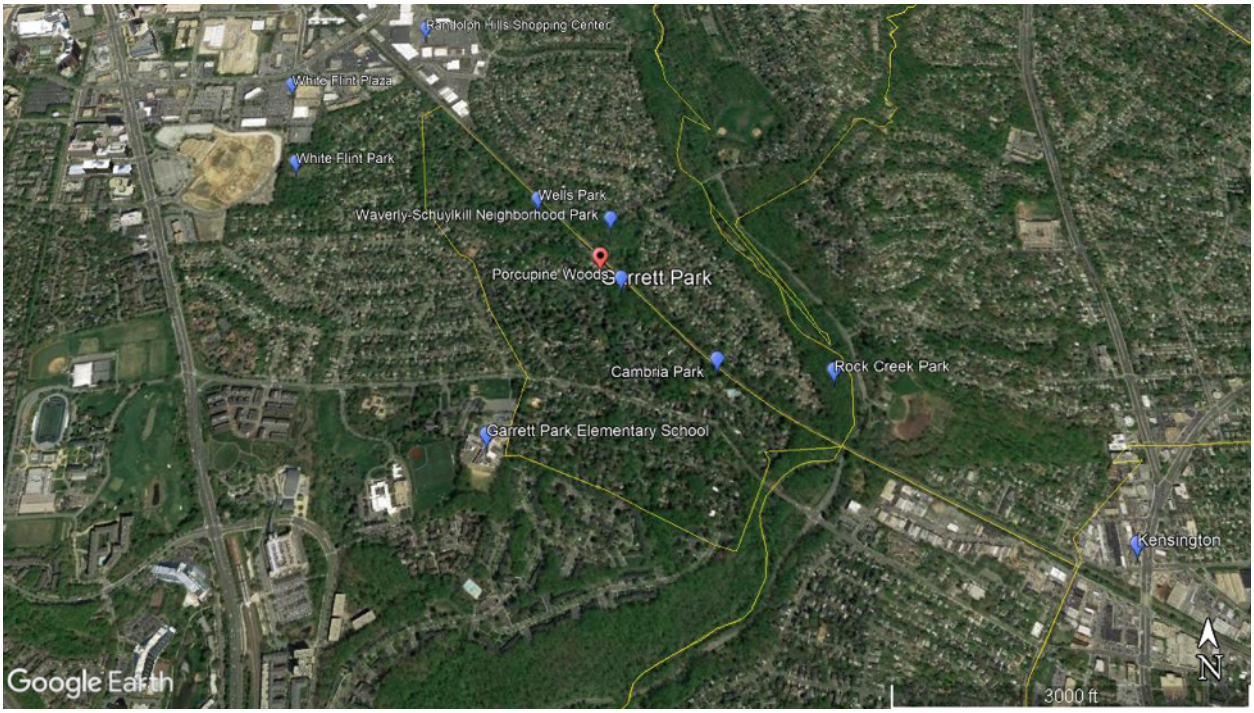


FIGURE 4. GARRETT PARK'S SURROUNDING LANDSCAPE

Fragmentation.

Fragmentation increases the risk of damage to the forest. Wind can reach further into the forest interior, drying the atmosphere and increasing wind damage to interior trees. Air and water pollutants can more easily reach the interior. Soil disturbance and more sunlight along edges can allow competitive invasive plants to establish and move into the forest interior.

Fragmented woodlands have an increased "edge" that further exposes the forest to detrimental pressures; it is easier for invasive plants to become established, and the decrease in square footage of forest interior decreases some wildlife habitat. Fragmentation changes wildlife habitat and the ability of animals to move through the landscape. Some populations of animals that require large expanses of forest are eliminated, such as bobcats and ovenbirds. Others face gradual population declines as mates and food resources become harder to find. Other animals such as raccoons, coyotes, and deer have thrived in close proximity to human developments.

Before European settlement, it is likely that this area was mostly forested, with some Native American settlements and small-scale agriculture. Large-scale clearing of forests for agriculture and timber began in the area in the 1700s. Forest patches became smaller and more isolated from each other, first by farm fields, and later by housing developments. Construction of suburbs established around the turn of the century and post-WWII fragmented the once-rural landscape.

Because Garrett Park's remaining forests are small, they require extra attention to minimize disturbance along edges. The forests should be considered in the context of the surrounding landscape, working to enhance or maintain connections among natural areas through ***greenways*** and backyard wildlife habitats. Small forest remnants are more susceptible to damage and erosion caused by stormwater and invasive plant proliferation. Therefore, the town

of Garrett Park should implement the following plans: a stormwater management plan, an invasive plant management plan, and an invasive fauna management plan.

Deer.
Deer were nearly exterminated in the 1800s, but their populations have now rebounded to above pre-Colonial levels. Deer thrive on the margins between woodlands and fields or lawns, and their predators have been eliminated in suburbia. Deer overpopulation can:

A. Damage forest regeneration because of their appetite for tree seedlings;
B. Increase deer tick populations, contributing to the spread of tick-borne diseases including Lyme disease;
C. Reduce ground nesting bird populations in forests;
D. Carry invasive plant seeds into forests;
E. Increase car collisions; and
F. Damage ornamental plantings.

Garrett Park relies on Montgomery County for any deer control efforts. Additional information on deer control efforts in Montgomery County is available at https://www.montgomeryparks.org/caring-for-our-parks/wildlife/deer/deer-management/. Deer activity within the town can be monitored and new plantings protected from deer.

Invasive plants.
Invasive plants are plants introduced outside of their native range that establish and spread rapidly, causing damage to native plant or animal communities. Vines can girdle trees and make them more vulnerable to storm damage. Plants that form a groundcover or solid shrub layer can reduce regeneration of native plants and change wildlife habitat by altering nest sites or food availability. Invasive trees can form dense stands that outcompete a more diverse native forest canopy (Kaufman and Kaufman, 2013). Introduced species support far less animal diversity than native species do (Tallamy, 2007). Controlling or eradicating existing invasive plants and discouraging the planting of new invasive plants will help preserve and enhance wildlife habitat within the Town.

Forest pests and diseases.
Pests and diseases have the potential to significantly alter forest plant communities. Chestnut blight eliminated a once abundant tree from regional forests in the early 1900s. Emerald ash borer was first detected in the Midwestern US in 2002; it reached Montgomery Co., MD in 2012, and has since killed millions of ash trees in the region as it has spread. Asian longhorn beetle can kill a wide range of hardwood trees; so far its populations found in NJ, NY, IL, OH, and MA have been eliminated, but it remains a significant concern. Other potentially damaging insects and diseases are spotted lanternfly, thousand canker disease of walnut, and oak wilt, to name a few. Regular monitoring of trees and keeping up-to-date on new pest threats will help to protect the Town's trees.

Construction.
Development often plays a destructive force on individual parcels (private lots) as the activities involved in remodeling and building can damage trees—particularly mature trees—in the following ways:

- Excavation frequently severs tree roots, thereby severely damaging if not killing the tree.
- Typical construction traffic of machinery or activities, as well as storage of heavy construction materials on tree roots, often compacts the soil so much that tree roots cannot respire, and slowly suffocates the tree from the ground up.
- New additions and surface grades change the hydrology of the site, resulting in the decline of the trees' health.

Trees can take as many as three to five years to show the adverse effects of a construction project, which makes it difficult for residents to see the link between construction and tree decline and death.

In addition, ***stormwater*** volumes increase during construction due to the larger footprint of impervious surfaces, and the increased velocity of stormwater runoff leads to soil erosion. Recent County ordinances have helped mitigate some of the construction-related damage and stormwater impacts, but many projects do not require tree protection permits at the county level, so trees remain at risk of severe damage. Mature trees also serve to absorb stormwater and mitigate the erosive power of rain because of their canopy structure, so as trees die or decline from construction related injuries, stormwater-related erosion increases. Some stormwater requirements can exacerbate the risk to trees, if installation of stormwater management systems such as pervious paving, rain gardens, or detention basins are placed in the ***critical root zones*** of established trees.

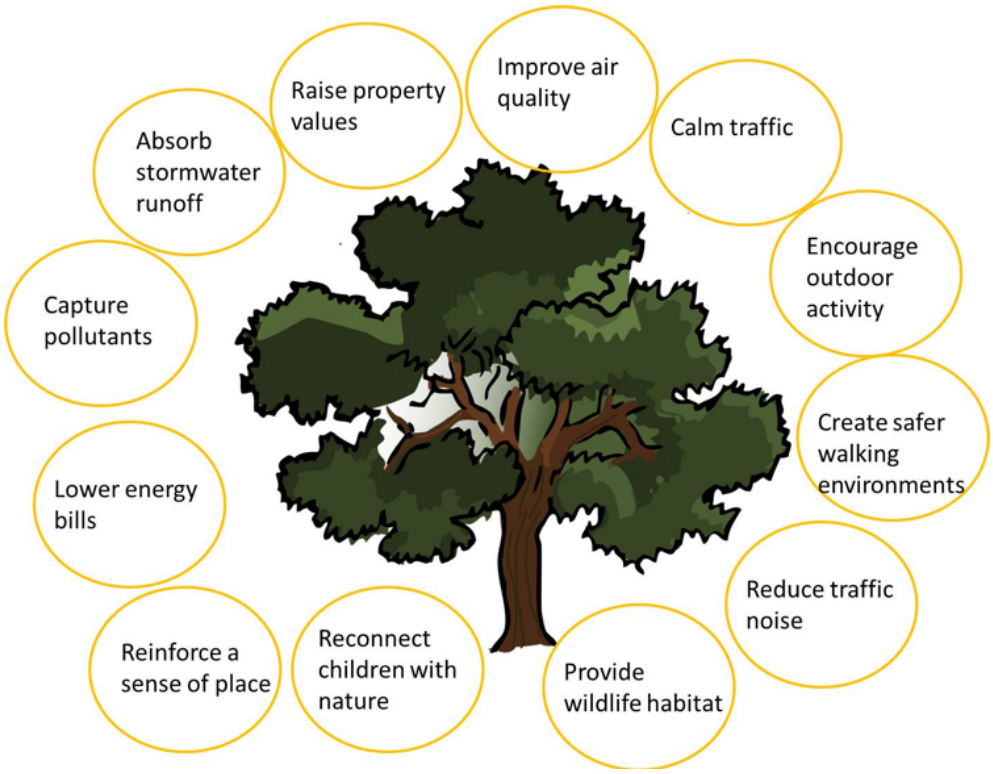
Pollutants.
Pesticides used in surrounding managed landscapes can impact desirable plants and animals. By killing small insects, pesticides reduce food sources for many insectivorous bird and animal species. They can also accumulate in animal diets and cause population declines over time. Herbicides can run off in water and harm plants in urban forests. ***Salts*** used on roadways can wash off and kill trees as well. Reducing the use of pesticides, herbicides, and salts—and using them in a safe manner—will protect trees and wildlife.

Other human activities.
Some forests run the risk of being used to death by people. Trails allow access to woods, but they can also compact soils, increase erosion, and become vectors for invasive plants. Pet waste can introduce diseases, and it increases nitrogen and phosphorous depositions. Regular maintenance of trails and public education will help to preserve Garrett Park's remaining forests.

Benefits of Urban Forests

Trees serve many roles in the environment and provide extensive services to the people that live near them. Ecologically, trees:

A. Filter and clean air and water.
B. Store carbon and release oxygen.
C. Provide shelter and nesting sites for animals.
D. Provide food for wildlife.



The services provided to people in urban and suburban areas include:

A. Providing shade. Shading buildings reduces cooling costs in summer. Street trees and trees in parks can cool the air by several degrees, as well as reduce glare.
B. Providing wind breaks. Wind breaks can reduce heating costs in winter and can reduce wind speeds in open areas.
C. Reducing air pollution. Gaseous pollutants are absorbed into plant leaves. Particulate pollution is trapped by leaves, stems, and twigs, and is then washed to the ground during storms.
D. Reducing noise pollution. Trees absorb and dampen noises in urban environments.
E. Conserving water and improving soils. Tree roots open pores in the soil that allow greater permeability. Their roots hold soil in place, reducing erosion. Many trees associate with mycorrhizal fungi, and together they add nutrients to the soil and aid movement of water and nutrients through the soil.
F. Adding beauty and improving personal health. Trees provide color and texture to the environment and soften harsh edges. They provide security and a sense of privacy. They create relaxation and sense of well-being. A distinctive, heavily- treed environment such as Garrett Park contributes to a "sense of place."
G. Property values. A healthy urban forest has been shown to increase property values by up to 20% (Kane, 2009).

Urban forests have a ***structural value*** based on the trees themselves (e.g., the cost of having to replace a tree with a similar tree); they also have functional values (either positive or negative) based on the functions the trees perform. The structural value of an urban forest tends to increase with a rise in the number and size of healthy trees (Nowak et al 2002a). Annual functional values also tend to increase with increased number and size of healthy trees. Through proper management, urban forest values can be increased; however, the values and benefits also can decrease as the amount of healthy tree cover declines.

Intensively managed town trees in Garrett Park have the following structural values (iTree Eco report, **Appendix B**):

- Structural value: $5.72 million
- Carbon storage: $158 thousand

Urban town trees in Town of Garrett Park have the following annual functional values:

- Carbon sequestration: $3.39 thousand
- Avoided runoff: $2.47 thousand
- Pollution removal: $3.12 thousand

The Comprehensive Arboretum Plan

The Purpose of the Comprehensive Plan

The Garrett Park Comprehensive Arboretum Plan (CAP) – comprising this document and a separate operations manual - establishes policies and procedures for the Town to preserve and enhance its collection, engage the community, and to optimize available resources to achieve a long-term vision for the Arboretum. New plantings have been documented since the 1980s, and an extensive inventory of existing publicly-owned trees in 2018 provides a new reference point for assessing the current status of the collection. This CAP provides standards for those charged with the development and management of the living collections. The Plan includes policies and procedures for tree selection, care, and maintenance; for changes to regulations regarding trees; and for enhancing public engagement.

Implementation and Review of the CAP

The Arboretum and an Arboretum Committee were established in 1977 and formalized within the Town's Code of Ordinances in 1994. The Arboretum Committee members are appointed by the mayor to 5-year terms and the Committee advises the Town Council through the Committee's Council-appointed liaison. Since the mid-1990's, the Town has also regularly engaged the contract services of a Consulting Arborist.

The identification of ***species*** and ***cultivars*** and collection development priorities are the role of the Arboretum Committee in coordination with the Town Arborist and within the policies provided by this CAP. *The Committee will meet at least quarterly to discuss species acquisitions (**accessions**) and removals (**deaccessions**). The Committee advises the Town Manager and Council on implementation of any tree maintenance, plantings, and removals.*

The Arboretum Committee also organizes educational programs and occasionally publishes news about the Arboretum in the Bugle, the town newsletter. The Town Arborist offers seasonal tree walks.

At least once every five years, the Arboretum Committee will review and, as necessary, recommend revisions to the goals, policies, and processes listed in the CAP.

Objectives and Goals for the Tree Collection

The Comprehensive Arboretum Plan (CAP) is driven by key strategic objectives and guiding principles that include ecological, educational, and sustainability goals. The basic goals are to:

- Increase the urban forest's health and resiliency by expanding tree taxa diversity while planning for climate change's effects and challenges.
- Maintain a healthy and resilient tree canopy through a commitment to planting and best management practices to maintain the Arboretum and ensure safety of residents and structures.
- Restore natural forest areas with native plantings and manage invasive plants, deer browsing, and erosion.
- Engage the citizens of Garrett Park in caring for the urban forest.

Tree diversity goals.
An urban forest that enhances the community's aesthetic and ecological appeal for generations to come. Increasing diversity of tree taxa (taxa include genera, species, cultivars and hybrids) is a primary driver in the choice of new accessions for the living collection. The Garrett Park Arboretum founders encouraged tree diversity for the thrill of experiencing trees collected from all over the world. Today we additionally encourage tree diversity to ensure genetic diversity within the forest that can help make the urban forest more resilient to disturbances like insects, diseases, and climactic changes. In addition to genetic diversity, trees should be diverse in age groups and sizes.

Tree maintenance goals.
A plan for regular maintenance and coordination among public agencies, residents, and Town management. Maintaining a healthy forest canopy increases public safety, environmental health, and quality of life. Proper tree care reduces overall costs of managing public trees and allows the town to be proactive rather than reactive in its management.

Restoration goals.
Rebuilding the Town's natural areas to provide a diversity of wildlife habitat and ecosystem services. Restoration goals are directed largely toward the Town's parks and natural areas. Invasive plants should be removed and suitable habitat for native fauna and flora expanded. New trees should be protected from deer browse. Citizens should be encouraged to plant a diversity of native species on their own properties.

Citizen engagement goals.
Engaging citizens in stewardship activities through education and open dialogue. Residents who care about the trees will work to protect them. People who live in Garrett Park likely were drawn to the town in part because of the beauty of a leafy canopy. Educating residents about best management practices for trees will build civic pride along with a healthy urban forest.

Summary of the Current Collection

According to the Town's Arboretum ordinance, "The Arboretum shall consist of all trees, shrubs, woody plants, and other herbaceous material planted or maintained by the Town on any and all public land owned by the Town, including but not limited to such material in parks, playgrounds, rights-of-way, and lands leased by the Town to others, together with such property (whether or not owned by the Town) for which the Town may from time to time have maintenance responsibility." This means that trees on privately owned land are not considered part of the Arboretum collection unless that land is being maintained by the Town.

A tree inventory was conducted by Natural Resources Design, Inc. (NRD) in October – December of 2018. A complete list of species can be found in **Appendix A**.

As part of the inventory, each inventoried tree was examined for structural defects and health concerns; the NRD arborist performed a Level Two Basic Tree Risk Assessment on trees identified as warranting risk assessment. Trees with significant defects were given a risk rating ranging from low to extreme and a priority level, all reflected in the inventory file. Fortunately, there were few trees that pose a high risk, and none that pose an extreme risk of failure.

Urban forest tree canopy. Canopy coverage - the percent of an area that is occupied by a tree's canopy – is the most meaningful metric to characterize an urban forest. Montgomery County has a tree canopy coverage calculator that is based on a LIDAR analysis that was done

in 2014. LIDAR is a remote sensing mapping technology that uses lasers to detect light refraction, and applies an algorithm to translate the data into different ground covering surfaces including trees. NRD did an analysis of a nearby residential area, and the canopy coverage is a much lower, but still robust, 58.3 percent.

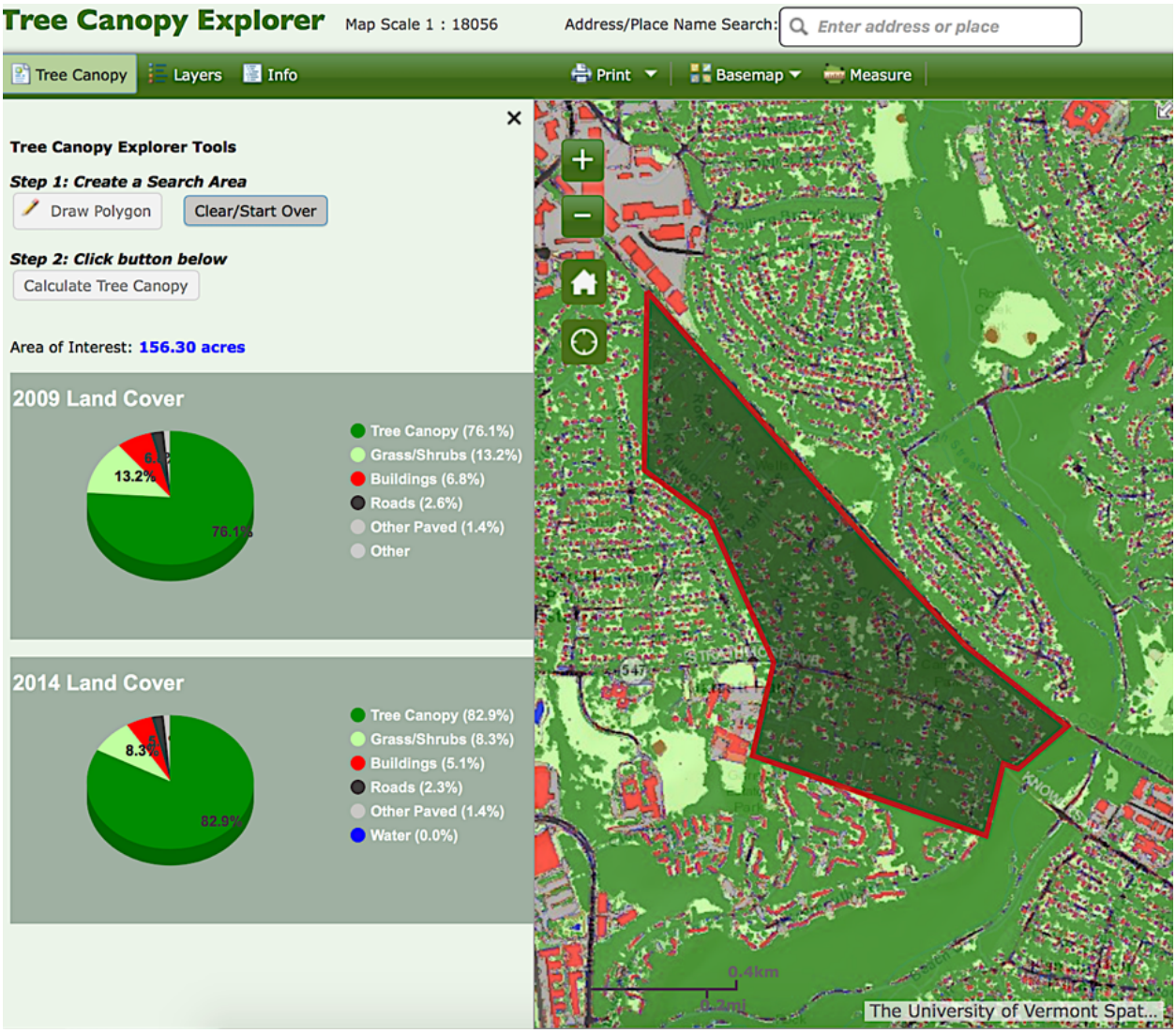


FIGURE 6. A LIDAR ANALYSIS OF THE TREE CANOPY COVERAGE OF GARRETT PARK IN 2009 AND 2014

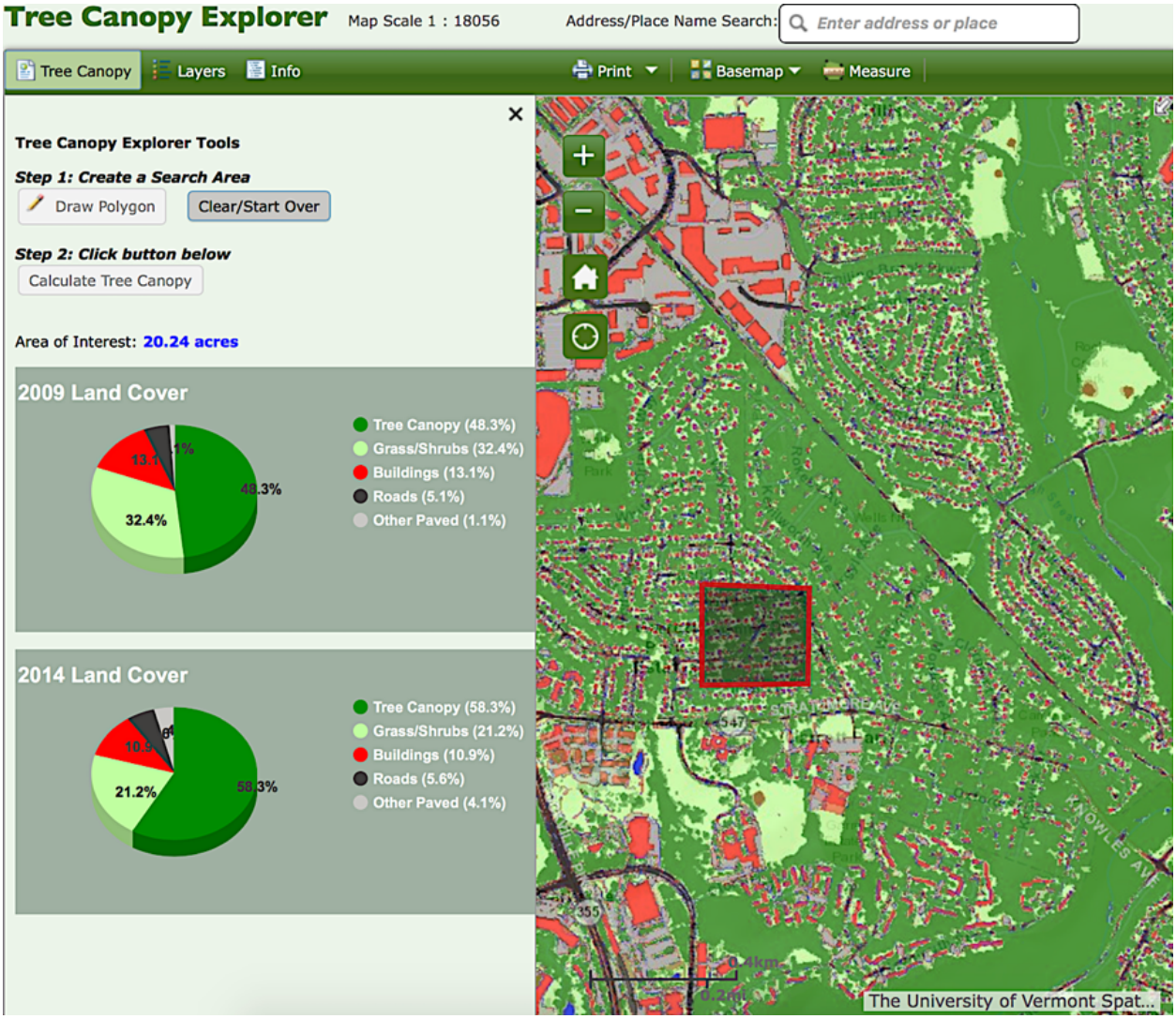


FIGURE 7. A COMPARISON LIDAR ANALYSIS OF TREE CANOPY COVERAGE IN A NEIGHBORHOOD ADJACENT TO GARRETT PARK

For many jurisdictions that study the mapping of their canopy coverage, the focus is on increasing the percent of tree canopy coverage. To do that, planners examine planting opportunities that exist in the "grass and shrubs" category—as it is there that planting spaces are most easily filled. Garrett Park is almost at complete canopy coverage, so there is marginal opportunity to increase canopy coverage. *The goal is to maintain the nearly 83% coverage.* Montgomery County will map its tree resources about every decade, so monitoring the canopy coverage can continue in the future.

Maintaining this level of tree canopy coverage requires the efforts of both the Town and private citizens, as the vast majority of the canopy is on private land. The mature canopy of tulip trees and other large-statured trees such as maples and oaks is a dominant feature of Garrett Park. Large trees can continue to grow and be healthy as well as pose low risk, but trees do not live forever. A percentage of trees will be removed due to health or risk concerns each year, and so to maintain an almost 83% canopy coverage will require a high level of awareness of the value of large-statured ***canopy trees*** and an application of best management practices to maintain mature trees. It is common in the Washington, DC metropolitan area to see large canopy trees

removed, only to be replaced by smaller ornamental trees. Yes, there is a one-to-one tree replacement, but despite its beauty, a redbud or dogwood tree will not produce the legacy of leafy shade canopy that an oak, tulip tree, maple, or other canopy tree will.

This Plan sets out policies aimed at preserving the tree canopy of Garrett Park's urban forest, including tree preservation, best management practices, civic engagement, tree planting, and possible ordinance enhancements.

Species diversity.
Enabled by its complete tree inventory, Garrett Park will manage its trees to ensure species diversity. A ***species*** is the primary taxonomic unit that denotes a group of individual plants that can exchange genes and interbreed, and is given a binomial (two part) name. For example, the flowering dogwood is *Cornus florida* and the Korean dogwood is *Cornus kousa*. An individual of a species will share most aspects with other members of the species, but there is room for each individual plant to respond to its environment so that no two trees of the same species look exactly alike.

Greater species diversity increases the resilience of the tree population in the face of climate change as well as pests and diseases. A pest or disease can manifest extensive damage if a tree community is not diverse—many towns and cities lost virtually all of their street trees when Dutch elm disease killed most of the American elms along their roadways.

Garrett Park, in part because of the long-standing tradition of being an arboretum, has a very diverse street tree population. The most populous species is flowering dogwood (*Cornus florida*) at 7.7%; as noted above, these may have occurred spontaneously or been planted by residents. Other trees with high population numbers are sugar maples (*Acer saccaharum*), (nearly all town-planted) and tulip trees (*Liriodendron tulipfera*) (most native to site). This level of species diversity is a benefit to the town and its residents—there is no single species that, if lost to disease or insects, would result in a large loss of canopy. This diversity ensures that the overall structure and function of the urban forest will remain intact.

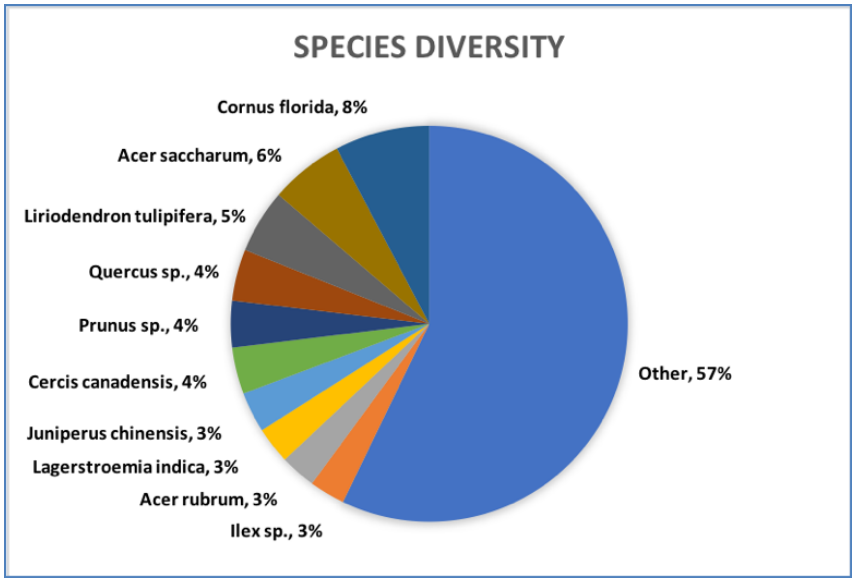


FIGURE 8. SPECIES DIVERSITY OF INVENTORIED TREES AT GARRETT PARK

Genera diversity.
Moving one step up the taxonomic diversity ladder is the ***genus*** *(plural: genera*). Members of the same genus share some taxonomic trait, but the individuals can be broken down into different species. For example, the genus *Cornus* includes the dogwoods—flowering, Korean, pagoda, red-twig—to name a few. Another example are the ashes (*Fraxinus*)—there are green, white, and blue, among others.

Many of the diseases and pests that confront our trees attack all members of a genus. For example, emerald ash borer attacks and kills all ash trees. An emerging discussion focuses on *trying to have genera diversity such that no genus represents more than 5% of a tree community*. If a jurisdiction can achieve that level of diversity, it will be much more resilient to future attacks of pests and diseases.

In the Garrett Park inventory, 17.3% of the trees are in the maple (*Acer*) genus, followed by dogwoods (*Cornus*) and oaks (*Quercus*) at just over 11%. This concentration of maples does constitute a potential threat to the tree population, as Asian longhorn beetle, which has been found (and fortunately eradicated) in several areas of the United States, is a scourge of maples. With global trade, the influx of devastating pests and diseases are unlikely to abate, and there is every indication that trees in the United States will confront imported pests and diseases well into the future. In addition, climate change has already brought about an intrusion of pests that had previously been found only in warmer climates. Since insects are temperature-dependent, warming temperatures will mean insects that previously could not survive DC winters will be able to do so.

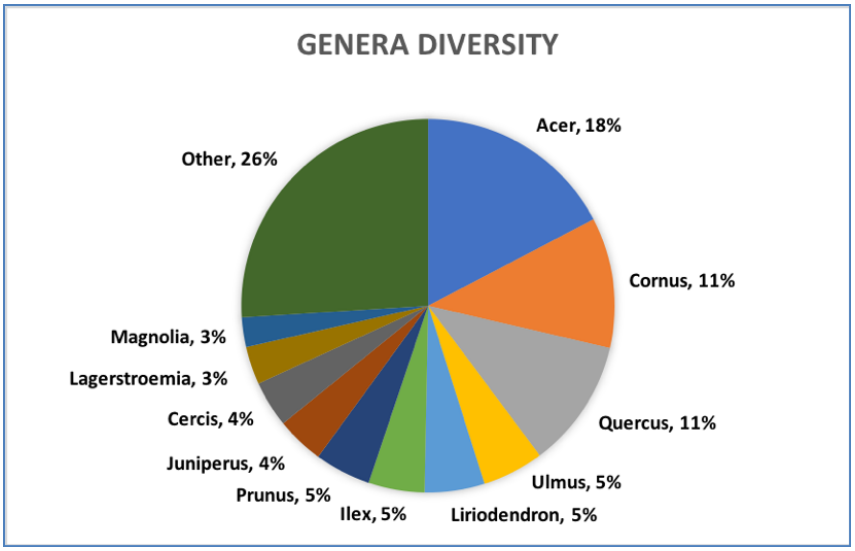


FIGURE 9. GENERA DIVERSITY OF INVENTORIED TREES AT GARRETT PARK

Family diversity.
Garrett Park has a relatively diverse tree population with respect to families. The family with the greatest number (18.45%) is *Sapindaceae,* which is the family that maples are in. This percentage is well below the suggested 30%, and so managing the tree population for genera diversity will also increase the family diversity.

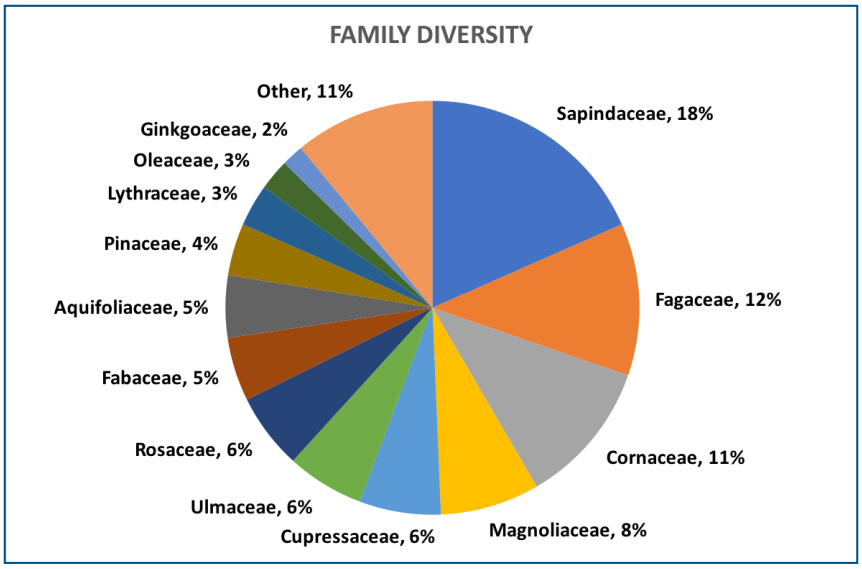


FIGURE 10. FAMILY DIVERSITY OF INVENTORIED TREES AT GARRETT PARK.

General age distribution.
You might think that urban foresters want a tree population of mature trees. While this "single aged stand" of mature trees would be beautiful, there is risk in having all mature or overly mature (so old that the tree starts to decline) trees. As the decades go on, the forest will lose a huge percentage of trees, and with no younger trees to take their place, the canopy coverage decreases. Urban foresters work to ensure there are plenty of young trees in the "pipeline" to be the canopy of the future.

Garrett Park has a lot of mature trees, but also a healthy number of younger (trees with a ***DBH*** less than 12"). The chart below, taken from the ***iTree Eco*** report, shows the size distribution of all the inventoried trees.

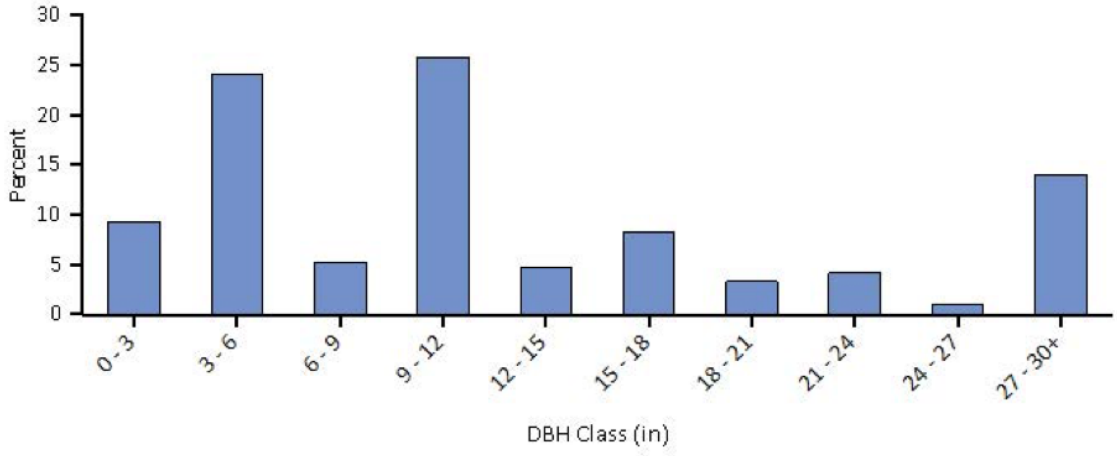


FIGURE 11. PERCENT OF TREE POPULATION BY DIAMETER CLASS (DBH – STEM DIAMETER AT 4.5 FEET)

The above chart is helpful, but a better indication of future canopy and age distribution is to analyze the size distribution of canopy trees—the trees that will become leafy shade in the future. For Garrett Park, there is a nice bell curve of younger trees in the 3" to 15" DBH size range. There is a slight dip in the number of larger trees, and then a large contingent of mature trees. This indicates that, given good care is provided to the largest of the trees, there should be a smooth transition as these "senior citizens" eventually are replaced with younger trees. It does show, too, the importance of keeping as many of the larger trees for as long as reasonably possible, as it takes many decades for a tree to attain mature stature.

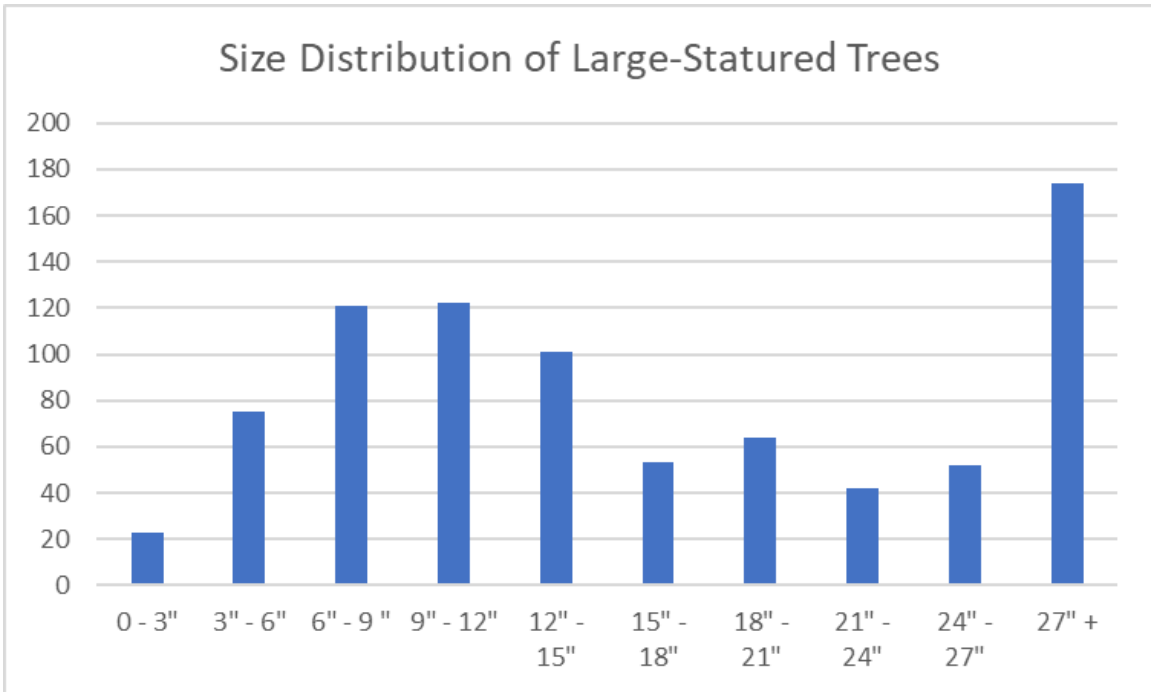


FIGURE 12. THE DISTRIBUTION OF INVENTORIED TREES WITHIN EACH DBH SIZE CLASS

Native/Non-Native/Invasive.
According to the iTree Eco report, almost half of the inventoried trees hail from North America, with 44% of the inventoried trees listed as being native to Maryland. The majority of the non-native trees originate in Asia.

Given that the Town trees are the backbone of the Arboretum, it is appropriate to have both native and non-native trees along the streets. However, two species of the inventoried trees are considered invasive and play a disruptive role in ecosystem benefits: Norway maple (*Acer platanoides*) and Bradford pear (*Pyrus calleryana*). A phased removal plan will be undertaken for long term planning.

Tree Condition.
In general, as of 2018, the condition of the vast majority of the inventoried trees is good. The inventory documented 11 dead trees, 63 trees in poor condition (typically because a higher percentage of deadwood), 168 trees as fair and the balance—1279—as good condition. Typically, trees in the ROW, especially in the tree lawns, have a much harder time thriving—there are so many insults to them: deicing salts, compacted soil, limited soil, mechanical damage and the like. Likely the good condition of most of the trees is due to a greater access

to soil volume for the trees planted in the ROW in front yards, and the relatively wide tree lawns.

Tree Risk Assessment.
One of the most difficult parts of managing an urban forest is deciding when it is time for a tree to be removed. Tree removal is considered when trees are severely damaged, diseased or unsafe. Dead trees are always a candidate for removal unless they are in a natural area like Porcupine Woods and pose no threat to people or property should they fail. In the latter locations, dead trees referred to as ***snags*** increase the overall health of the forest by providing habitat for insects and wildlife.

Tree risk assessment is both science and art—or rather arborists' experience. A licensed arborist will usually serve as risk assessor. They first document the part(s) of the tree that are at the highest risk of failure due to defects or other conditions of concern. Next, they note the likelihood that these part(s) will fail. Then, they note what each tree part would hit should it fail (the "target"). and gauge the likelihood of each part hitting each target. Finally, the consequence of the failure is determined (from minor to severe) and, combined with the likelihood that the tree part will impact a target, a tree risk rating is assigned. Each tree has the problem noted, a recommended action, and a priority level assigned to it (A+ being the highest, and C the lowest).

The tree inventory includes a complete list of trees of concern and their priority rating should it be necessary to mitigate some of the associated tree risk.

The highest tree risk rating is extreme, and this rating would behoove the risk manager (Garrett Park) to move quickly to mitigate the risk by either removing the tree or taking another action (such as pruning or cabling) that would lower the tree risk rating. In the 2018 inventory, no trees were found to be an extreme risk. The next risk level down from extreme is high risk. These trees should be removed within 3 months to a year depending on their rating.

Some of the trees have a priority level of A because there is a dead limb or limbs that could cause significant damage. These trees should be pruned ("crown cleaned") within 6 months. In many cases, there are only one or two dead limbs that need to be pruned out in order to reduce the tree risk rating. Note that there is a category on the ISA Tree Risk Assessment Form for residual risk. This is the risk the tree is expected to pose once the recommended mitigation is complete. No tree is completely without risk—there is always a risk, if remote, that some part could fail, causing damage to a target.

In some cases, a tree will require further tree risk inspection and analysis. Often in these cases there is an issue with access -- either the tree is covered by vines, or the root flare is buried and there could be decay below ground that a Level Two Basic Visual Assessment would not detect. This is where the arborists' senses play an important role.

Trees that have priority B recommendations are assigned a lower priority based on being less likely to fail, or the consequence of failure not being as severe. Trees with a priority rating of C mean that the town has time to build the recommended tasks into a future budget—say within three years—to accomplish the mitigating tasks.

Living Amongst Tulip Trees
Garrett Park, like many formerly farmed areas in Montgomery County, contains an abundance of tulip trees (*Liriodendron tulipifera)* 100 years old or less. In this area, they are the first wave of trees that appear as part of the natural tendency of unmanaged or abandoned lands to

return to forest, and they frequently form pure stands to the exclusion of other tree species. From the beginning, the town was built in this homogeneous sort of forest.

Tulip trees are among the tallest, most majestic of forest trees. In the spring, they are covered with large, beautiful, green-yellow-orange flowers resembling tulips. Many birds and insects feed on the nectar from these flowers, and the trees themselves are hosts to caterpillars of desirable insects such as the Eastern Tiger Swallowtail butterfly. If growing in undisturbed, rich and well-drained soil, the trees thrive and are relatively stable. However, they are not without their faults.

By nature they are soft-wooded, and they produce thick leaves that catch the wind. They are known to occasionally lose large limbs after rain, snow, and wind, even when otherwise perfectly healthy. It is their self-cleaning nature to shed deadwood. Mature tulip trees do not have a taproot, and their extensive root systems can be compromised by compacted soil, construction activities, poor drainage, or uneven rainfall, making them susceptible to uprooting. However, they tend to be stable in undisturbed, well-drained soil.

These characteristics have implications both for managing Town trees and residents' perception of large trees as a whole. In Garrett Park, some street-side tulips were planted a century ago, before heavy traffic and increased stormwater runoff, and prior to the current professional recommendation that tulip trees should not be placed near pavement. Recognizing the problems – and occasional hazards – posed by mature tulips immediately adjacent to roadways and in town-owned parcels such as parks, the Town of Garrett Park has been proactive in the management of street-side tulip poplars, including assessment, monitoring, pruning, and removal where warranted. Going forward, the Town will not plant tulip poplars adjacent to town streets and will continue its elevated level of monitoring and assessment of remaining tulip trees on town property, and provide guidance to residents in managing tulip trees on their own properties.

Planting in the ROW lawns.
One of the features of the intensively managed street trees is that many of them do not grow in traditional ***tree lawns*** (the area between the street and sidewalk; similarly defined in Garrett Park's ordinance as the "planting strip."). Garrett Park's ROW often goes many feet into the front yards of residents. This can present a challenge in that residents view their property as extending to the street or sidewalk and sometimes feel that part of "their" property has been co-opted by the town. Residents may be hesitant to accept a new tree planting, or ignore the town planting guidelines and plant what they want to plant in the ROW. See Recommendations for ways to inform residents and create civic engagement such that some of these issues are addressed and minimized.

Parks. Garrett Park has several parks: town-owned and -maintained parks include Porcupine Woods, Cambria Park, and the park around the Community Center. Manny's Woods is a small area at one end of Cambria Park. Maryland-National Capital Park and Planning Commission (MNCPPC) owns and manages two parks within the Town boundaries: Garrett-Waverly and Wells Parks. Another MNCPPC property, Waverly-Schuylkill Park, lies just across the railroad track.

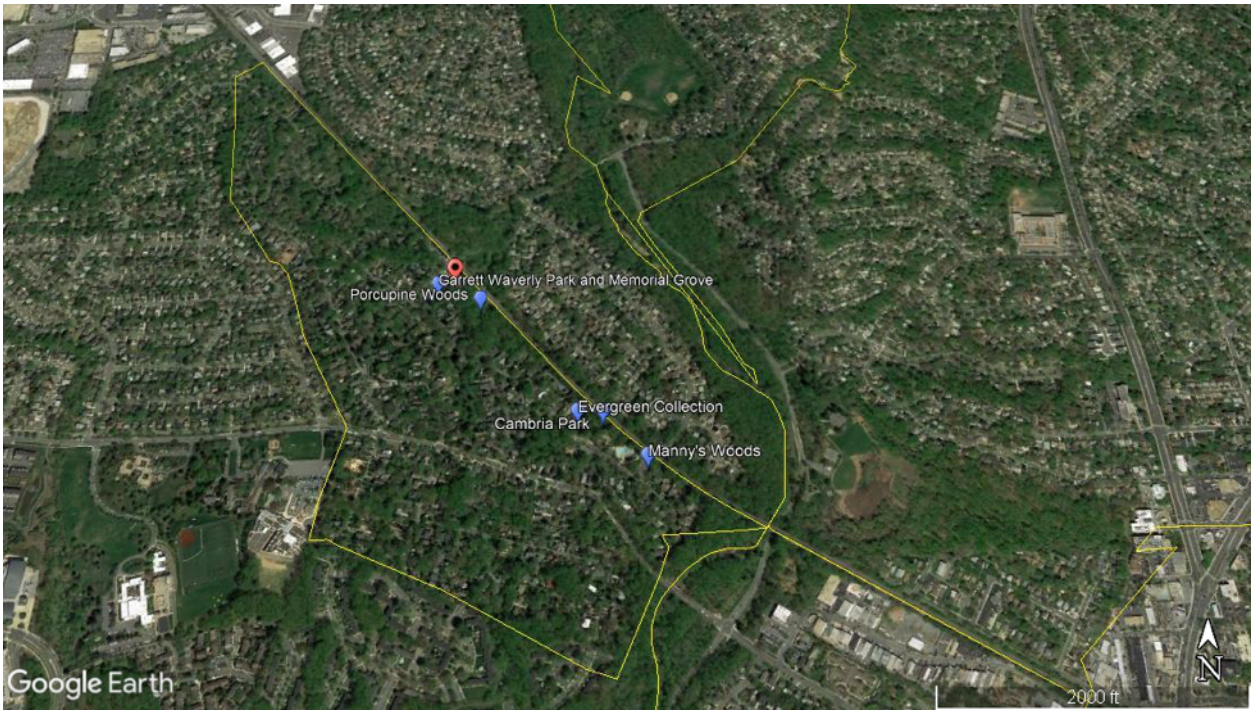


FIGURE 12. TOWN-MANAGED PARKS

Garrett-Waverly Park.
In this park by the Town-owned Penn Place, the Town owns about a quarter of the park (nearest Penn Place) and Montgomery County owns the remainder of the property. The County maintains the tennis courts and is responsible for all major maintenance and capital improvements; pursuant to formal agreement with Montgomery Parks, the Town is responsible for routine maintenance (such as lawn mowing and leaf removal) including routine tree care.

Memorial Grove.
This area is in Garrett-Waverly Park, bordering the intersection of Montrose and Waverly. Under an informal agreement, the Town has planted some trees (constituting the "Memorial Grove") in both town ROW bordering Garrett-Waverly Park and the M-NCPPC parkland immediately adjacent to the ROW and two sides of the tennis courts. Most of the trees are noted in the inventory as memorial trees (Table 1).

TABLE 1. SPECIES IN THE MEMORIAL GROVE AREA.

Species	Common Name	Donor	Memorial information
Hovenia dulcis	Japanese raisin tree	Town Council	In memory of Mrs. Jean Raisen, mother of Councilman Norbert Kraich
Sinojackia rehderiana	Japanese umbrella tree	Town Council	Memorial to honor Warren Johnston
Syringa reticulata	Chinese tree lilac	Town Council	In memory of Kathy Harris Rowley
Euonymus bungeanus	Winterberry euonymus		

Magnolia macrophylla	Bigleaf magnolia		
Diospyros virginiana	Persimmon		
Cornus florida	Flowering dogwood		
Acer palmatum 'Sango Kaku'	Coral bark Japanese maple		In memory of Robert Frost.
Cornus kousa	Kousa dogwood	Barbara and Roger Pope	In memory of Laurie Crichton
Cornus florida 'Pendula'	Weeping Flowering dogwood	Friends of Joan Richards	In memory of Joan Richards
Magnolia kobus var. *loebneri*	Loebner magnolia		
Cercis canadensis	Eastern redbud		
Davidia involucrata	Dove-tree		
Cornus kousa	Kousa dogwood		
Styrax japonicus 'Fragrant Fountain'	Japanese snowbell		In memory of Margaret Human

Cambria Park.
Most of Cambria Park borders the railroad along Cambria Avenue between Keswick and Raleigh Streets. The playground area has 1.5 acres of woods at the corner of Cambria and Keswick. This steeply-sloped wooded area surrounds a depression with a stormwater outlet. The canopy is dominated by tulip trees and oaks, with some beech and black walnut. The woods are heavily invaded by Amur honeysuckle and Italian arum among other plants. Because it is close to the playground, this area should have the invasive shrubs and invasive herbaceous plants removed and be made more inviting as a natural play area. Residents bordering the site should be encouraged to plant non-invasive plants along the park border.

A small strip of trees and a deep ravine lies between the back of Cambria Park's ball field and the railroad embankment. This area is heavily invaded, but it does have some large tulip trees, red maples, and sycamores. This area is within the CSX railroad ROW.

Conifer Collection.
The conifer collection consists of 9 trees at the northern end of Cambria Park (Table 2). All are in good condition.

TABLE 2. LIST OF SPECIES IN THE EVERGREEN COLLECTION IN CAMBRIA PARK.

Species	Common Name
Juniperus chinensis	Chinese juniper
Cedrus deodara	Deodar cedar
Taxodium distichum 'Mickelson'	Bald cypress

Thuja occidentalis 'Douglasii'	Arborvitae
Cryptomeria japonica 'Yoshino'	Japanese cedar
Juniperus sp.	Juniper sp.
Juniperus chinensis 'Robusta Green'	Chinese juniper
Juniperus sp.	Juniper sp.
Metasequoia glyptostroboides	Dawn redwood

Manny's Wood.
Manny's Wood lies at the southern edge of Cambria Park on a disused town road ROW and under the power line. This area is heavily invaded and has few trees. Mile-a-minute, or tearthumb vine, is growing near the corner of the dog park and will be a high priority for removal because of its ability to spread rapidly around the town. Because of the power line, only small trees or shrubs are appropriate for this area.

The dog park next to Manny's Wood was formerly a tennis court. This area has potential for tree plantings to provide shade for residents and their pets. The old court would need to be removed.

Porcupine Woods.
Porcupine Woods is a 2.5 acre mature woodland bordered by the railroad track and running between Clermont Avenue and Penn Place (Post Office). This is the largest forested tract of land owned and managed by the Town. The forest has trees that are likely 80 – 100 years old, with some older specimens as well. It is a mesic floodplain forest dominated by tulip trees. Other canopy tree species include sycamore, black gum, red maple, and black cherry. In the mid-canopy are young beech trees, box elder, and American holly. Spicebush shrubs are common. A mulched path runs the length of the forest, inviting residents to enjoy the shade and beauty of the woods. This woodland could be greatly enhanced by managing invasive plants and stormwater runoff.

The area is a floodplain for a small creek, but the railroad, stormwater drains, and development along the edges has greatly altered the hydrology of the floodplain. With increased runoff during storms, the stream bed has eroded the ground at the southern edge of the woods. The railroad embankment blocks water flow along the eastern edge, although a culvert allows water to flow under the embankment.

The forest contains numerous types of invasive plants, which are mostly woody shrubs and herbaceous plants (Appendix C., Pages 72-73 and 93). Combined with heavy deer browse, these invasives impact the ability of the forest to regenerate, and lower diversity of native understory plants.

Many native plant species could thrive in this habitat. Redbud, *Cercis canadensis* cultivars, and pawpaw, *Asimina triloba* were planted along the path at both ends of the forest within the last 5 years. *In selecting plants for this area, the emphasis will be on selecting native plant species that will add to the diversity of the plant community and provide habitat for wildlife.* A preference for locally sourced, straight species rather than cultivars or plants raised far away is preferred for this area to maintain its natural aspect.

Other town-owned properties

Community Center (4812 Oxford Ave).
This 0.3 acre property lies outside the Town boundary; it is owned by the Town and leased to the Garrett Park Cooperative Nursery School. It contains at least two noteworthy large mature oaks (a willow oak and a sawtooth oak) and several more recently-planted trees. The plantings, together with the rain garden in the rear of the property, afford an opportunity for simple horticultural education for the 2- to 5-year-olds who attend the Nursery School.

Yeandle property (11321 Kenilworth Ave).
This 0.2 acre property, currently a large residential lot, lies within the Town. The property was deeded to the Town with a life-tenancy retained by the donor. At the extinguishing of the life interest, the Town must demolish the residence and replace it with a playground. The remainder of the property, currently covered in a variety of native and invasive plants, will be available for development as a native planting educational site.

Penn Place parking area.
A narrow strip of woods borders the slope above the parking area along Rokeby Avenue across from the MARC train stop. Canopy trees in this area include tulip poplars and oak along with a sugar maple street tree. Numerous sugar maple saplings are in the forest understory. This area is heavily invaded by Norway maple, Amur honeysuckle shrubs, Japanese honeysuckle, and English ivy. Given that this area is viewed by many residents and people visiting Garrett Park, it should be maintained to be an attractive natural area with removal of exotic species, the addition of a chipped-path entry point, and plantings of diverse native shrubs and perennials.

Regulations and Permitting Regarding Tree Planting, Maintenance, and Removal

The Town's ordinances currently address all plants planted or maintained by the town on all public land owned by the town, including parks, playgrounds, rights-of-way, planting strips, lands leased by the town to others, and properties for which the town has maintenance responsibilities. The Town regulates tree planting, maintenance, and removals within planting strips adjacent to residential properties. Requests for any tree-related issue (from residents, the Arboretum Committee, or elsewhere) are funneled to the Town Manager, who consults with the Town Arborist and Arboretum Committee.

Planting Strips.
Section 715 regulates what residents can plant within planting strips. Planting strips are defined as "Planting Strip: areas shall mean those strips of land in Town rights-of-way which are not paved for vehicular use and which lie between the paved portion of said streets and adjacent private property lines." All tree planting, maintenance, and removal within planting strips are the responsibility of the town.

Tree protection.
Section 716 protects all Town-owned trees from injury by people, and requires that anyone who receives a permit from MD DNR to prune or remove a tree notify the Town Manager within 10 days. Any trees removed have to be replaced within six months by a species on the Town's approved tree species list. In addition, Montgomery County requires a tree protection plan for anyone seeking a sediment control permit from Montgomery County for construction.

Utilities and trees (PEPCO).
PEPCO can exercise rights of maintenance of trees within power line ROWs and where trees could interfere with power lines. PEPCO follows ANSI pruning standards and uses certified arborists for tree maintenance work.

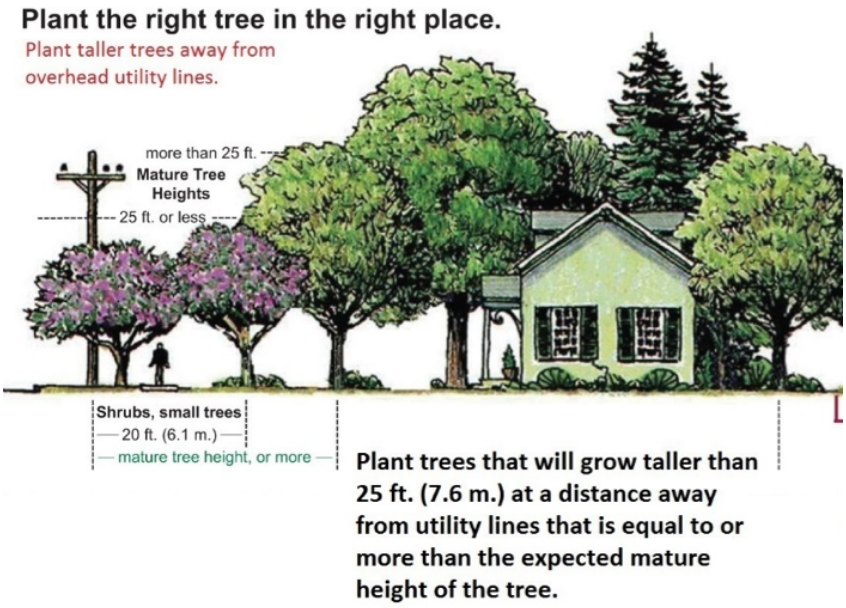


FIGURE 13 PLANTING NEAR POWER LINES
(FROM HTTPS://WWW.PEPCO.COM/SAFETYCOMMUNITY/SAFETY/PAGES/PLANTINGTREES.ASPX)

Roads and trees (SHA, Town of Garrett Park). State highway 547 (Strathmore Avenue/ Knowles) is owned and maintained by the State of Maryland State Highway Administration. Pursuant to agreement with the State Highway Administration, all the trees in State ROW are the responsibility of the Town to maintain. The state also maintains the sidewalks along Rte. 547. There is no Garrett Park ROW on Strathmore. All other streets within the boundaries of Garrett Park are owned and maintained by the Town of Garrett Park. The Town also maintains the paved areas (driveway, parking lot) immediately adjacent to the Community Center, outside the boundaries of the Town.

Historically, the Town has sought to minimize salt use during the winter on its streets. Growing traffic on town streets has made that goal increasingly difficult in recent years. Excessive salting of Route 547 by SHA has been a perennial problem for the Town, with large, interstate-highway-size salting trucks often distributing salt far on to resident's front yards, 15 to 20 feet *beyond* the ROW border.

Sidewalks and trees (Town of Garrett Park).
The Town owns and maintains all sidewalks and trees on public property within the Town of Garrett Park, including trees in ROW planting strips, parks, the Yeandle property, and around public buildings such as Penn Place and Town Hall. The Town also owns and maintains trees and walkways around the Community Center.

Stormwater management (MD DOE). Maryland's efforts to control erosion and runoff may have some significant implications for trees in Garrett Park. In some cases, the development permit may require stormwater management solutions that result in damage to trees. For instance,

a cistern may be required to handle roof runoff stormwater, but the installation of the cistern will be in the critical root zone of a valued tree. Stormwater management facilities can thus be in direct conflict with the long term well-being of mature trees. All stormwater management plans should be reviewed and approved by a certified arborist who has experience with stormwater management.

"'Environmental site design (ESD) means using small-scale stormwater management practices, nonstructural techniques, and better site planning to mimic natural hydrologic runoff characteristics and minimize the impact of land development on water resources." (MDE, 2009).

Invasive plants.
The state of Maryland has listed some ornamental exotic plants as Tier 1 and Tier 2 invasive plants under the Maryland Invasive Plants Prevention and Control Law. Although this list does not currently include any tree species, the list is updated each year and may in future include tree species (https://mda.maryland.gov/plants-pests/Pages/maryland_invasive_plants_prevention_and_control.aspx) (**Appendix C**, Table 2).
Montgomery County Parks has a more comprehensive list of plants it considers invasive, which should be used as guidelines for the Town as well (**Appendix C**, Table 3) (Montgomery Parks, 2019).

Summary of Permits for Homeowners and Contractors Related to Tree Planting, Maintenance, and Removal

State.
The State of Maryland Roadside Tree Law requires that before removing, planting, or trimming any roadside tree in Maryland, the landowner must obtain a Tree Care permit from the Department of Natural Resources Forest Service, and the work must be done by a licensed tree care expert (Maryland Forest Service, 2019). Garrett Park has a blanket permit with DNR allowing the Town to plant, remove, and maintain trees; annual reporting of these activities is required in order to renew the permit.

County.
Building permits are issued by both the Town and by Montgomery County. Montgomery County requires that street trees may not be removed, cut, trimmed, or injured without an additional permit, and that construction staging or storing of materials not be within the critical root zone of any street tree (MoCo DPS, 2019).

Montgomery County (MoCo DEP, 2019) requires any new development (defined by the need to acquire a sediment control permit) to plant shade trees. This requirement includes development that:

- disturbs more than 5,000 square feet of land including cutting trees;
- constructs a new primary residential or commercial building; or
- moves 100 cubic yards or more of earth on or off the property.

If a landowner refuses to or cannot plant a shade tree then a fee of $250 goes to the county to plant a street tree as close as possible to the site.

Montgomery County's Elm Disease ordinance (18-3) applies to Garrett Park allowing the county forester to inspect and remove any trees with Dutch elm disease (http://montgomeryco-md.elaws.us/code/coor_ptii_ch18_sec18-4).

Building permits are issued by both the Town and by Montgomery County. Montgomery County requires that street trees may not be removed, cut, trimmed or injured without an additional permit and that construction staging or storing of materials not be within the critical root zone of any street tree (MoCo DPS, 2019).

Recommendations - Goals and Strategies

Tree Selection and Planting

The process of tree selection involves consideration of both the site and the species. The main goals for enhancing the diversity of the collection are to select species that:

- Increase tree diversity and forest resilience.
- Increase habitat for wildlife.
- Are non-invasive.
- Help to interpret Garrett Park's natural and historical heritage.
- Create education potential.

Increase diversity and resilience.
Aim to have diversity in genera such that no one genus constitutes more than 5% of the total intensively managed trees. New trees should be adapted to a warming climate, and one with variable (and sometimes intense) weather events.

Appended is a table showing the genera inventoried by NRD (**Appendix A**). Seven genera exceed the 5% guideline (*Acer, Cornus, Ilex, Liriodendron, Quercus, Pinus*, and *Ulmus*). We recommend a moratorium on planting these genera, while boosting the numbers of the other genera (except *Fraxinus*, due to Emerald Ash Borer). Several of these under-represented genera are canopy trees, such as horsechestnuts (*Aesculus*), hackberries (*Celtis*), hickories (*Carya*), and plane trees (*Platanus*), to name a few. *Species and varieties should also be selected to take into account insect and disease resistance and structural strength.* (For example, several cultivars of flowering dogwood (*Cornus florida*) display resistance to anthracnose, and several cultivars of American elm have been developed with resistance to Dutch elm disease.) Other insects and diseases to be aware of include emerald ash borer and thousand canker disease of walnuts. These would preclude the planting of any new ash or walnut trees until resistant cultivars are developed or a control is found for these introduced pests. Maryland Extension is the best source of information on current and emerging pest and disease issues affecting ornamental and forest plants (https://mda.maryland.gov/plants-pests/Pages/invasive_species.aspx).

Trees that are known for having structural issues, such as poor branch attachment, will be avoided, and specific trees chosen that have optimal branch attachment. For example, yellowwood is a beautiful native tree, but many young trees have narrow forks that can lead to failure as the tree matures. Choosing the tree at the nursery will help avoid these structural failures.

Wildlife habitat.
The fragmentation of the forest has made it more difficult for our native wildlife to persist because of a loss of food sources, nesting sites, and shelter. This makes it imperative that we manage our remaining forests to support wildlife. Plants are the base of the food chain and native plants support far more insects, birds, and other wildlife than introduced plants (Tallamy, 2007). Oaks, willows, cherries, and birches all support more than 400 species of butterfly and moth caterpillars (Tallamy, 2007). Some animal species specialize to depend on only one or a few plant species, and without those plant species present the animals will cease to exist. For example, the spicebush swallowtail feeds only on paw paw tree leaves.

To as great an extent as possible, Garrett Park's Arboretum will include native plants with value to wildlife.

Invasive plants.
Unfortunately, many introduced ornamental plant species have become invasive. Able to establish and spread rapidly, these plants outcompete native species, alter wildlife habitat, and in some cases pose a threat to infrastructure and human health. Some examples of introduced trees and woody ornamental plants considered invasive in Maryland include Norway maple, tree of heaven, bee bee tree, Amur corktree, white mulberry, Japanese barberry, burning bush, nandina, common privet and Amur honeysuckle. As an Arboretum, the Town should consider following the Invasive Plant Species Codes of Conduct endorsed by the American Public Gardens Association (**Appendix C**.)

The species list could be developed and updated from the Maryland Invasive Species Council list or Montgomery County Parks list (**Appendix C**, Tables 2 and 3). The Town should also refer to the shorter list of plants regulated by the Maryland Department of Agriculture, and review this list annually (MDA, 2019).

The Town will commit to not planting known invasive plant species on Town property. Consideration will be given to regulations that prohibit planting invasive plants on private property.

Interpretation of natural and historical heritage.
Garrett Park is located in the Upland Piedmont ecoregion of Maryland in what was once a vast mixed hardwood and pine forest with smaller areas of successional grasslands and thickets. Oaks and hickories dominated the uplands, and tulip trees, red maples, and sycamore dominated broad creek valleys. These and many other species of trees represent the natural heritage of Garrett Park.

The tree collection should have representatives of the many beautiful and ecologically important trees of the mid-Atlantic Piedmont region.

As noted previously, Garrett Park was designed by the horticulturist William Saunders in the 1890s. He introduced many new plants to the United States through his work at USDA, and he often used those plants in his designs (TCLF, 2018; Kaplan, 2013). Displaying plants from around the world was in general a popular concept in the Victorian era when Garrett Park was founded.

In the spirit of horticultural display, and with a nod to its history, Garrett Park's tree collection should include taxa new to the Horticulture industry, so long as they are not invasive, and trees that might represent those introduced or favored by Saunders such as Japanese cedar, Cryptomeria japonica and magnolias (Kaplan, 2013). Additional plants might be found in his plan for the original National Arboretum (White, 2011).

Some streets highlight certain trees, for example, the 10900 block of Kenilworth and both blocks of Waverly have been planted exclusively in sugar maples since the 19th Century. The Arboretum has adhered to that historic pattern; recognizing that this creates a 'mini-monoculture,' the Arboretum has chosen diverse cultivars, focusing on heat-resistant varieties. More recent examples include Weymouth Street and the 11000 block of Montrose Avenue, where ginkgoes have been planted to deal with challenging sites; and Shelley Court, which has both old and newer cherry trees. Several Shelley Court trees are reaching the end of their lifespan; to maintain the landscape design of the street, as the old trees die they should be

replaced with other cherry tree cultivars. Argyle Avenue features redbuds; again, a mini-monoculture will be alleviated by planting a wide range of varieties.

Education potential. Trees can provide many great lessons on botany, horticulture, ecology, history, and philosophy. As people learn more about the trees in their neighborhood, they will come to care for the trees—not just for their beauty, but for all of the other benefits they provide. Tree talks and walks, tree plantings, and self-guided tours can help to engage residents in learning more about trees.

Selecting a diversity of tree species will provide many opportunities for education.

Guidelines for specific sites.
Not every tree is a good fit for every site. A site assessment should be performed at every site selected for tree planting before choosing a species to plant. Part II of this document includes guidelines for selection of trees for planting strips, parks and forested areas. In addition, the inventory (**Appendix A**) describes the planting area as well as presence of utility lines for each tree and planting site. The Urban Horticulture Institute of Cornell University has several useful resources for tree selection. The first is the site assessment checklist and tree information in *Recommended Urban Trees* (http://woodyplants.cals.cornell.edu/collection/1) and the second is a searchable database of trees and shrubs (http://woodyplants.cals.cornell.edu/plant/search).

Plant canopy trees where the site is appropriate. Plant smaller-statured trees where soil volume is limited or there is an infrastructure conflict.

Garrett Park is graced by a robust urban forest canopy that is among the highest in the area. To continue to have more than 80% tree canopy cover, NRD recommends that the Town commit to planting canopy street trees where the sites permit healthy long-term growth. This means the planting site will have a tree lawn or ROW of at least 5' wide and no overhead utilities or other issues like driveways or fire hydrants. Canopy trees are particularly warranted where the ROW is in a front yard, so the tree will have relatively unrestricted rooting volume to exploit.

Parks – Parks present an opportunity to plant large canopy trees unsuited to smaller spaces, but factors such as foot traffic, mowing, and other park uses can affect species choices.

Forested areas – Forested areas should be planted with species native to the local area. These plants should preferably be sourced from local ecotypes (plants raised from seeds, divisions or cuttings taken from local wild plants), and cultivars of native species should not be planted in natural areas. Natural areas are places where the genetic diversity of existing populations should be encouraged, as local populations may have particular adaptations to the site. Cultivars of native plants may be suited to certain planting areas within parks and planting strips.

Tree dedication guidelines. Dedicatory tree plantings should follow the same selection criteria as outlined in this plan. Discussions of species selection should be held between the giver and the Arboretum Committee, with extensive advisory involvement of the Town's consulting arborist. Specific rules for tree dedication, whether a new planting or designation of an existing specimen, are set out in Part II of this Plan.

Currently the Town acquires many of its trees from the Montgomery County Department of Parks' Pope Farm Nursery.

Care and Maintenance of the Collection

Urban environments are tough on trees, and without proper care and maintenance, the Town's trees will rapidly decline. This section addresses funding for tree care, standards for tree protection, and best management practices for tree care. Specific operating procedures are detailed in Part II.

Funding/budget.
The Town's annual budget includes funding for tree care. Additional sources of funding may come from donations and grants. A list of potential grant opportunities can be found in **Appendix D**.

Dedicate funding for tree planting, pruning, and periodic tree risk assessment.

Garrett Park should build into their budget enough resources to plant new trees as replacement for any removals, and to fill any identified void spaces. The budget should also include a five-year pruning cycle, funds for tree risk mitigation, and a five-year cycle of tree risk assessments and re-inventory work. In addition, there will have to be contingency funds for any storm-related repairs, and an expectation of higher frequency of intense storm events due to a warming climate.

Typically, the year after an inventory and tree risk assessment is more expensive, as more trees are identified as needing removal or risk mitigation.

Garrett Park is extremely fortunate to have Phil Normandy to guide the Town in all tree-related issues. NRD recommends that Mr. Normandy continue as the Town's consulting arborist.

Dedicate funding for a consulting arborist to guide the town through the many known and potential tree-related issues, and to provide education for residents about tree care.

Best Management Practices.
Best management practices for tree care include risk assessment, pruning, and pest management. Public safety, environmental health, and quality of life are all intimately associated with the care of the urban forest. Moreover, proper tree care reduces the overall costs of managing the Town's public trees, including survival and development of newly planted trees, mitigation of insects and diseases, tree pruning, tree removal, and emergency services.

Utilize best management practices when planting new trees, and provide for their after care, structural pruning, and deer protection so the trees establish well and thrive.

Pruning.
The pruning of trees is one of the most essential services the Town can perform. The Town should consider adopting the American National Standards Institute (ANSI) *American National Standard for Tree Care Operations - Tree, Shrub, and Other Woody Plant Management - Standard Practices (Pruning)* standards. Note that these standards are updated every 5 years, so the most recent standard (currently 2017) should always be employed. The standards are used as a tool, recognizing that trees are individually unique in form and structure, and their pruning needs may not always fit strict rules. Any tree care company that is contracted with the Town should also do their work in accordance to the latest ANSI standards of tree care as well as the ANSI Z 133 Safety Standard.

Every contract with a tree care company should stipulate that the company will follow the most recent ANSI A 300 tree care and Z 133 safety standards.

As a rule, the most important pruning events occur the first years after a tree is planted. Prune each newly planted tree to improve structure the year after establishment planting, and every two or three years after, for a total of three pruning events.

Planting and establishment.
The Town, its arboretum committee or consulting arborist are also responsible for the planting and establishment of trees. This requires knowledge of site-specific planting preparation, current professional planting standards, and proper aftercare of young trees. The International Society of Arboriculture publishes guides to the ANSI standards (which can be tough for a layperson to read) called Best Management Practices. The following BMP is for planting: https://wwv.isa-arbor.com/store/product/104/cid/117/. The Town, under the guidance of the arboretum committee, could organize citizen planting days. Community planting events are a great way to build civic pride, educate residents, and have a great time.

Watering is an important aftercare step. Use irrigation bags to provide sufficient water to get the tree roots established. Neighboring residents could be educated about using the irrigation bag and asked to fill them at least once per week for the first two months. The irrigation bags can be re-used for several seasons.

Protection from deer.
Deer browse and deer rubbing can wreak havoc on young trees. Bucks habitually rub the fuzz off their antlers using a young tree, and they can rub the bark off the tree, killing it outright or initiating structural weakness.

Place deer protection around each newly planted tree to shield it from deer. The protection should stay in place until the tree has grown above the graze line.

Protection from invasive vines.
Manage invasive plants, including vines, that threaten the trees. It was clear that there is an ongoing effort to keep vines from growing up the trunks of Garrett Park's intensively managed trees. These efforts should continue, and also residents should be trained on how best to remove vines from trees. If a Tree Stewards group is established, they could work to limit vine growth on the trees, or organize work days under the supervision of the Town Arborist. One suggestion is to use Martin Luther King Jr. Day (commemorating his birthday) as a day of service to the trees. Older children and residents could be encouraged to make a group effort to cut the vines.

Risk Management.
NRD, as part of its inventory, visually assessed each intensively managed public tree for structural defects. The NRD arborist made prioritized recommendations for trees that pose a high risk, and those recommendations are part of the inventory deliverables.
Conditions are always changing for trees, so a tree risk assessment has a "shelf life". In general, it is a good practice to keep an eye out for possible tree defects at all times. *Conduct a Level Two Basic Tree Risk Assessment every five years.* (Note: Some of the assessed trees have a shorter inspection interval.)

No tree risk assessment is ironclad—we cannot see inside trees nor can we anticipate storms, root decay, and the like. A tree risk assessment is a powerful tool, but it is not a perfect tool. Arborists use their knowledge to quickly determine whether a tree has obvious defects that

could pose a risk to people or property. There are certain defects that are not seen until the part fails and the decay reveals itself. Having said that, a tree risk assessment is a prudent way for towns to manage their risk, and Garrett Park should be proud that they took an appropriate step to reduce the risk trees pose to their residents and visitors.

Adopt procedures for tree risk management. The procedures, set out in more detail in Part II of this Plan, involve tree risk assessments, methods to document tree condition and risk, guidelines for timing of removals/pruning, and methods to disseminate tree risk mitigation tasks to residents.

Tree Protection.
Adopt a tree protection plan. The objectives of a Tree Protection Plan are to minimize the impact of construction activities on trees. Construction can cause mechanical injury to roots, trunks and branches; compaction of soil that degrades functioning roots and inhibits the development of new ones; and changes in grade that can cut off or suffocate roots. See **Appendix E** for sample tree protection plans.

Regulations and Permitting

Tree Protection.
Increase the scope of tree ordinances to preserve trees and newly-planted trees, especially with respect to construction and development in the Town. All Town projects should undertake tree protection measures to help mitigate the risk of tree damage/death due to construction.

Ordinances are a means for a town to control what tree species can get planted where, who maintains the trees, whether a tree can be removed, what measures must be taken to protect trees during construction, and the like. They can be effective if they are well-crafted, however, ordinances can have unintended consequences if they are not well-written or are viewed as being too intrusive to residents' rights.

There are neighboring towns (Village of Chevy Chase, Town of Chevy Chase, and Town of Somerset) that have ordinances that regulate privately owned trees above a certain size. This is a good way to maintain canopy coverage, but it means that a jurisdiction prescribes what can and cannot be done on private property, so it is a step that requires much thought and resident input. Some of the towns protect all trees over 4" diameter, while others only protect larger trees, say over 15 or 17" diameter. The smaller the tree that is protected, the larger the role the Town and Town Arborist will play in writing and tracking permits for removal.

For example, the Town of Chevy Chase regulates canopy trees on private property including their removal and any activity that might harm a canopy tree. The Town also offers programs to provide the assistance of a consulting arborist, to plant canopy trees, and to defray the costs of some maintenance of canopy trees on private property (https://www.townofchevychase.org/281/Private-Tree-Programs).

An intermediate step would be to require residents who are seeking a building permit from the town to develop a tree protection plan and take tree protection measures prior to being issued a permit and commencing work (See Tree Protection under Care and Maintenance). Montgomery County already requires these steps if a sediment permit is required. It would not be a huge step to require all construction projects to submit a tree protection plan to the town and have the consulting arborist sign off on the tree protection plan and measures prior to commencing work.

Require all construction projects (except emergencies such as a water main break) to have a tree protection plan in place prior to receiving a building permit.

The tree protection plan submitted to the county, if one is required, is sufficient for the Town's requirement. NRD further recommends that the Town manager upon the advisement by its consulting arborist have the power to inspect a job site for tree protection measures and recommend that the Town shut down the project should there be a deviation from the plan that imperils trees. Furthermore, NRD recommends that should a sediment plan be required, and thus a tree protection plan be required as well, that all projects that excavate soil (and sever roots) be accounted for as a disturbance of the critical root zone. All tree protection plans should have measures in place that protect not only the publicly owned trees, but any tree impacted by construction, including trees whose critical root zone is significantly impacted (including neighboring trees).

Utilities.
Establish an on-going relationship with PEPCO and other infrastructure companies whose work may impact trees. Engage with the consulting arborist of these companies to ensure proper treatment of the trees.

Urban foresters understand the role utility ROW maintenance crews play in a municipality. The utility companies are charged with keeping the power grid safe and stable, and few residents would argue with that. However, residents can be very adversarial with utility tree workers as they don't like their trees being pruned. NRD recommends that the Town staff and Consulting Arborist maintain ties with PEPCO and other infrastructure companies so that they 1) are aware of work scheduled in the area, and its scope; 2) can meet with representatives prior to the commencement of work to plan logistics and specific tree care; and 3) can impress upon the utility representative to bring her or his best crew to do the job. Having clear understandings between the Town and the companies goes a long way to a satisfactory outcome. It also helps alleviate the fears of residents who view utility companies with ire.

Garrett Park could consider adding an ordinance on pruning by public utilities. The following guidelines are adapted from one such ordinance from the Town of Somerset, MD:

> Pruning by Public Utility. A public utility may only prune roadside trees if:
> 1. Said trees are not located on property owned by the Town (including but not limited to Town parks) or on a public ROW adjacent to or adjoining property owned by the Town;
> 2. The utility has obtained and fully complies with a permit issued by the Maryland Department of Natural Resources pursuant to Section 5-406, Natural Resources Article, Annotated Code of Maryland; and
> 3. The utility has given at least two weeks' notice to the Town Manager of its intent to prune specified trees, and included with its notice a copy of the State-issued permit.

Sidewalk installation. **Sidewalks and trees (Town of Garrett Park).**
New sidewalks should include a 5 foot wide tree lawn planting strip if the ROW is wide enough. This spacing provides a setback for sidewalk safety as well as a planting strip wide enough for a ***tree allee,*** which would preserve the historical look of the Town. Narrower planting strips are not sufficient for healthy tree growth (especially large-statured trees). The Town Consulting Arborist should be involved in the planning of any sidewalk installation or major repair, especially if it means cutting tree roots. The Town could consider other approaches, such as root bridges or innovative paving techniques (like rubberized surfaces) that can be used rather than replacing a heaved sidewalk if it is deemed important to do so to avoid severing large tree roots.

Document all tree tasks in the inventory so that it is kept current.
The Town of Garrett Park Arboretum is committed to the maintenance of accurate, up-to-date, and pertinent records on its accessioned living collections. Comprehensive surveys and inventories are crucial to better understanding our forest and how best to care for it over the long term. The current tree inventory exists as an Excel spreadsheet. Additionally, an ArcGIS map shows the location of every tree, along with its details. Each tree has a round aluminum tag nailed to the trunk corresponding with its number in the database.

The tree inventory conducted by NRD involves several deliverables. NRD recommends that the Town, Arboretum Committee, and Consulting Arborist share the Excel spreadsheet so any tree-related task will be recorded on one document. The Town Manager will have the primary responsibility for maintenance of the spreadsheet in one place. The inventory could be put in cloud-based storage so that there is only one version of the document.

The NRD survey provides Garrett Park with an online tree map that can be viewed by the public and updated with new information. This virtual map can also be used to design tree tours available to the public online. Most online databases require some knowledge of ArcGIS, although different programs may offer easy-to-use interfaces.

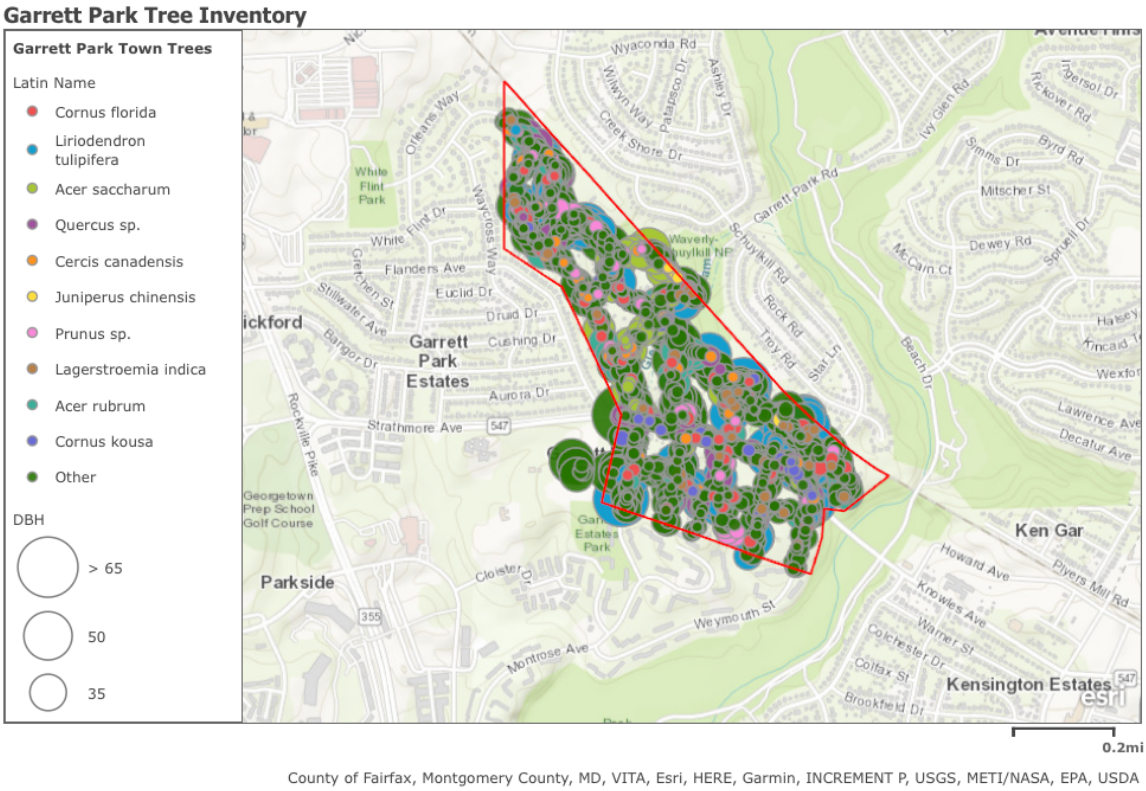


FIGURE 16. IMAGE OF INTERACTIVE ARCGIS MAP PREPARED FOR GARRET PARK SHOWING THE 2018 TREE INVENTORY

City of Baltimore, http://treebaltimore.org/maps/#.XBlo4WhKjIU

Washington DC, https://caseytrees.org/resources-list/d-c-street-trees-map/

Arlington, VA, https://www.urbanforestry.frec.vt.edu/STREETS/reports/ArlingtonReport.pdf

Tree signage.
Each tree has a round aluminum numbered tag corresponding with its number in the database. The round number tags are nailed into the tree leaving space for tree growth or if the tree is small the tags are wired onto a branch. As trees are re-assessed for condition, the nails and wires should be checked to make sure they are still leaving space for tree growth (nails could be checked by volunteers). Round aluminum tags are available from Forestry Suppliers (www.forestry-suppliers.com) among other sources.

In addition, a subset of trees has a rectangular embossed aluminum tag with additional information about the tree. These tags were added 10-20 years ago and have proven difficult to maintain. Rectangular name tags are wired onto branches and could potentially girdle the branches if the wires are not loosened as the tree grows. Town maintenance staff or the consulting arborist should remove the rectangular aluminum tags because they have been replaced by the circular tags.

Often Arboreta use signs placed in the ground at the base of trees or tags nailed or screwed onto tree trunks with springs behind the sign. Both of these techniques require some physical maintenance to either clear around signs placed at ground level or to loosen signs placed on the tree.

FIGURE 4. OLDER SQUARE TAGS AND NEW ROUND NUMBERED TAGS CORRESPOND WITH TREE NUMBERS IN THE EXCEL SPREADSHEET

Recording new plantings.
Any new trees planted will be tagged and entered into the inventory within 2 months. New plantings should include information about the source of the plant, size at planting, date planted, and condition. The Arboretum Committee should determine whether the Arborist or a member of the Committee will be in charge of data entry. Any additions or changes need to be relayed to the Town Manager for safekeeping.

Future tree inventories and mapping.
Most arboreta keep records of routine maintenance done on individual accessions. It would be the Town Arborist's responsibility to note which trees were being maintained and by whom. Any inspections of tree condition conducted by the Town Arborist should also be entered into

the database. *Future complete tree inventories and risk assessments should be scheduled every 5 years, and appropriate additions and edits to the Inventory undertaken soon thereafter.*

Additional inventory and mapping of trees within the Town's forested areas could give a more accurate assessment of the health of these natural areas, and what steps might be needed to restore them.

Public Education and Outreach

The residents of Garrett Park are the ones who see and enjoy the benefits of the trees every day. Many trees live on private property outside the jurisdiction of the Town. If residents do not care about the trees, then there will be little incentive for residents to maintain their own trees or for the Town to maintain public trees. The Town needs interested, motivated citizens to continue to improve its urban forest and maintain the town's historic tree legacy. To keep the community engaged, education and outreach programs offer new insight and information that will lead to better stewardship.

Educate residents about the need for diverse taxa in their home landscapes, how stormwater management affects trees, and what effects climate change will have on the health of their home landscapes. Residents may have some hesitancy about welcoming unfamiliar trees to their streetscapes. However, we recommend that the Town, Arboretum Committee, and Consulting Arborist work together to educate residents on the need for a resilient tree population and why this goal is so important. The task should be easier in Garrett Park than in other municipalities because of the Town's longstanding commitment to being an arboretum, not locked into the typical street tree plantings recommended by the county.

In addition, residents should have opportunities to learn about climate change, such as hardiness zones shifting northward, warmer winters, much warmer summer evenings, and changes in the frequency and intensity of storms will continue to affect the urban forest and ornamental landscapes. If residents understand the role they can play in mitigating some effects of climate change, the environment will be enhanced and civic pride will grow. With individual and collective effort, residents will share a common vision and knowledge of how their properties can be an agent for good in the onslaught of climate-related changes.

Educate the public about tree care issues, including tree pests and diseases and their management. NRD recommends that the Arboretum Committee serve as the lead for educating residents of Garrett Park about tree-related topics and concerns. This could be in the form of a monthly column in the newsletter, continued tree walks (but with a new focus on urban forest benefits and best management practices), Citizen Pruners, and talks given by the consulting arborist and other experts. Master Gardeners who live in Garrett Park might also be willing to hold workshops on planting, pest identification and management, and the like.

The Arboretum Committee should also ensure that there are up-to-date resources in the library and ways for residents to get research-based information about trees and the landscape. Montgomery County Master Gardeners run Plant Clinics on a regular basis, and can be a wonderful, free resource for Garrett Park residents.
http://extension.umd.edu//mg/locations/plant-clinics

The Arboretum Committee offers programs on trees and tree walks. They also publish articles in the local e-newsletter. Other groups that could be involved in educational programs include garden clubs, MD Master Gardeners and Master Naturalists, Montgomery County Weed Warriors, the Maryland Native Plant Society, and the Montgomery Bird Club.

Additional suggestions for outreach include:

- Developing self-guided tree walks
  - http://www.lakecoleridgenz.info/uploads/9/0/4/8/90486139/tree_trail_-_hart_arboretum_self-guided_walk_website_version.pdf
  - https://www.du.edu/arboretum/media/documents/treewalkguideprint2014.pdf
- Publishing a list of recommended trees and shrubs for planting
- Holding an Arbor Day event at the Elementary School
- Hosting Weed Warrior invasive plant removal workshops
  - https://www.montgomeryparks.org/caring-for-our-parks/natural-spaces/weed-warriors/

Additionally, engaging volunteers to help with and to record natural history observations will serve to motivate long-term care for the urban forest.

Tree Steward Programs
Citizen Pruners (NY): https://treesny.org/citizen-pruners-stewardship/citizen-pruner-course/
Tree Stewards (VA): http://www.treesvirginia.org/outreach/tree-stewards
Tree Keepers (Baltimore): http://treebaltimore.org/programs/treekeepers/#.XCzlqVxKjIU

Citizen Science Projects
Cornell's eBird: https://ebird.org/home
iNaturalist: https://www.inaturalist.org/
National Phenology Network: https://www.usanpn.org/usa-national-phenology-network

Long Term Goals and Plans

The Town of Garrett Park strives to maintain the health and resilience of its urban canopy. The following table shows different performance indicators to meet the town's goals and how far along the town is towards meeting different goals. This table should be reviewed annually to assess the Town's progress towards meeting its goals.

The Town of Garrett Park should consider becoming a TreeCity USA through a program administered by the Arbor Day Foundation. The four criteria for achieving this designation are, maintaining a tree board or department, having a community tree ordinance, spending at least $2 per capita on urban forestry and celebrating Arbor Day (https://www.arborday.org/programs/treecityusa/).

The Town should also apply for accreditation as an Arboretum through ArbNet, a program administered by the Morton Arboretum. This program establishes a set of industry standards for arboreta and serves as a way of unifying the community of arboreta. The program is free and requires self-assessment and documentation of standards that include planning, governance, number of species, staff or volunteer support, education and public programming, and tree science research and conservation. (http://arbnet.org/arboretum-accreditation-program).

Many arboreta are also members of the American Public Gardens Association (https://www.publicgardens.org/), an organization that provides professional training and networking opportunities for public gardens professionals.

RECOMMENDATIONS

Summary of Goals and Strategies

Goal: Increase the urban forest's health and resiliency by expanding tree taxa diversity while planning for climate change's effects and challenges

1. Aim to have diversity in genera such that no one genus constitutes more than 5% of the total intensively managed trees. New trees should be adapted to a warming climate, and one with variable (and sometimes intense) weather events.
2. Select species that are non-invasive and include many native species to increase wildlife habitat and overall species diversity.
3. Select species and varieties to take into account insect and disease resistance and structural strength.
4. Maintain a diverse age and size distribution of trees.
5. Educate residents about the need for diverse taxa in their home landscapes, how stormwater management affects trees, and what effects climate change will have on the health of their home landscapes.

Goal: Maintain the Arboretum's healthy and resilient tree canopy through a commitment to planting and best management practices.

1. Plant canopy trees where the site is appropriate. Plant smaller-statured trees where soil volume is limited or there is an infrastructure conflict. Do not plant invasive species.
2. Utilize best management practices when planting new trees. Provide for their after care, structural pruning, and deer protection so the trees establish well and thrive.
3. Utilize a risk management plan, and conduct regular tree risk assessments of the intensively managed trees.
4. Increase the scope of tree ordinances to preserve trees and plant new trees, especially with respect to construction and development in the Town.
5. Dedicate funding for a consulting arborist to guide the town through the many known and potential tree-related issues, and to provide education for residents about tree care.
6. Dedicate funding for tree planting, pruning, and periodic tree risk assessment.
7. Document all tree tasks in the inventory so that it is kept current.
8. Educate the public about tree care issues, including tree pests and diseases and their management.
9. Manage invasive plants, such as vines, that threaten the trees.
10. Establish an on-going relationship with PEPCO and other infrastructure companies whose work may impact trees. Engage the consulting arborist with these companies to ensure proper treatment of the trees.

Goal: Restore natural forest areas with native plantings and manage invasive plants, deer browsing, and erosion.

1. Inventory natural areas to determine what species are present. Use citizen scientists to enhance data collection.
2. Develop a natural areas management plan that covers invasive plant control, restoration plantings, trail maintenance, and erosion control.
3. Plant only native species within the natural areas to maximize wildlife habitat.
4. Prohibit planting invasive plants on Town property. The Town should consider an ordinance that forbids planting invasive plant species on private property.

Goal: Engage the citizens of Garrett Park in planting and caring for the urban forest

1. Encourage citizen science in the natural areas to track bird sightings, identify other animals and plants, and to engage the community in caring about the natural areas.

2. Hold a tree planting event where citizens' or children's groups can participate in tree planting.
3. Hold educational walks focusing on the benefits of the urban tree canopy, how stormwater management affects trees, and what effects climate change will have on the health of their home landscapes.
4. Provide educational materials on tree care issues, problems with invasive plants, and the need for diverse taxa in home landscapes.

Urban Forest Criteria and Performance Indicators Matrix

The following pages have an urban forest criteria matrix that was created for the Town, Arboretum Committee, and consulting arborist to use as a "yardstick" to measure progress in the urban forest. The criteria follow the goals of the Comprehensive Arboretum plan.

For each criterion, there is a range of performance indicators, from a low level of performance to optimal. NRD has shaded in the performance level we know, or believe, Garrett Park has achieved. Some of the criteria have no shading. This is because we at NRD are not aware of where Garrett Park lies on the continuum, and we hope the Town, Arboretum Committee, and consulting arborist can work together to determine where the town is on these criteria.

This matrix is a useful tool for creating action items to directly address issues in the urban forest and to track progress. NRD hopes that this matrix, along with the current Comprehensive Arboretum Plan, will guide Garrett Park well into the future.

Criteria	Performance Indicator Ratings				Objective	Recommendations
	Low	Moderate	Good	Optimal		
Tree canopy, diversity and suitability						
Urban forest canopy cover (categories from Montgomery County)	Existing canopy cover < 38%	Existing canopy cover = 38–52%	Existing canopy cover =53–66%	Existing canopy cover = 67–83%	Achieve climate-appropriate amount of tree cover, community wide.	Canopy cover in Garrett Park is exemplary continue to enhance and maintain canopy cover through management and ordinances
Species distribution of intensively managed trees	≤5 species dominate town tree population	No species >20% of town tree population	No species >10% of town tree population	No species >5% of town tree population	Species distribution of town trees is varied	Avoid the use of species that are overly represented and continue to plant a diversity of species
Genera distribution of intensively managed trees	No genera of town trees exceeds 30% of total population	No genera of town trees exceeds 20% of total population	No genera of town trees exceeds 10% of total population	No genera of town trees exceeds 5% of total population	Genera distribution of town trees is diverse	Avoid the use of genera that are overly represented and continue to plant a diversity of genera
Family distribution of intensively managed trees	No family of town trees exceeds 50% of total population	No genera of town trees exceeds 40% of total population	No genera of town trees exceeds 30% of total population	No genera of town trees exceeds 20% of total population	Family distribution of town trees is diverse	Family diversity is optimal and will likely continue to be if genera diversity is followed
Species suitability for the	<50% suitable species	50 to 70% of species	Greater than 75% of species	100% of species are	Species suitability	All species are suited to the

Criteria	Performance Indicator Ratings				Objective	Recommendations
	Low	Moderate	Good	Optimal		
current climate of intensively managed trees		are suitable to area	are suitable to area	suitable to area	for the area	current climate
Intensively managed trees tree age distribution of canopy-sized trees (e.g. oaks, maples, tulip trees)	Unbalanced canopy-sized tree population (most trees are in one size range), no new canopy trees planted	Unbalanced canopy-sized tree population, but new canopy trees are being planted in suitable sites	Somewhat balanced canopy-sized tree population (sizes range from small, young trees, middle aged trees and older, large diameter trees), and new canopy trees are being planted in suitable sites	Balanced canopy-size tree population and new canopy trees are being planted in suitable sites. As the trees mature (and die) there are plenty of younger trees to take their place in the canopy.	Provide for uneven-aged distribution throughout the town of canopy-sized trees.	Put in place/enforce ordinances and management to protect all the trees, especially the largest ones; plant canopy trees wherever there is sufficient rooting volume and no utility conflicts
Town Management of Intensively Managed Trees						
Tree inventory and canopy cover	No inventory	Complete or sample-based inventory of intensively managed trees • Recently completed street tree inventory • No inventory of other publicly	Complete inventory of intensively managed trees	Complete inventory of intensively managed trees and urban tree canopy cover analysis included in town-wide GIS	Develop a complete inventory of intensively managed trees to direct their management, including species mix, tree condition, and risk	Garrett Park will have a current tree inventory of the intensively managed trees and canopy cover analysis.

Criteria	Performance Indicator Ratings				Objective	Recommendations
	Low	Moderate	Good	Optimal		
		owned trees • Difficulty in maintaining up-to-date GIS data			assessment. Tree inventory will be on town-wide GIS and data on each inventoried tree will help in tree management	
Tree Risk and Health Condition of intensively managed trees are systematically assessed	No tree maintenance or risk assessment • Request based, reactive system • Urban forest condition unknown	Town collects resident-driven information on trees at high risk	Complete tree inventory of intensively managed trees that includes detailed tree condition ratings	Complete tree inventory of intensively managed trees that includes detailed tree condition and risk ratings for trees with significant visible structural defects. Re-assess every 5 years	Compile a detailed understanding of the condition and risk potential of all publicly owned trees (both intensively managed and natural area trees	Garrett Park will have a complete tree risk assessment so that risk mitigation can be planned and executed
Town wide management plan	No plan	Existing plan limited in scope and implementation	Comprehensive plan for publicly owned intensively managed trees is accepted and implemented	Strategic multitiered plan for the trees in the urban forest accepted and implemented with adaptive management mechanisms	Develop and implement a comprehensive urban forest management plan for private	The CAP will be adopted by the town and used to maximize the benefits of the urban forest.

Criteria	Performance Indicator Ratings				Objective	Recommendations
	Low	Moderate	Good	Optimal		
					and public property	
Maintenance of intensively managed trees	No maintenance	• Maintained on a request/reactive basis • No systematic (block) pruning	All trees systematically maintained on a cycle >5 years (Newly planted trees are watered.)	All mature trees maintained on 5-year cycle All immature trees structurally pruned at least twice in their early years	Plant and maintain all intensively managed trees to maximize current and future benefits. Tree health and condition ensure maximum longevity	
Tree risk management of publicly owned trees	No tree risk assessment / remediation program • Request based/reactive system • Condition of the urban forest is unknown	Sample-based tree inventory including general tree risk information Request-based, reactive risk abatement program system	Complete tree inventory of intensively managed trees that includes detailed tree failure risk ratings for trees judged to be at high risk of failure. Program to address the high risk trees within one year, and extreme risk trees	Complete tree inventory of intensively managed trees that includes detailed tree failure risk ratings for trees judged to be at high risk of failure. Risk abatement program in effect Eliminating high risk hazards within 6 months, or within one month of a tree extreme	All publicly owned trees are managed to reduce risk to property and residents.	The town should adopt the CAP and its recommendations for risk mitigation

Criteria	Performance Indicator Ratings				Objective	Recommendations
	Low	Moderate	Good	Optimal		
			within one month. Natural area trees are included in the risk management	risk of failure. Natural area trees are included in the risk management		
Tree establishment planning and implementation	Ad hoc distribution objectives.	Occurs on an annual basis, not based on analysis of needs from a tree inventory	Directed by needs derived from a tree inventory	Directed by needs derived from a tree inventory and is designed to meet canopy cover objectives and species planted are suitable for climate change and shifting hardiness zones	Ensure urban forest renewal through a comprehensive tree establishment program driven by canopy cover, species diversity, and wildlife value.	Tree species selections should aim to increase canopy coverage where suitable; increase diversity of species, genera and family and increase wildlife value.
Tree habitat suitability	Trees planted without consideration of the site conditions	Tree species considered in planting site selection	Community-wide guidelines in place to improve planting sites and select suitable species (The town has suggested species lists, but even at the town hall,	All trees planted in sites with adequate soil quality, quantity, and growing space to achieve their genetic potential	Plant all publicly owned trees in habitats that will maximize current and future benefits provided to the site.	Best management practices should be used to improve transplant success, avoid deer damage, and be planted in sufficient rooting volume to support excellent growth

Criteria	Performance Indicator Ratings				Objective	Recommendations
	Low	Moderate	Good	Optimal		
			there were invasive species used as shrubs.)			
Municipality-wide funding	Funding for reactive management	Funding to optimize existing urban forest	Funding to provide for net increase in urban forest benefits	Adequate public funding to sustain maximum urban forest benefits	Develop and maintain adequate funding to implement a town wide urban forest management plan/CAP.	
Knowledge of tree-related issues amongst town staff	No knowledge of how town projects or tree work in town staff	Some level of understanding of how town projects might impact trees; no technical guidance available	Ad hoc use of consulting arborist or tree care professional; working knowledge of how town projects impact trees	Consulting arborist is either on staff or under contract and has a fiduciary responsibility to protect the interests of the town and trees, works to educate all staff about the needs and care of trees	Town staff understands the role of trees in a community and has the knowledge base to make informed decisions about town projects to minimize damage to trees and maximize their contribution and health	
Public agency	Conflicting goals	Common goals but no	Informal teams	Municipal policy	Insure all town	

Criteria	Performance Indicator Ratings				Objective	Recommendations
	Low	**Moderate**	**Good**	**Optimal**		
cooperation	among departments	cooperation among departments	among departments implementing common goals on a project-specific basis	implemented by formal interdepartmental working teams on all municipal projects	departments cooperate with common goals and objectives.	
Tree protection policy development, ordinances, and enforcement	No tree protection	Minimal policies in place to protect intensively managed trees with inconsistent enforcement	Comprehensive policies in place to protect publicly owned trees and enforcement is consistent	Integrated municipality-wide policies that ensure the protection of trees of publicly owned trees are consistently enforced and supported by significant deterrents. Efforts are made in the design and permitting stage to avoid tree damage. Privately owned trees are subject to tree protection ordinances and enforcement.	The benefits derived from large-stature trees are ensured by the enforcement of municipality-wide policies	
Natural area management						
Inventory of publicly	Limited or no	Identified in a “natural	Plant communiti	Ecological structure and	Develop a detailed	Complete inventory and

Criteria	Performance Indicator Ratings				Objective	Recommendations
	Low	**Moderate**	**Good**	**Optimal**		
owned natural areas	information available	areas survey" or similar document	es identified, invasive plants noted, condition assessed	function documented and included in the town-wide GIS	understanding of the ecological structure and function of all publicly owned natural areas.	mapping of natural areas that includes the plant communities present and threats to ecosystem health
Native vegetation	No program of integration	Voluntary use of native species on public lands • Invasive species recognized	Use of native species encouraged on a project appropriate basis in both intensively and extensively managed areas • Invasive species recognized, use discouraged	•Native species required on project appropriate basis in both intensively and extensively managed areas. •Invasive species recognized and prohibited.	Preserve and enhance local natural biodiversity	Institute a policy of using locally collected native plant species (not cultivars) within natural areas
Publicly owned natural areas management planning and implementation	No stewardship plans or implementation in effect	Reactionary stewardship in effect to facilitate public use (e.g., hazard abatement, trail maintenance)	Stewardship plan in effect for each publicly owned natural area to facilitate public use (e.g. hazard abatement, trail	Stewardship plan in effect for each publicly owned natural area focused on sustaining the ecological structure and function of the feature including invasive	The ecological structure and function of all publicly owned natural areas are protected and, where appropriate, enhanced	Develop a stewardship plan for the natural areas that includes planting plans, invasive plant control, and erosion control.

Criteria	Performance Indicator Ratings				Objective	Recommendations
	Low	**Moderate**	**Good**	**Optimal**		
			maintenance)	species control and erosion control.		
Community Awareness and Engagement						
General awareness of trees in the community resource (Anecdotal information; no opinion survey data available)	Trees seen as a problem/drain on budget	Trees seen as important to the community	Trees seen as providing specific and quantifiable environmental, social, and economic services	Urban forest recognized as vital and integral to the community's environmental, social, and economic well-being	The general public understands the role of the urban forest in a community	Keep records of public comments regarding trees and landscaping within the community
Residents play an active role in maintaining and preserving town trees	No interaction with residents	Ad hoc resident participation in maintaining and planning	Residents serve on tree committees and do some tasks to help trees	Trained residents perform arboricultural tasks and play an active role in planning and oversight of the town trees; residents educate others in the value of town and privately owned trees; residents build civic pride in their town	Residents work together to assist the town in maintaining and preserving town trees	Develop a tree care training program for volunteers. Some of the tasks a trained cohort of residents could do are: removing vines from trees, doing structural pruning of young trees, monitoring newly planted trees, educating residents on the care of trees, carrying out Arbor Day

Criteria	Performance Indicator Ratings				Objective	Recommendations
	Low	Moderate	Good	Optimal		
						events, and providing committee support to the town
Community tree education	No education available	Signs on trees, Arboretum web page on town website	Regular guided walks, educational materials available online	Interactive map on web site, educational materials easily available, guided activities regularly offered	Develop an educated citizenry who care about trees and the Town's arboretum	Make the interactive map available online and enhance the Arboretum web page to include educational materials and self-guided walks.
Involvement of town residents in tree management goals to enhance the privately owned trees in Garrett Park	Ignorance of issues • No proactive approach for private tree management	Educational materials available to residents, Town Arborist available to provide limited advice	Residents understand the need for research-based tree management practices on their properties, Town Arborist available to provide limited advice	Residents work to develop and follow best management practices on their private properties Incentives for preservation of private trees Town Arborist available to provide limited advice	Residents embrace town-wide goals and objectives through specific resource management plans.	Consider offering incentives for tree care and potential availability of Town Arborist to answer tree care questions.

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Glossary

Accession A new item (in this case a tree) added to a collection, or the act of adding a new item to a collection**.**

ANSI A300 Standards American National Standards Institute standards for the Tree Care Industry Association. Consensus performance standards based on current research and sound practice for writing specifications to manage trees, shrubs, and other woody plants.

Canopy tree A tree that will, when mature, have a medium to large-sized canopy, both in height and canopy spread. Typical canopy tree species include: oaks, maples, tulip trees.

Certified Arborist identifies professional arborists who have a minimum of three years' full-time experience working in the professional tree care industry and who have passed an extensive examination Certification is issued by the ISA (International Society of Arboriculture).

Critical Root Zone (CRZ) Typically, the Critical Root Zone of a tree is a radius from the trunk of the tree out at a distance that is 1' radius for each 1 to 1.5" of diameter (DBH). The greater the area of the CRZ that is protected during construction, the greater the chance the tree has to survive the construction. A general rule is that you do not want to impact more than 1/3rd of the CRZ during a construction project.

Cultivar A plant variety that has been produced in cultivation by selective breeding. A cultivar is usually a distinct genetic selection, and every individual within the cultivar is genetically identical.

DBH (diameter at breast height) The diameter of trees is typically measured at the standard height of 54" above the ground. There are other variations, but basically, DBH indicates diameter of the tree's trunk.

Deaccession Removal of an item from a collection. In the case of a tree planted at an Arboretum, the plant may have died or been removed. Usually the database will still contain a record of the plant even after deaccessioning for historical purposes.

Ecoregion A major ecosystem defined by distinctive geography and receiving uniform solar radiation and moisture.

Ecosystem services An ecosystem service is any positive benefit that ecosystems provide to people. Forests provision us with food, fuel, and clean water. They regulate climate, store carbon, and clean air. They support natural services such as photosynthesis, the creation of soil, and nutrient and water cycling.

Fragmentation Division of a once contiguous land use type into pieces separated by different land use types.

Intensively managed trees Those trees in which the town plays an important role in managing—both the street ROW trees, as well as those trees growing in a natural area like a park, but the park contains a feature such as a ball field or playground that elevates the need for the town to actively manage the surrounding trees for risk. For example, a large dead limb would be removed if it were an intensively managed tree, but allowed to rot and fall if it were a natural area tree.

Invasive plant plants that have been introduced outside of their native range that establish and spread rapidly. Invasive plants often cause harm to native species, communities, or ecosystems, or to human health or activities.

GLOSSARY

MD Roadside Tree Expert an individual representing a governmental agency who: a) Is designated to supervise that government's roadside tree planting and maintenance operations; b) passed the Forest Service's examination for Roadside Tree Care Experts; and c) Has been approved by the Forest Service as qualified to supervise that government's tree care program.

Native plant A plant that lives or grows naturally in a particular region without direct or indirect human intervention.

Natural area trees Trees that are growing in the woodlands owned by the Town, such as Porcupine Woods. These trees are growing where there are few, if any, high-value targets, so the burden of care for these trees is lower.

Pesticides Pesticides include herbicides (weed killers), insecticides, and fungicides. Pesticides can be derived from organic sources as well as inorganic sources. Most pesticides are regulated by the EPA and are assigned a label that outlines the use and restrictions of the product. Some pesticides are considered of low enough toxicity that they are not regulated by the EPA and are given no pesticide label.

Publicly owned trees Trees that are either in the town ROW, on parcels of land that the town owns (e.g. Yeandle property), or are in the natural areas and parks.

Salts Many of the products used to make roadways safe during ice and snow events are a form of salt. Salts, when used in large amounts, run off the roadways and onto the nearby landscape. At high concentrations, salt causes a reverse flow of water near roots, and water is sucked out of tree roots into the soil.

Species The primary taxonomic unit that denotes a group of individuals that can exchange genes and interbreed.

Stormwater rainwater that strikes an impervious surface and runs off – often to the local storm sewer system. In addition, if a storm event is of a high intensity, water cannot infiltrate soil and runs off the soil surface, possibly causing erosion and further stressing the stormwater system.

Structural value of trees The cost of replacing a tree with a similar size and species.

Taxon (taxa pl.) A group of one or more populations of an organism, or organisms seen by taxonomists to form a unit.

Tree allee A straight path or road with a line of trees or large shrubs running along each side.

Tree Lawns The growing space between a street curb and the sidewalk. Tree lawns that are less than 4’ wide pose challenges for trees, as the rooting volume is often not great enough to support healthy tree growth. Many people believe that tree roots will just grow under the sidewalk towards a greater soil area in the front yards, but that is not always possible, nor does the root “know” to grow past the sidewalk to the front yard. Tree lawns are also where the greatest salt load occurs, as de-icing salts are splashed or plowed onto the tree lawn in the winter.

Urban forest The urban forest is the sum total of all trees that are growing in the town of Garrett Park, both privately owned and publicly owned.

Urban Forest Tree Canopy Coverage The percent of land of a jurisdiction or area that is covered by tree canopy (leaves and branches). Montgomery County has a webpage to calculate a municipality’s tree canopy coverage located at: http://montgomeryplanning.org/planning/environment/forest-conservation-and-trees/tree-canopy-analysis/tree-canopy-explorer/

Appendix A. List of Species from 2018 Inventory

Population Summary by Species

Location: Garrett Park, Montgomery, Maryland, United States of America
Project: Town of Garrett Park, Series: Tree Inventory, Year: 2018
Generated: 12/19/2018

Latin Name	Common Name	Number of Trees	Percent of Population
Cornus florida	Flowering dogwood	116	7.70%
Acer saccharum	Sugar maple	90	6.00%
Liriodendron tulipifera	Tulip tree	78	5.20%
Quercus sp.	Oak sp.	64	4.20%
Prunus sp.	Cherry sp.	58	3.80%
Cercis canadensis	Eastern redbud	57	3.80%
Juniperus chinensis	Chinese juniper	50	3.30%
Lagerstroemia indica	Crape myrtle	46	3.00%
Acer rubrum	Red maple	44	2.90%
Ilex sp.	Holly sp.	44	2.90%
Cornus kousa	Kousa dogwood	43	2.80%
Acer japonicum	Japanese maple	38	2.50%
Quercus phellos	Willow oak	32	2.10%
Ulmus americana	American elm	32	2.10%
Acer platanoides	Norway maple	27	1.80%
Ulmus parvifolia	Lacebark elm	27	1.80%
Quercus alba	White oak	24	1.60%
Ilex opaca	American holly	23	1.50%
Magnolia sp.	Magnolia sp.	23	1.50%
Quercus acutissima	Sawtooth oak	21	1.40%
Ginkgo biloba	Ginkgo	20	1.30%
Nyssa sylvatica	Black tupelo	20	1.30%
Pinus strobus	Eastern white pine	19	1.30%
Ulmus sp.	Elm sp.	19	1.30%
Picea abies	Norway spruce	18	1.20%
Syringa sp.	Lilac	16	1.10%
Acer sp.	Maple	15	1.00%
Morus alba	White mulberry	12	<0.1%
Picea sp.	Spruce sp.	12	<0.1%
Sassafras albidum	Sassafras	12	<0.1%
Fraxinus sp.	Ash sp.	11	<0.1%
Juglans nigra	Black walnut	11	<0.1%
Acer palmatum	Palmate maple	10	<0.1%
Acer saccharum 'Green Mountain'	Sugar maple	10	<0.1%

APPENDIX A

Population Summary by Species

Location: Garrett Park, Montgomery, Maryland, United States of America
Project: Town of Garrett Park, Series: Tree Inventory, Year: 2018
Generated: 12/19/2018

Latin Name	Common Name	Number of Trees	Percent of Population
Magnoliopsida	Magnoliopsida	10	<0.1%
Platanus occidentalis	American sycamore	10	<0.1%
Platanus x acerifolia	London planetree	9	<0.1%
Prunus serotina	Black cherry	9	<0.1%
Zelkova serrata	Japanese zelkova	9	<0.1%
Betula nigra	River birch	8	<0.1%
Carya sp.	Hickory sp.	8	<0.1%
Juniperus virginiana	Eastern red cedar	8	<0.1%
Styrax japonicus	Japanese snowbell	8	<0.1%
Ilex cornuta	Chinese holly	7	<0.1%
Koelreuteria paniculata	Goldenrain tree	7	<0.1%
Malus sp.	Apple sp.	7	<0.1%
Chamaecyparis	Falsecypress sp.	6	<0.1%
Fagus grandifolia	American beech	6	<0.1%
Quercus rubra	Northern red oak	6	<0.1%
Acer saccharinum	Silver maple	5	<0.1%
Magnolia grandiflora	Southern magnolia	5	<0.1%
Metasequoia glyptostroboides	Dawn redwood	5	<0.1%
Aesculus pavia	Red buckeye	4	<0.1%
Cornus alternifolia	Pagoda dogwood	4	<0.1%
Cornus mas	Cornelian cherry	4	<0.1%
Fagus sylvatica	European beech	4	<0.1%
Ginkgo biloba 'Autumn Gold'	Ginkgo	4	<0.1%
Juniperus sp.	Juniper sp.	4	<0.1%
Liquidambar styraciflua	Sweetgum	4	<0.1%
Magnolia virginiana	Sweetbay magnolia	4	<0.1%
Robinia pseudoacacia	Black locust	4	<0.1%
Taxodium distichum	Baldcypress	4	<0.1%
Thuja sp.	Arborvitae sp.	4	<0.1%
Tsuga canadensis	Eastern Hemlock	4	<0.1%
Acer campestre	Hedge maple	3	<0.1%
Acer griseum	Paperbark maple	3	<0.1%
Acer x freemanii	Freeman maple	3	<0.1%

APPENDIX A

Population Summary by Species

Location: Garrett Park, Montgomery, Maryland, United States of America
Project: Town of Garrett Park, Series: Tree Inventory, Year: 2018
Generated: 12/19/2018

Latin Name	Common Name	Number of Trees	Percent of Population
Cercidiphyllum japonicum	Katsura tree	3	<0.1%
Chamaecyparis obtusa	Hinoki falsecypress	3	<0.1%
Cladrastis kentukea	Yellowwood	3	<0.1%
Cupressocyparis leylandii	Leyland cypress	3	<0.1%
Pterocarya stenoptera	Chinese wingnut	3	<0.1%
Quercus bicolor	Swamp white oak	3	<0.1%
Quercus lyrata	Overcup oak	3	<0.1%
Sophora japonica	Japanese pagoda tree	3	<0.1%
Syringa reticulata	Chinese tree lilac	3	<0.1%
Thuja occidentalis	Arborvitae	3	<0.1%
Acer buergerianum	Trident maple	2	<0.1%
Acer rubrum 'Brandywine'	Red maple	2	<0.1%
Acer tataricum	Amur maple	2	<0.1%
Amelanchier sp.	Serviceberry sp.	2	<0.1%
Amelanchier x grandiflora 'Autumn'	Serviceberry	2	<0.1%
Catalpa sp.	Catalpa sp.	2	<0.1%
Cedrus deodara	Deodar Cedar	2	<0.1%
Celtis sp.	Hackberry sp.	2	<0.1%
Cornus sp.	Dogwood sp.	2	<0.1%
Cryptomeria japonica	Japanese cedar	2	<0.1%
Davidia involucrata	Dove-tree	2	<0.1%
Fraxinus americana	White ash	2	<0.1%
Fraxinus quadrangulata	Blue ash	2	<0.1%
Ginkgo biloba 'Fairmont'	Ginkgo	2	<0.1%
Gymnocladus dioicus	Kentucky coffeetree	2	<0.1%
Hovenia dulcis	Japanese raisin tree	2	<0.1%
Larix decidua	European larch	2	<0.1%
Maackia amurensis	Amur maackia	2	<0.1%
Magnolia kobus	Kobus magnolia	2	<0.1%
Parrotia persica	Persian ironwood	2	<0.1%
Phellodendron amurense	Cork tree	2	<0.1%
Picea glauca	Dwarf alberta spruce	2	<0.1%
Platanus sp.	Sycamore sp.	2	<0.1%
Prunus subhirtella	Higan cherry	2	<0.1%

Population Summary by Species

Location: Garrett Park, Montgomery, Maryland, United States of America
Project: Town of Garrett Park, Series: Tree Inventory, Year: 2018
Generated: 12/19/2018

Latin Name	Common Name	Number of Trees	Percent of Population
Prunus x incam 'okame'	Cherry	2	<0.1%
Quercus macrocarpa	Bur oak	2	<0.1%
Quercus robur	English oak	2	<0.1%
Quercus shumardii	Shumard oak	2	<0.1%
Quercus variabilis	Oriental oak	2	<0.1%
Salix babylonica	Wisconsin weeping willow	2	<0.1%
Stewartia sp.	Stewartia sp.	2	<0.1%
Styrax sp.	Snowbell sp.	2	<0.1%
Tilia cordata	Littleleaf linden	2	<0.1%
Ulmus wilsoniana	Prospector elm	2	<0.1%
Acer crataegifolium	Snakebark maple	1	<0.1%
Acer miyabei	Miyabe maple	1	<0.1%
Acer negundo	Boxelder	1	<0.1%
Acer palmatum 'Dissectum'	Laceleaf japanese maple	1	<0.1%
Acer pseudosieboldianum	Korean maple	1	<0.1%
Acer rubrum 'October glory'	Red maple	1	<0.1%
Acer truncatum	Shantung maple	1	<0.1%
Aesculus sp.	Buckeye sp.	1	<0.1%
Aesculus hippocastanum	Horsechestnut	1	<0.1%
Aesculus x carnea	Red horsechestnut	1	<0.1%
Alnus cordata	Italian alder	1	<0.1%
Amelanchier laevis	Serviceberry	1	<0.1%
Betula sp.	Birch sp.	1	<0.1%
Calocedrus sp.	Cedar sp.	1	<0.1%
Calocedrus decurrens	Incense cedar	1	<0.1%
Carpinus sp.	Hornbeam	1	<0.1%
Carpinus cordata	Heartleaf Hornbeam	1	<0.1%
Cedrela sinensis	Chinese toon	1	<0.1%
Celtis occidentalis	Northern hackberry	1	<0.1%
Cephalotaxus harringtonia	Japanese Plum Yew	1	<0.1%
Cercis sp.	Redbud	1	<0.1%
Cercis reniformis	Oklahoma redbud	1	<0.1%
Cercis siliquastrum	Arbol de judea	1	<0.1%

Population Summary by Species

Location: Garrett Park, Montgomery, Maryland, United States of America
Project: Town of Garrett Park, Series: Tree Inventory, Year: 2018
Generated: 12/19/2018

Latin Name	Common Name	Number of Trees	Percent of Population
Chionanthus virginicus	Fringetree	1	<0.1%
Cornus controversa	Giant dogwood	1	<0.1%
Corylus colurna	Turkish hazel	1	<0.1%
Crataegus sp.	Hawthorn sp.	1	<0.1%
Cunninghamia lanceolata	Chinese fir	1	<0.1%
Cupressus arizonica	Arizona Cypress	1	<0.1%
Diospyros virginiana	Persimmon	1	<0.1%
Eucommia ulmoides	Hardy rubber tree	1	<0.1%
Euonymus bungeanum	Winterberry euonymus	1	<0.1%
Fagus sp.	Beech sp.	1	<0.1%
Halesia sp.	Silverbell tree	1	<0.1%
Halesia carolina	Carolina silverbell	1	<0.1%
Halesia diptera	Winged silverbell	1	<0.1%
Juniperus rigida	Temple juniper	1	<0.1%
Koelreuteria paniculata Fastigiata	Fastigate goldenrain tree	1	<0.1%
Lagerstroemia sp.	Crape myrtle	1	<0.1%
Lagerstroemia x Muskogee	Crape myrtle	1	<0.1%
Lagerstroemia x Tuscarora	Tuscarora crape myrtle	1	<0.1%
Liriodendron tulipifera Fastigiatum	Fastigate tulip tree	1	<0.1%
Magnolia acuminata	Cucumbertree	1	<0.1%
Magnolia grandiflora Little Gem	Southern magnolia	1	<0.1%
Magnolia hypoleuca	Japanese cucumber tree	1	<0.1%
Magnolia macrophylla	Bigleaf magnolia	1	<0.1%
Magnolia stellata	Star magnolia	1	<0.1%
Malus sargentii	Sargent crabapple	1	<0.1%
Morus sp.	Mulberry sp.	1	<0.1%
Ostrya virginiana	American hop hornbeam	1	<0.1%
Picea pungens	Blue spruce	1	<0.1%
Pistacia chinensis	Chinese pistache	1	<0.1%
Populus deltoides	Eastern cottonwood	1	<0.1%
Prunus sargentii	Sargent Cherry	1	<0.1%

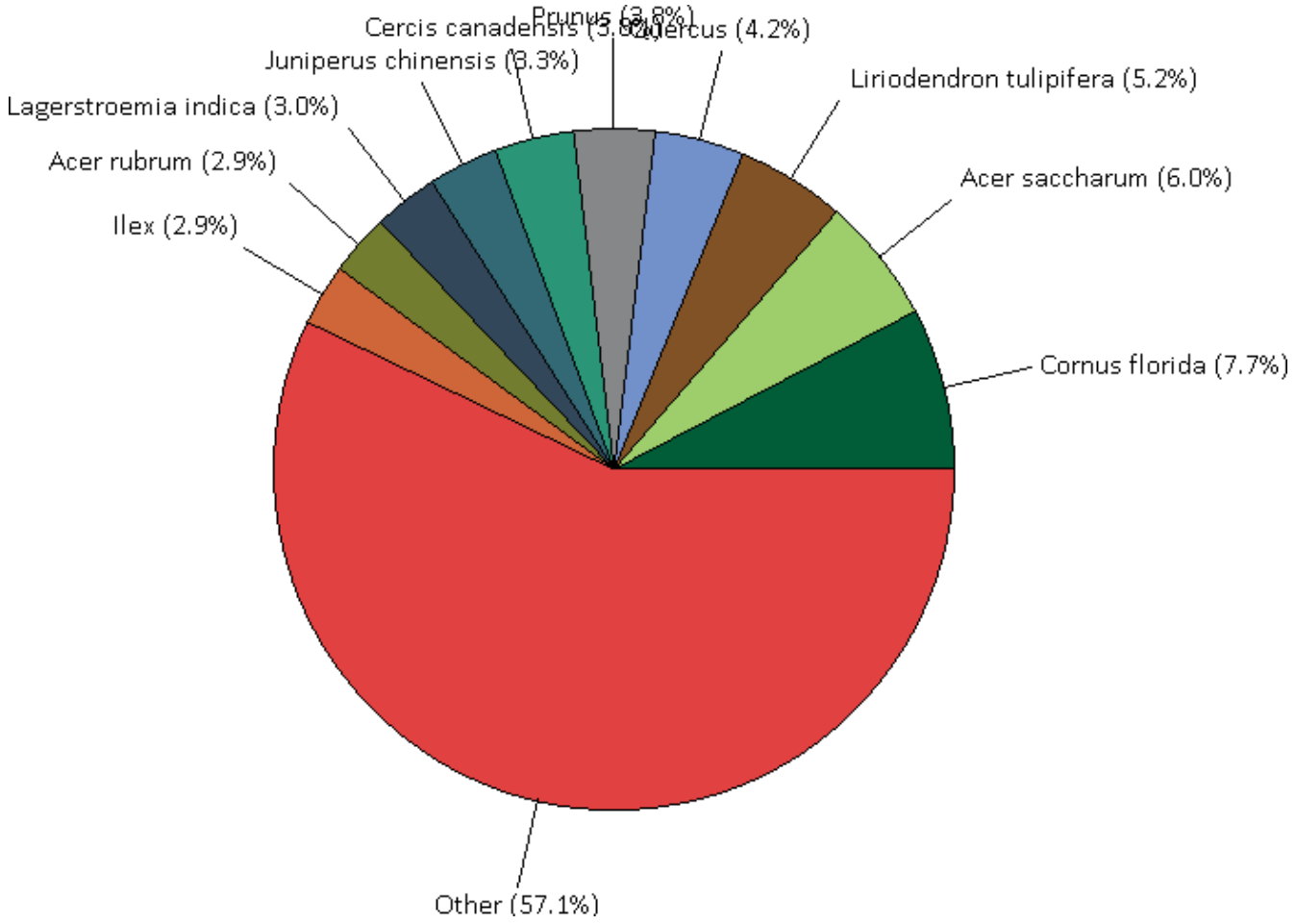
Population Summary by Species

Location: Garrett Park, Montgomery, Maryland, United States of America
Project: Town of Garrett Park, Series: Tree Inventory, Year: 2018
Generated: 12/19/2018

Latin Name	Common Name	Number of Trees	Percent of Population
Prunus spachiana f. ascendens	Cherry	1	<0.1%
Prunus yedoensis	Yoshino cherry	1	<0.1%
Pseudocydonia sinensis	Chinese quince	1	<0.1%
Pyrus calleryana	Bradford pear	1	<0.1%
Quercus aliena	Oriental white oak	1	<0.1%
Quercus dentata	Korean oak	1	<0.1%
Quercus falcata	Southern red oak	1	<0.1%
Quercus frainetto	Hungarian oak	1	<0.1%
Quercus michauxii	Swamp chestnut oak	1	<0.1%
Quercus muehlenbergii	Chinkapin oak	1	<0.1%
Quercus oglethorpensis	Oglethorpe oak	1	<0.1%
Quercus pagoda	Cherrybark oak	1	<0.1%
Quercus prinus	Pin Oak	1	<0.1%
Salix sp.	Willow	1	<0.1%
Sciadopitys verticillata	Japanese umbrella tree	1	<0.1%
Stewartia ovata	Mountain camellia	1	<0.1%
Stewartia pseudocamellia	Japanese stewartia	1	<0.1%
Styrax obassia	Fragrant snowbell	1	<0.1%
Tetradium daniellii	Korean evodia	1	<0.1%
Tilia tomentosa	Silver linden	1	<0.1%
Tsuga sp.	Hemlock sp.	1	<0.1%
Ulmus 'Frontier'	Elm	1	<0.1%
Viburnum prunifolium	Blackhaw viburnum	1	<0.1%
Zelkova serrata 'Musashino'	Japanese zelkova	1	<0.1%
Zelkova sinica	Chinese zelkova	1	<0.1%
Total		**1,509**	**100%**

Population Summary by Species

Location: Garrett Park, Montgomery, Maryland, United States of America
Project: Town of Garrett Park, Series: Tree Inventory, Year: 2018
Generated: 12/19/2018



Appendix B. List of Genera from 2018 Inventory

TABLE 1. NUMBER AND PERCENTAGE OF TREES BY GENUS. HIGHLIGHTED ROWS ARE GENERA THAT EXCEED 5% OF THE CANOPY.

Genera	# of trees	Percentage
Acer	264	17.3
Aesculus	7	0.5
Alnus	1	0.1
Amelanchier	5	0.3
Betula	9	0.6
Calocedrus	2	0.1
Carpinus	2	0.1
Carya	8	0.5
Catalpa	2	0.1
Cedrela	1	0.1
Cedrus	2	0.1
Celtis	3	0.2
Cephalotaxus	1	0.1
Cercidiphyllum	3	0.2
Cercis	61	4.0
Chamaecyparis	9	0.6
Chionanthus	1	0.1
Cladrastis	3	0.2
Cornus	172	11.3
Corylus	1	0.1
Crataegus	1	0.1
Cryptomeria	2	0.1
Cunnimghamia	1	0.1
Cupressus	1	0.1
Davidia	2	0.1

APPENDIX B

Diospyros	1	0.1
Eucomia	1	0.1
Euonymus	1	0.1
Evodia	1	0.1
Fagus	11	0.7
Fraxinus	17	1.1
Ginkgo	26	1.7
Gymnocladus	2	0.1
Halesia	3	0.2
Hovenia	2	0.1
Ilex	74	4.9
Juglans	11	0.7
Juniperus	63	4.1
Koelruteria	9	0.6
Lagerstroemia	50	3.3
Larix	2	0.1
Liquidambar	4	0.3
Liriodendron	79	5.2
Maackia	2	0.1
Magnolia	39	2.6
Malus	8	0.5
Metasequoia	5	0.3
Morus	13	0.9
Nyssa	20	1.3
Ostrya	1	0.1
Parrotia	2	0.1
Phellodendron	2	0.1
Picea	30	2.0
Pinus	23	1.5
Pistacia	1	0.1
Platanus	21	1.4
Populus	1	0.1

APPENDIX B

Prunus	74	4.9
Pseudocydonia	1	0.1
Pterocarya	3	0.2
Pyrus	1	0.1
Quercus	170	11.2
Robinia	5	0.3
Salix	3	0.2
Sassafras	12	0.8
Sciadopitis	1	0.1
Sinojackia	1	0.1
Sophora	3	0.2
Stewartia	4	0.3
Styrax	11	0.7
Syringa	19	1.2
Taxodium	4	0.3
Thuja	7	0.5
Tilia	3	0.2
Tsuga	5	0.3
Ulmus	81	5.3
Unknown	10	0.7
Viburnum	1	0.1
x Hesperotropsis	3	0.2
Zelkova	11	0.7

Appendix C. i-Tree Report

i-Tree
Ecosystem Analysis

Town of Garrett Park

Urban Forest Effects and Values
December 2018

Page 1

APPENDIX C

Summary

Understanding an urban forest's structure, function and value can promote management decisions that will improve human health and environmental quality. An assessment of the vegetation structure, function, and value of the Town of Garrett Park urban forest was conducted during 2018. Data from 1509 trees located throughout Town of Garrett Park were analyzed using the i-Tree Eco model developed by the U.S. Forest Service, Northern Research Station.

- Number of trees: 1,509
- Tree Cover: 19.44 acres
- Most common species of trees: Cornus florida, Acer saccharum, Liriodendron tulipifera
- Percentage of trees less than 6" (15.2 cm) diameter: 33.4%
- Pollution Removal: 1028 pounds/year ($3.12 thousand/year)
- Carbon Storage: 925.6 tons ($158 thousand)
- Carbon Sequestration: 19.89 tons ($3.39 thousand/year)
- Oxygen Production: 53.04 tons/year
- Avoided Runoff: 36.91 thousand cubic feet/year ($2.47 thousand/year)
- Building energy savings: N/A – data not collected
- Avoided carbon emissions: N/A – data not collected
- Structural values: $5.72 million

Ton: short ton (U.S.) (2,000 lbs)
Monetary values $ are reported in US Dollars throughout the report except where noted.
Ecosystem service estimates are reported for trees.

For an overview of i-Tree Eco methodology, see Appendix I. Data collection quality is determined by the local data collectors, over which i-Tree has no control.

APPENDIX C

Table of Contents

Summary 2
I. Tree Characteristics of the Urban Forest 4
II. Urban Forest Cover and Leaf Area 7
III. Air Pollution Removal by Urban Trees 9
IV. Carbon Storage and Sequestration 11
V. Oxygen Production 13
VI. Avoided Runoff 14
VII. Trees and Building Energy Use 15
VIII. Structural and Functional Values 16
IX. Potential Pest Impacts 17
Appendix I. i-Tree Eco Model and Field Measurements 19
Appendix II. Relative Tree Effects 23
Appendix III. Comparison of Urban Forests 24
Appendix IV. General Recommendations for Air Quality Improvement 25
Appendix V. Invasive Species of the Urban Forest 26
Appendix VI. Potential Risk of Pests 27
References 32

I. Tree Characteristics of the Urban Forest

The urban forest of Town of Garrett Park has 1,509 trees with a tree cover of Cornus florida. The three most common species are Cornus florida (7.7 percent), Acer saccharum (6.0 percent), and Liriodendron tulipifera (5.2 percent).

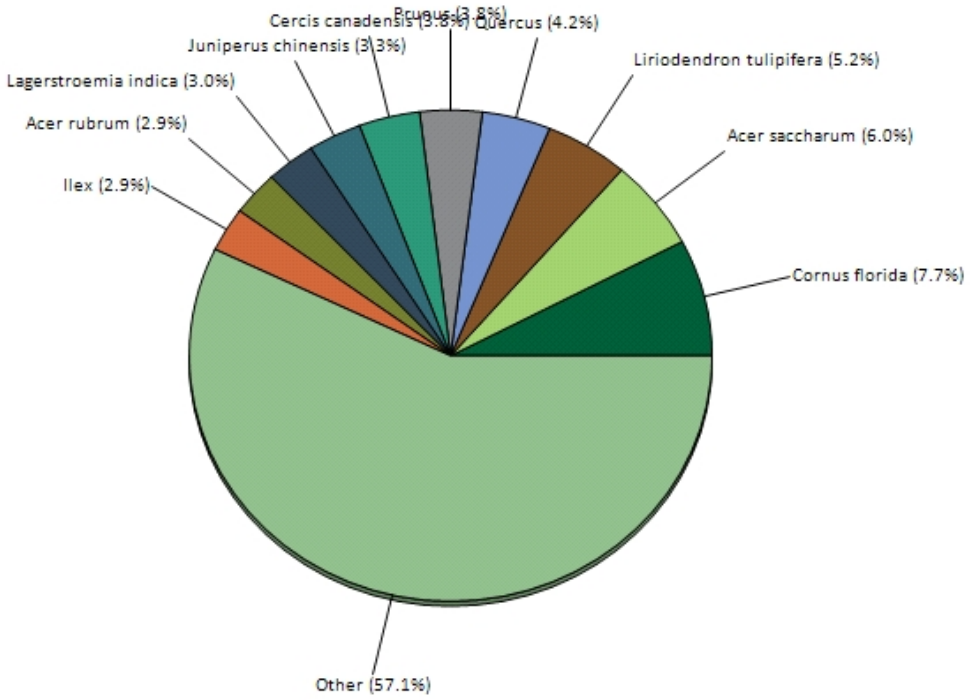


Figure 1. Tree species composition in Town of Garrett Park

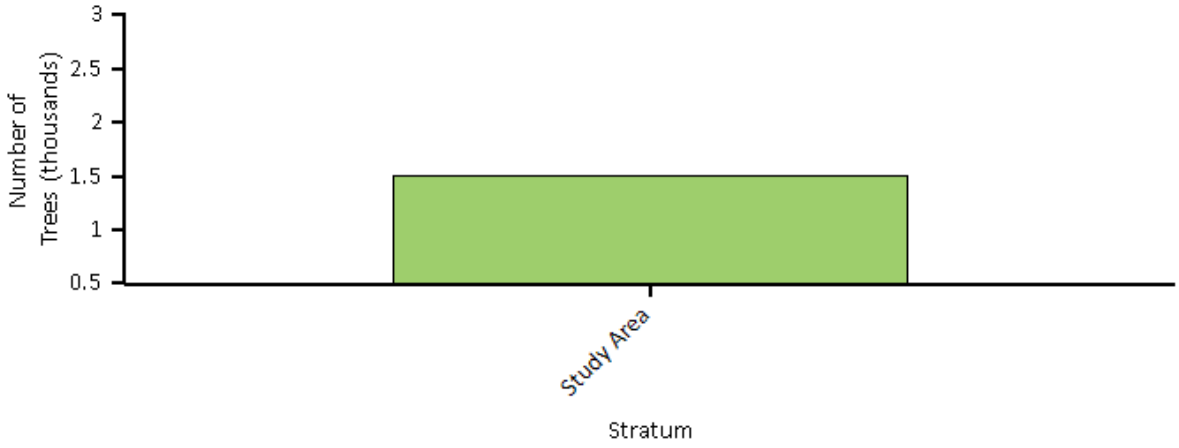


Figure 2. Number of trees in Town of Garrett Park by stratum

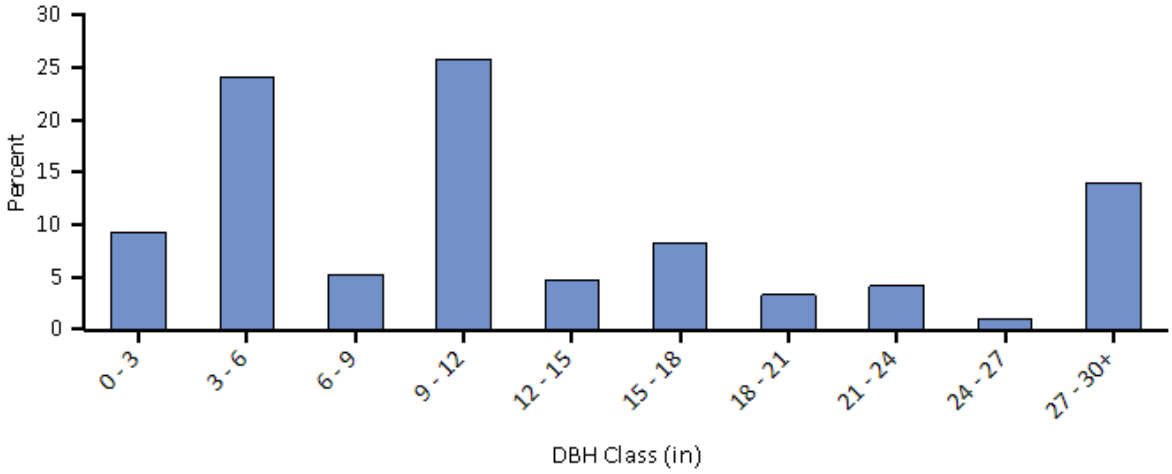


Figure 3. Percent of tree population by diameter class (DBH - stem diameter at 4.5 feet)

Urban forests are composed of a mix of native and exotic tree species. Thus, urban forests often have a tree diversity that is higher than surrounding native landscapes. Increased tree diversity can minimize the overall impact or destruction by a species-specific insect or disease, but it can also pose a risk to native plants if some of the exotic species are invasive plants that can potentially out-compete and displace native species. In Town of Garrett Park, about 49 percent of the trees are species native to North America, while 44 percent are native to Maryland. Species exotic to North America make up 51 percent of the population. Most exotic tree species have an origin from Asia (24 percent of the species).

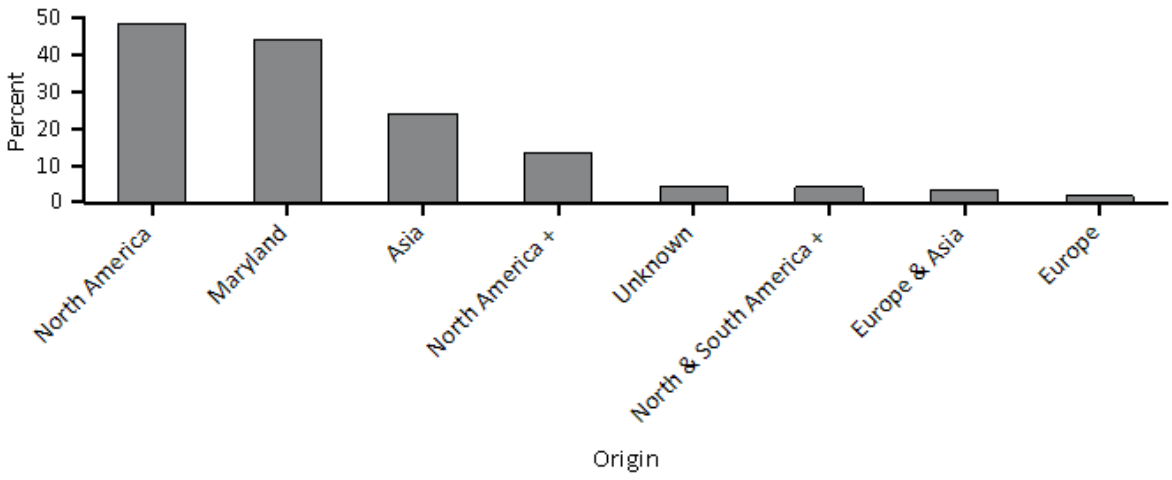


Figure 4. Percent of live tree population by area of native origin, Town of Garrett Park

The plus sign (+) indicates the tree species is native to another continent other than the ones listed in the grouping.

APPENDIX C

Invasive plant species are often characterized by their vigor, ability to adapt, reproductive capacity, and general lack of natural enemies. These abilities enable them to displace native plants and make them a threat to natural areas. Two of the 190 tree species in Town of Garrett Park are identified as invasive on the state invasive species list (Maryland Invasive Species Council 2014a; 2014b). These invasive species comprise 1.9 percent of the tree population though they may only cause a minimal level of impact. These two invasive species are Acer platanoides (1.8 percent of population) and Pyrus calleryana (0.1 percent) (see Appendix V for a complete list of invasive species).

II. Urban Forest Cover and Leaf Area

Tree species vary in the size and density of leaves they have in their canopy. In addition, the larger the tree, the more leaves they have, and the greater the leaf area surface. Trees with greater leaf area surface provide greater ecosystem benefits—they intercept more rainfall, convert more CO2 to oxygen, trap more pollutants, and the like.

Large-canopied trees with great amounts of leaf area play an outsized role in providing ecosystem benefits. For example, a large red maple will provide greater ecosystem services than a dogwood. The chart below demonstrates the outsized role canopy trees play in the Garrett Park ecosystem, where trees cover about 19.44 acres of Town of Garrett Park and provide 92.71 acres of leaf area.

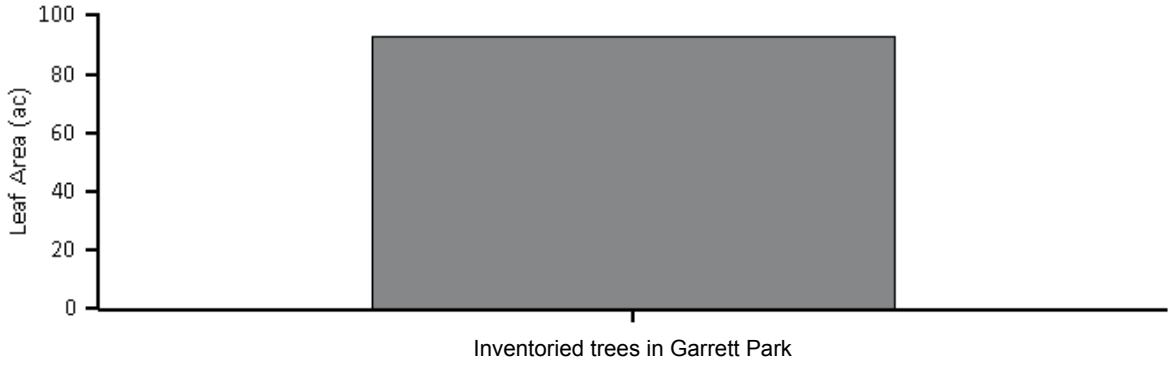


Figure 5. Leaf Area of Inventoried Trees, Town of Garrett Park

In Town of Garrett Park, the most dominant species in terms of leaf area are Liriodendron tulipifera, Acer saccharum, and Acer rubrum. The 10 species with the greatest importance values are listed in Table 1. Importance values (IV) are calculated as the sum of percent population and percent leaf area. High importance values do not mean that these trees should necessarily be encouraged in the future; rather these species currently dominate the urban forest structure.

Table 1. Most important species in Town of Garrett Park

Species Name	*Percent Population*	*Percent Leaf Area*	*IV*
Liriodendron tulipifera	5.2	20.8	26.0
Acer saccharum	6.0	8.2	14.2
Cornus florida	7.7	2.4	10.1
Quercus	4.2	4.8	9.0
Acer rubrum	2.9	4.8	7.7
Quercus phellos	2.1	4.0	6.1
Prunus	3.8	1.9	5.8
Ulmus americana	2.1	3.3	5.4
Cercis canadensis	3.8	0.9	4.7
Juniperus chinensis	3.3	1.1	4.4

Common ground cover classes (including cover types beneath trees and shrubs) in Town of Garrett Park are not available since they are configured not to be collected.

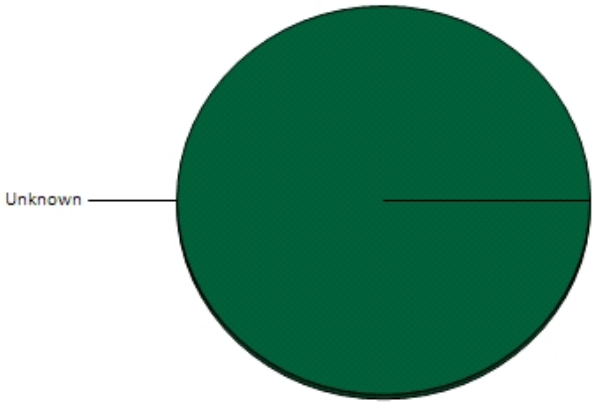


Figure 6. Percent of land by ground cover classes, Town of Garrett Park

III. Air Pollution Removal by Urban Trees

Poor air quality is a common problem in many urban areas. It can lead to decreased human health, damage to landscape materials and ecosystem processes, and reduced visibility. The urban forest can help improve air quality by reducing air temperature, directly removing pollutants from the air, and reducing energy consumption in buildings, which consequently reduces air pollutant emissions from the power sources. Trees also emit volatile organic compounds that can contribute to ozone formation. However, integrative studies have revealed that an increase in tree cover leads to reduced ozone formation (Nowak and Dwyer 2000).

Pollution removal[1] by trees in Town of Garrett Park was estimated using field data and recent available pollution and weather data available. Pollution removal was greatest for ozone (Figure 7). It is estimated that trees remove 1028 pounds of air pollution (ozone (O3), carbon monoxide (CO), nitrogen dioxide (NO2), particulate matter less than 2.5 microns (PM2.5)[2], and sulfur dioxide (SO2)) per year with an associated value of $3.12 thousand (see Appendix I for more details).

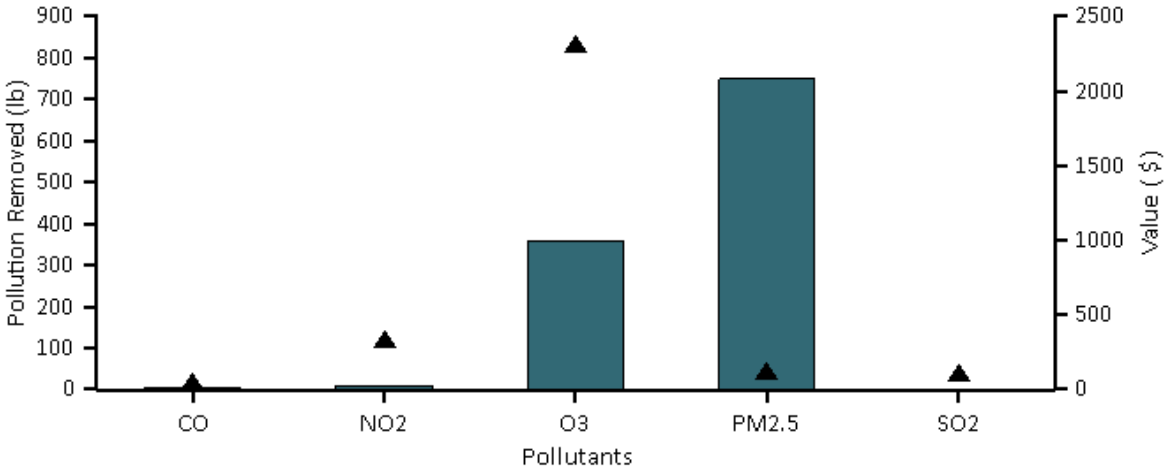


Figure 7. Annual pollution removal (points) and value (bars) by urban trees, Town of Garrett Park

[1] Particulate matter less than 10 microns is a significant air pollutant. Given that i-Tree Eco analyzes particulate matter less than 2.5 microns (PM2.5) which is a subset of PM10, PM10 has not been included in this analysis. PM2.5 is generally more relevant in discussions concerning air pollution effects on human health.

[2] Trees remove PM2.5 when particulate matter is deposited on leaf surfaces. This deposited PM2.5 can be resuspended to the atmosphere or removed during rain events and dissolved or transferred to the soil. This combination of events can lead to positive or negative pollution removal and value depending on various atmospheric factors (see Appendix I for more details).

In 2018, trees in Town of Garrett Park emitted an estimated 772.3 pounds of volatile organic compounds (VOCs) (590.2 pounds of isoprene and 182.1 pounds of monoterpenes). Emissions vary among species based on species characteristics (e.g. some genera such as oaks are high isoprene emitters) and amount of leaf biomass. Forty- one percent of the urban forest's VOC emissions were from Quercus and Quercus phellos. These VOCs are precursor chemicals to ozone formation.[3]

General recommendations for improving air quality with trees are given in Appendix VIII.

[3] Some economic studies have estimated VOC emission costs. These costs are not included here as there is a tendency to add positive dollar estimates of ozone removal effects with negative dollar values of VOC emission effects to determine whether tree effects are positive or negative in relation to ozone. This combining of dollar values to determine tree effects should not be done, rather estimates of VOC effects on ozone formation (e.g., via photochemical models) should be conducted and directly contrasted with ozone removal by trees (i.e., ozone effects should be directly compared, not dollar estimates). In addition, air temperature reductions by trees have been shown to significantly reduce ozone concentrations (Cardelino and Chameides 1990; Nowak et al 2000), but are not considered in this analysis. Photochemical modeling that integrates tree effects on air temperature, pollution removal, VOC emissions, and emissions from power plants can be used to determine the overall effect of trees on ozone concentrations.

IV. Carbon Storage and Sequestration

Climate change is an issue of global concern. Urban trees can help mitigate climate change by sequestering atmospheric carbon (from carbon dioxide) in tissue and by altering energy use in buildings, and consequently altering carbon dioxide emissions from fossil-fuel based power sources (Abdollahi et al 2000).

Trees reduce the amount of carbon in the atmosphere by sequestering carbon in new growth every year. The amount of carbon annually sequestered is increased with the size and health of the trees. The gross sequestration of Town of Garrett Park trees is about 19.89 tons of carbon per year with an associated value of $3.39 thousand. See Appendix I for more details on methods.

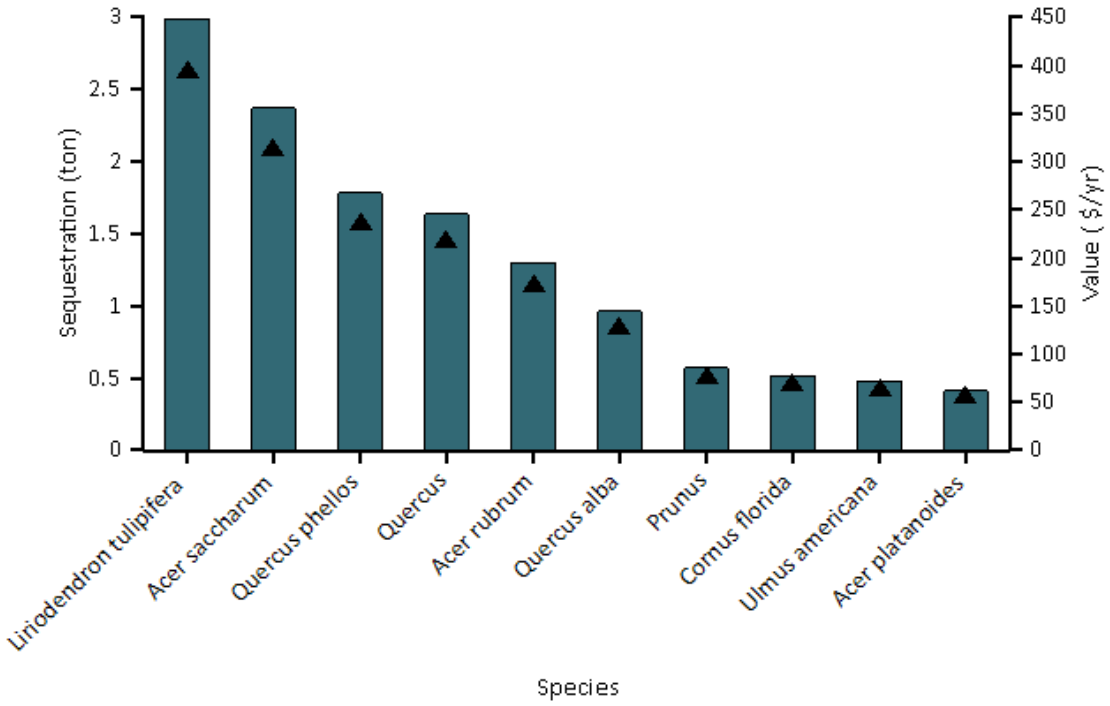


Figure 8. Estimated annual gross carbon sequestration (points) and value (bars) for urban tree species with the greatest sequestration, Town of Garrett Park

Carbon storage is another way trees can influence global climate change. As a tree grows, it stores more carbon by holding it in its accumulated tissue. As a tree dies and decays, it releases much of the stored carbon back into the atmosphere. Thus, carbon storage is an indication of the amount of carbon that can be released if trees are allowed to die and decompose. Maintaining healthy trees will keep the carbon stored in trees, but tree maintenance can contribute to carbon emissions (Nowak et al 2002c). When a tree dies, using the wood in long-term wood products, to heat buildings, or to produce energy will help reduce carbon emissions from wood decomposition or from fossil-fuel or wood-based power plants.

Trees in Town of Garrett Park are estimated to store 926 tons of carbon ($158 thousand). Of the species sampled, Liriodendron tulipifera stores and sequesters the most carbon (approximately 20.7% of the total carbon stored and 13.2% of all sequestered carbon.)

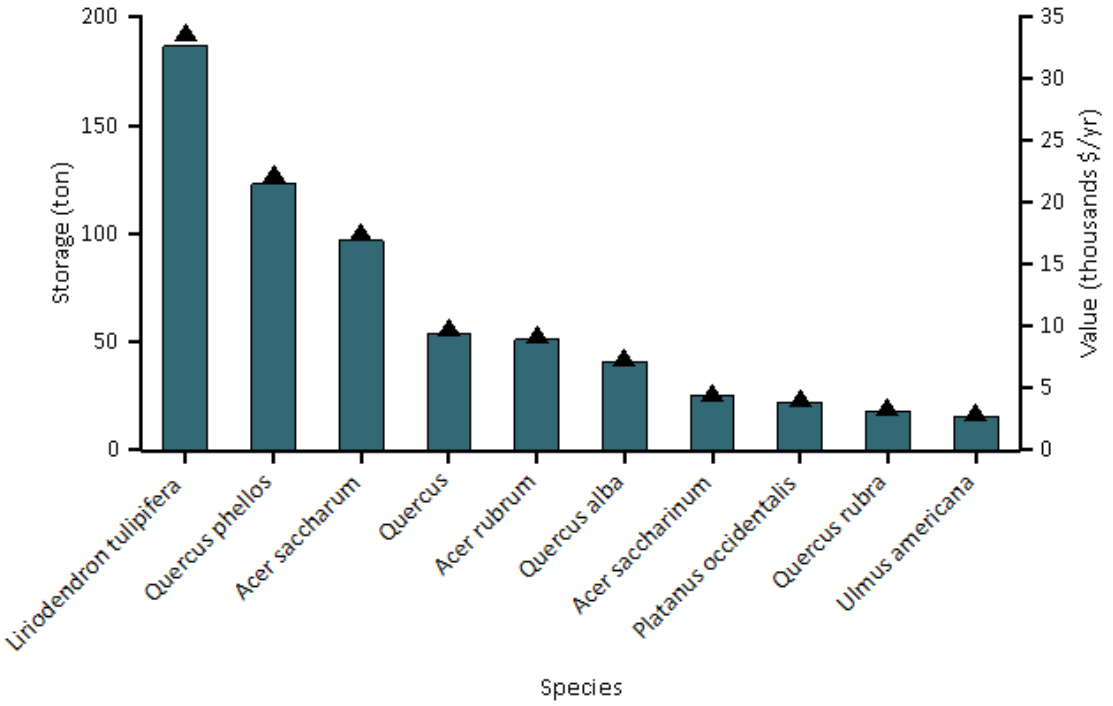


Figure 9. Estimated carbon storage (points) and values (bars) for urban tree species with the greatest storage, Town of Garrett Park

V. Oxygen Production

Oxygen production is one of the most commonly cited benefits of urban trees. The annual oxygen production of a tree is directly related to the amount of carbon sequestered by the tree, which is tied to the accumulation of tree biomass.

Trees in Town of Garrett Park are estimated to produce 53.04 tons of oxygen per year.[4] However, this tree benefit is relatively insignificant because of the large and relatively stable amount of oxygen in the atmosphere and extensive production by aquatic systems. Our atmosphere has an enormous reserve of oxygen. If all fossil fuel reserves, all trees, and all organic matter in soils were burned, atmospheric oxygen would only drop a few percent (Broecker 1970).

Table 2. The top 20 oxygen production species.

Species	*Oxygen (ton)*	*Gross Carbon Sequestration (pound/yr)*	*Number of Trees*	*Leaf Area (acre)*
Liriodendron tulipifera	7.00	5,253.04	78	19.29
Acer saccharum	5.56	4,169.77	90	7.61
Quercus phellos	4.18	3,135.61	32	3.71
Quercus	3.84	2,879.33	64	4.43
Acer rubrum	3.05	2,287.96	44	4.48
Quercus alba	2.26	1,695.86	24	2.27
Prunus	1.34	1,008.17	58	1.79
Cornus florida	1.21	907.79	116	2.21
Ulmus americana	1.12	838.05	32	3.05
Acer platanoides	0.97	726.88	27	2.28
Platanus occidentalis	0.93	697.67	10	1.89
Quercus acutissima	0.80	600.99	21	1.06
Acer	0.77	580.53	15	1.42
Acer saccharum 'Green Mountain'	0.75	559.38	10	1.44
Quercus rubra	0.69	517.22	6	0.82
Ulmus parvifolia	0.62	462.67	27	1.78
Ilex opaca	0.62	462.52	23	0.69
Morus alba	0.62	461.89	12	0.68
Ulmus	0.57	427.38	19	1.36
Acer japonicum	0.56	416.98	38	1.24

VI. Avoided Runoff

Surface runoff can be a cause for concern in many urban areas as it can contribute pollution to streams, wetlands, rivers, lakes, and oceans. During precipitation events, some portion of the precipitation is intercepted by vegetation (trees and shrubs) while the other portion reaches the ground. The portion of the precipitation that reaches the ground and does not infiltrate into the soil becomes surface runoff (Hirabayashi 2012). In urban areas, the large extent of impervious surfaces increases the amount of surface runoff.

Urban trees and shrubs, however, are beneficial in reducing surface runoff. Trees and shrubs intercept precipitation, while their root systems promote infiltration and storage in the soil. The trees and shrubs of Town of Garrett Park help to reduce runoff by an estimated 36.9 thousand cubic feet a year with an associated value of $2.5 thousand (see Appendix I for more details). Avoided runoff is estimated based on local weather from the user-designated weather station. In Town of Garrett Park, the total annual precipitation in 2015 was 47.9 inches.

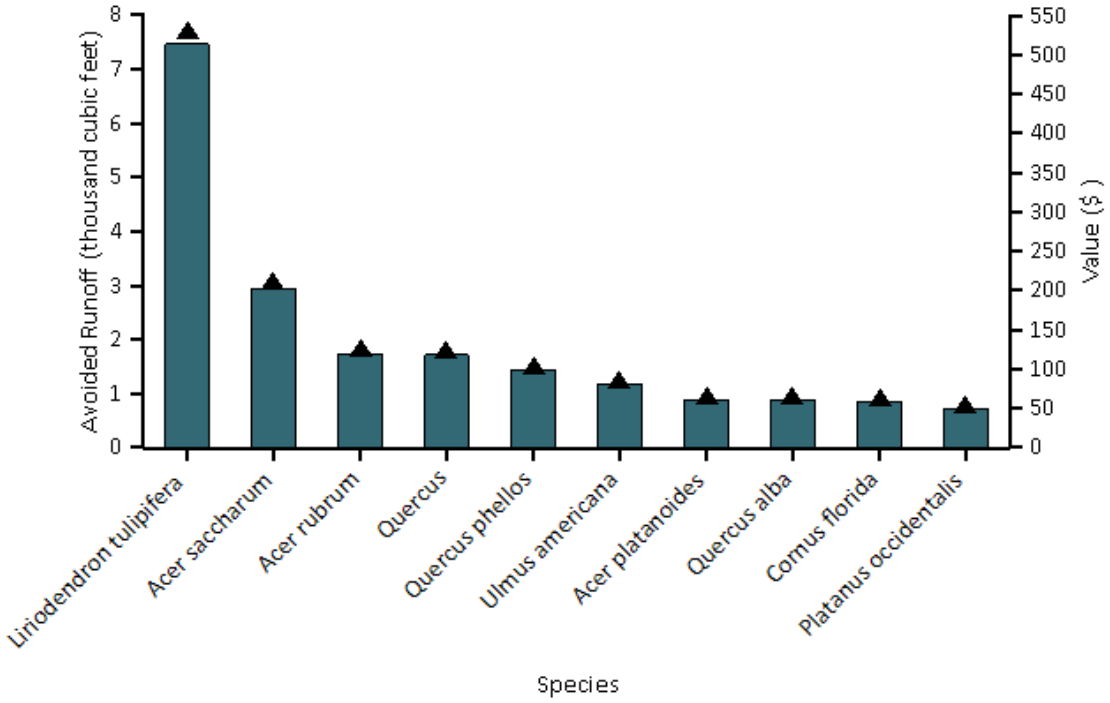


Figure 10. Avoided runoff (points) and value (bars) for species with greatest overall impact on runoff, Town of Garrett Park

VII. Trees and Building Energy Use

Because energy-related data were not collected, energy savings and carbon avoided cannot be calculated for Garrett Park based on this inventory.

However, as a general observation, trees affect energy consumption by shading buildings, providing evaporative cooling, and blocking winter winds. Trees tend to reduce building energy consumption in the summer months and can either increase or decrease building energy use in the winter months, depending on the location of trees around the building.[5] Estimates of tree effects on energy use are based on field measurements of tree distance and direction to space conditioned residential buildings (McPherson and Simpson 1999).

[5] Trees modify climate, produce shade, and reduce wind speeds. Increased energy use or costs are likely due to these tree-building interactions creating a cooling effect during the winter season. For example, a tree (particularly evergreen species) located on the southern side of a residential building may produce a shading effect that causes increases in heating requirements.

VIII. Structural and Functional Values

Urban forests have a structural value based on the trees themselves (e.g., the cost of having to replace a tree with a similar tree); they also have functional values (either positive or negative) based on the functions the trees perform.

The structural value of an urban forest tends to increase with a rise in the number and size of healthy trees (Nowak et al 2002a). Annual functional values also tend to increase with increased number and size of healthy trees. Through proper management, urban forest values can be increased; however, the values and benefits also can decrease as the amount of healthy tree cover declines.

Urban trees in Town of Garrett Park have the following structural values:

- Structural value: $5.72 million
- Carbon storage: $158 thousand

Urban trees in Town of Garrett Park have the following annual functional values:

- Carbon sequestration: $3.39 thousand
- Avoided runoff: $2.47 thousand
- Pollution removal: $3.12 thousand
- Energy costs and carbon emission values: $0

(Note: negative value indicates increased energy cost and carbon emission value)

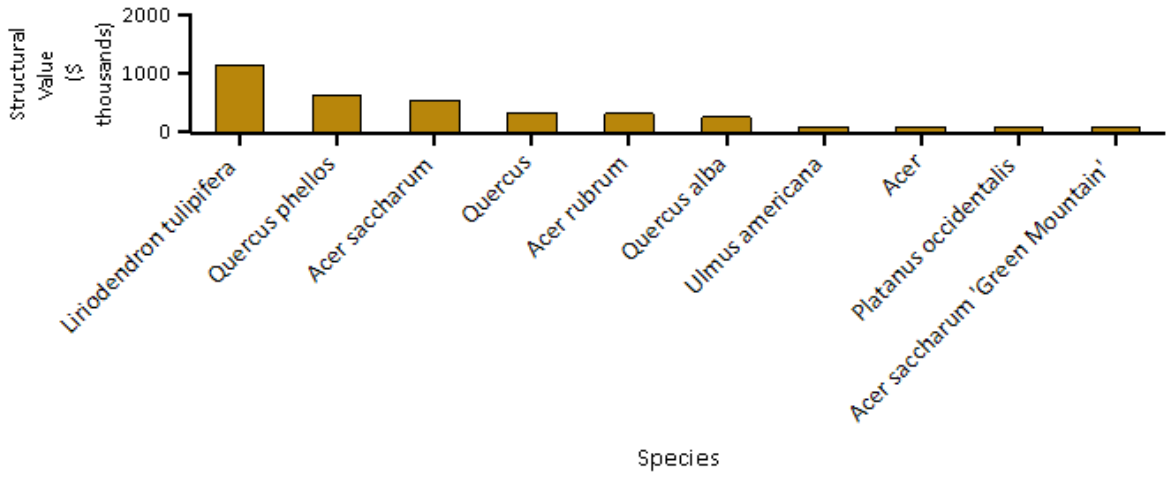


Figure 11. Tree species with the greatest structural value, Town of Garrett Park

IX. Potential Pest Impacts

Various insects and diseases can infest urban forests, potentially killing trees and reducing the health, structural value and sustainability of the urban forest. As pests tend to have differing tree hosts, the potential damage or risk of each pest will differ among cities.Thirty-six pests were analyzed for their potential impact and compared with pest range maps (Forest Health Technology Enterprise Team 2014) for the conterminous United States to determine their proximity to Montgomery County. Eleven of the thirty-six pests analyzed are located within the county. For a complete analysis of all pests, see Appendix VII.

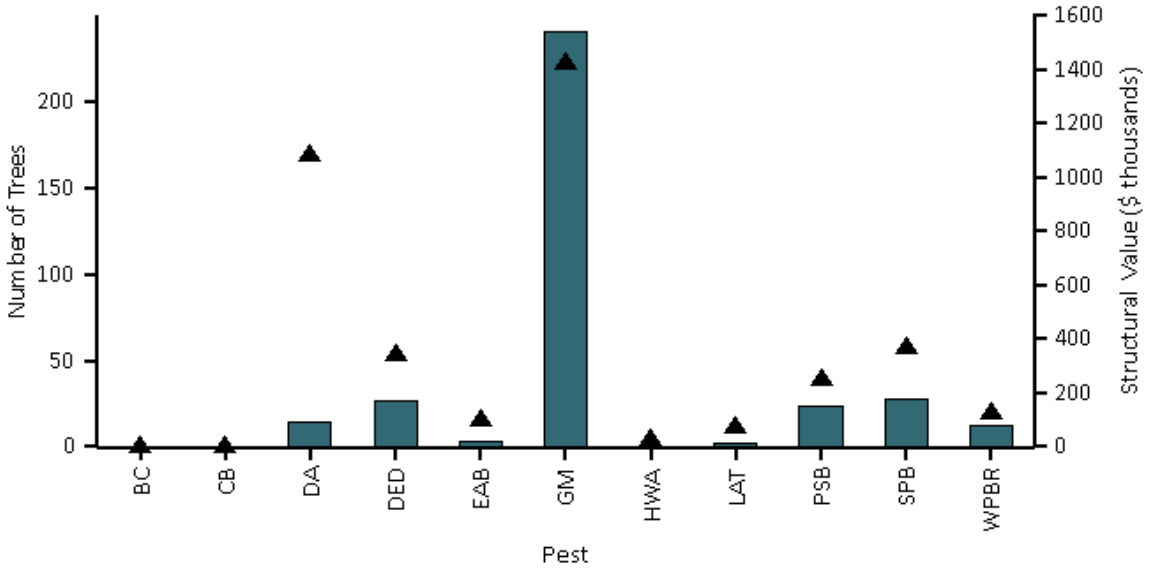


Figure 12. Number of trees at risk (points) and associated compensatory value (bars) for most threatening pests located in the county, Town of Garrett Park

Butternut canker (BC) (Ostry et al 1996) is caused by a fungus that infects butternut trees. The disease has since caused significant declines in butternut populations in the United States. Potential loss of trees from BC is 0.0 percent ($0 in structural value).

The most common hosts of the fungus that cause chestnut blight (CB) (Diller 1965) are American and European chestnut. CB has the potential to affect 0.0 percent of the population ($0 in structural value).

Dogwood anthracnose (DA) (Mielke and Daughtrey) is a disease that affects dogwood species, specifically flowering and Pacific dogwood. This disease threatens 11.2 percent of the population, which represents a potential loss of $91.8 thousand in structural value.

American elm, one of the most important street trees in the twentieth century, has been devastated by the Dutch elm disease (DED) (Northeastern Area State and Private Forestry 1998). Since first reported in the 1930s, it has killed over 50 percent of the native elm population in the United States. Although some elm species have shown varying degrees of resistance, Town of Garrett Park could possibly lose 3.5 percent of its trees to this pest ($171 thousand in structural value).

Emerald ash borer (EAB) (Michigan State University 2010) has killed thousands of ash trees in parts of the United States. EAB has the potential to affect 1.0 percent of the population ($22.9 thousand in structural value).

The gypsy moth (GM) (Northeastern Area State and Private Forestry 2005) is a defoliator that feeds on many species causing widespread defoliation and tree death if outbreak conditions last several years. This pest threatens 14.7 percent of the population, which represents a potential loss of $1.54 million in structural value.

As one of the most damaging pests to eastern hemlock and Carolina hemlock, hemlock woolly adelgid (HWA) (U.S. Forest Service 2005) has played a large role in hemlock mortality in the United States. HWA has the potential to affect 0.3 percent of the population ($1.65 thousand in structural value).

Quaking aspen is a principal host for the defoliator, large aspen tortrix (LAT) (Ciesla and Kruse 2009). LAT poses a threat to 0.7 percent of the Town of Garrett Park urban forest, which represents a potential loss of $14 thousand in structural value.

The pine shoot beetle (PSB) (Ciesla 2001) is a wood borer that attacks various pine species, though Scotch pine is the preferred host in North America. PSB has the potential to affect 2.6 percent of the population ($153 thousand in structural value).

Although the southern pine beetle (SPB) (Clarke and Nowak 2009) will attack most pine species, its preferred hosts are loblolly, Virginia, pond, spruce, shortleaf, and sand pines. This pest threatens 3.8 percent of the population, which represents a potential loss of $177 thousand in structural value.

Since its introduction to the United States in 1900, white pine blister rust (Eastern U.S.) (WPBR) (Nicholls and Anderson 1977) has had a detrimental effect on white pines, particularly in the Lake States. WPBR has the potential to affect 1.3 percent of the population ($81.9 thousand in structural value).

Appendix I. i-Tree Eco Model and Field Measurements

i-Tree Eco is designed to use standardized field data and local hourly air pollution and meteorological data to quantify urban forest structure and its numerous effects (Nowak and Crane 2000), including:

- Urban forest structure (e.g., species composition, tree health, leaf area, etc.).
- Amount of pollution removed hourly by the urban forest, and its associated percent air quality improvement throughout a year.
- Total carbon stored and net carbon annually sequestered by the urban forest.
- Effects of trees on building energy use and consequent effects on carbon dioxide emissions from power sources.
- Structural value of the forest, as well as the value for air pollution removal and carbon storage and sequestration.
- Potential impact of infestations by pests, such as Asian longhorned beetle, emerald ash borer, gypsy moth, and Dutch elm disease.

Typically, all field data are collected during the leaf-on season to properly assess tree canopies. Typical data collection (actual data collection may vary depending upon the user) includes land use, ground and tree cover, individual tree attributes of species, stem diameter, height, crown width, crown canopy missing and dieback, and distance and direction to residential buildings (Nowak et al 2005; Nowak et al 2008).

During data collection, trees are identified to the most specific taxonomic classification possible. Trees that are not classified to the species level may be classified by genus (e.g., ash) or species groups (e.g., hardwood). In this report, tree species, genera, or species groups are collectively referred to as tree species.

Tree Characteristics:

Leaf area of trees was assessed using measurements of crown dimensions and percentage of crown canopy missing. In the event that these data variables were not collected, they are estimated by the model.

An analysis of invasive species is not available for studies outside of the United States. For the U.S., invasive species are identified using an invasive species list (Maryland Invasive Species Council 2014a; 2014b)for the state in which the urban forest is located. These lists are not exhaustive and they cover invasive species of varying degrees of invasiveness and distribution. In instances where a state did not have an invasive species list, a list was created based on the lists of the adjacent states. Tree species that are identified as invasive by the state invasive species list are cross-referenced with native range data. This helps eliminate species that are on the state invasive species list, but are native to the study area.

Air Pollution Removal:

Pollution removal is calculated for ozone, sulfur dioxide, nitrogen dioxide, carbon monoxide and particulate matter less than 2.5 microns. Particulate matter less than 10 microns (PM10) is another significant air pollutant. Given that i-Tree Eco analyzes particulate matter less than 2.5 microns (PM2.5) which is a subset of PM10, PM10 has not been included in this analysis. PM2.5 is generally more relevant in discussions concerning air pollution effects on human health.

Air pollution removal estimates are derived from calculated hourly tree-canopy resistances for ozone, and sulfur and nitrogen dioxides based on a hybrid of big-leaf and multi-layer canopy deposition models (Baldocchi 1988; Baldocchi et al 1987). As the removal of carbon monoxide and particulate matter by vegetation is not directly related to transpiration, removal rates (deposition velocities) for these pollutants were based on average measured values from the literature (Bidwell and Fraser 1972; Lovett 1994) that were adjusted depending on leaf phenology and leaf area.

Particulate removal incorporated a 50 percent resuspension rate of particles back to the atmosphere (Zinke 1967). Recent updates (2011) to air quality modeling are based on improved leaf area index simulations, weather and pollution processing and interpolation, and updated pollutant monetary values (Hirabayashi et al 2011; Hirabayashi et al 2012; Hirabayashi 2011).

Trees remove PM2.5 when particulate matter is deposited on leaf surfaces (Nowak et al 2013). This deposited PM2.5 can be resuspended to the atmosphere or removed during rain events and dissolved or transferred to the soil. This combination of events can lead to positive or negative pollution removal and value depending on various atmospheric factors. Generally, PM2.5 removal is positive with positive benefits. However, there are some cases when net removal is negative or resuspended particles lead to increased pollution concentrations and negative values. During some months (e.g., with no rain), trees resuspend more particles than they remove. Resuspension can also lead to increased overall PM2.5 concentrations if the boundary layer conditions are lower during net resuspension periods than during net removal periods. Since the pollution removal value is based on the change in pollution concentration, it is possible to have situations when trees remove PM2.5 but increase concentrations and thus have negative values during periods of positive overall removal. These events are not common, but can happen.

For reports in the United States, default air pollution removal value is calculated based on local incidence of adverse health effects and national median externality costs. The number of adverse health effects and associated economic value is calculated for ozone, sulfur dioxide, nitrogen dioxide, and particulate matter less than 2.5 microns using data from the U.S. Environmental Protection Agency's Environmental Benefits Mapping and Analysis Program (BenMAP) (Nowak et al 2014). The model uses a damage-function approach that is based on the local change in pollution concentration and population. National median externality costs were used to calculate the value of carbon monoxide removal (Murray et al 1994).

For international reports, user-defined local pollution values are used. For international reports that do not have local values, estimates are based on either European median externality values (van Essen et al 2011) or BenMAP regression equations (Nowak et al 2014) that incorporate user-defined population estimates. Values are then converted to local currency with user-defined exchange rates.

For this analysis, pollution removal value is calculated based on the prices of $1,380 per ton (carbon monoxide), $2,407 per ton (ozone), $511 per ton (nitrogen dioxide), $120 per ton (sulfur dioxide), $111,412 per ton (particulate matter less than 2.5 microns).

Carbon Storage and Sequestration:

Carbon storage is the amount of carbon bound up in the above-ground and below-ground parts of woody vegetation. To calculate current carbon storage, biomass for each tree was calculated using equations from the literature and measured tree data. Open-grown, maintained trees tend to have less biomass than predicted by forest-derived biomass equations (Nowak 1994). To adjust for this difference, biomass results for open-grown urban trees were multiplied by 0.8. No adjustment was made for trees found in natural stand conditions. Tree dry-weight biomass was converted to stored carbon by multiplying by 0.5.

Carbon sequestration is the removal of carbon dioxide from the air by plants. To estimate the gross amount of carbon sequestered annually, average diameter growth from the appropriate genera and diameter class and tree condition was added to the existing tree diameter (year x) to estimate tree diameter and carbon storage in year x+1.

Carbon storage and carbon sequestration values are based on estimated or customized local carbon values. For international reports that do not have local values, estimates are based on the carbon value for the United States (U.S. Environmental Protection Agency 2015, Interagency Working Group on Social Cost of Carbon 2015) and converted to local currency with user-defined exchange rates.

For this analysis, carbon storage and carbon sequestration values are calculated based on $171 per ton.

Oxygen Production:

The amount of oxygen produced is estimated from carbon sequestration based on atomic weights: net O2 release (kg/yr) = net C sequestration (kg/yr) × 32/12. To estimate the net carbon sequestration rate, the amount of carbon sequestered as a result of tree growth is reduced by the amount lost resulting from tree mortality. Thus, net carbon sequestration and net annual oxygen production of the urban forest account for decomposition (Nowak et al 2007). For complete inventory projects, oxygen production is estimated from gross carbon sequestration and does not account for decomposition.

Avoided Runoff:

Annual avoided surface runoff is calculated based on rainfall interception by vegetation, specifically the difference between annual runoff with and without vegetation. Although tree leaves, branches, and bark may intercept precipitation and thus mitigate surface runoff, only the precipitation intercepted by leaves is accounted for in this analysis.

The value of avoided runoff is based on estimated or user-defined local values. For international reports that do not have local values, the national average value for the United States is utilized and converted to local currency with user-defined exchange rates. The U.S. value of avoided runoff is based on the U.S. Forest Service's Community Tree Guide Series (McPherson et al 1999; 2000; 2001; 2002; 2003; 2004; 2006a; 2006b; 2006c; 2007; 2010; Peper et al 2009; 2010; Vargas et al 2007a; 2007b; 2008).

For this analysis, avoided runoff value is calculated based on the price of $0.07 per ft^3.

Building Energy Use:

If appropriate field data were collected, seasonal effects of trees on residential building energy use were calculated based on procedures described in the literature (McPherson and Simpson 1999) using distance and direction of trees from residential structures, tree height and tree condition data. To calculate the monetary value of energy savings, local or custom prices per MWH or MBTU are utilized.

For this analysis, energy saving value is calculated based on the prices of $129.18 per MWH and $15.46 per MBTU.

Structural Values:

Structural value is the value of a tree based on the physical resource itself (e.g., the cost of having to replace a tree with a similar tree). Structural values were based on valuation procedures of the Council of Tree and Landscape Appraisers, which uses tree species, diameter, condition, and location information (Nowak et al 2002a; 2002b). Structural value may not be included for international projects if there is insufficient local data to complete the valuation procedures.

Potential Pest Impacts:

The complete potential pest risk analysis is not available for studies outside of the United States. The number of trees at risk to the pests analyzed is reported, though the list of pests is based on known insects and disease in the United States.

For the U.S., potential pest risk is based on pest range maps and the known pest host species that are likely to

experience mortality. Pest range maps for 2012 from the Forest Health Technology Enterprise Team (FHTET) (Forest Health Technology Enterprise Team 2014) were used to determine the proximity of each pest to the county in which the urban forest is located. For the county, it was established whether the insect/disease occurs within the county, is within 250 miles of the county edge, is between 250 and 750 miles away, or is greater than 750 miles away. FHTET did not have pest range maps for Dutch elm disease and chestnut blight. The range of these pests was based on known occurrence and the host range, respectively (Eastern Forest Environmental Threat Assessment Center; Worrall 2007).

Relative Tree Effects:

The relative value of tree benefits reported in Appendix II is calculated to show what carbon storage and sequestration, and air pollutant removal equate to in amounts of municipal carbon emissions, passenger automobile emissions, and house emissions.

Municipal carbon emissions are based on 2010 U.S. per capita carbon emissions (Carbon Dioxide Information Analysis Center 2010). Per capita emissions were multiplied by city population to estimate total city carbon emissions.

Light duty vehicle emission rates (g/mi) for CO, NOx, VOCs, PM10, SO2 for 2010 (Bureau of Transportation Statistics 2010; Heirigs et al 2004), PM2.5 for 2011-2015 (California Air Resources Board 2013), and CO2 for 2011 (U.S. Environmental Protection Agency 2010) were multiplied by average miles driven per vehicle in 2011 (Federal Highway Administration 2013) to determine average emissions per vehicle.

Household emissions are based on average electricity kWh usage, natural gas Btu usage, fuel oil Btu usage, kerosene Btu usage, LPG Btu usage, and wood Btu usage per household in 2009 (Energy Information Administration 2013; Energy Information Administration 2014)

- CO2, SO2, and NOx power plant emission per KWh are from Leonardo Academy 2011. CO emission per kWh assumes 1/3 of one percent of C emissions is CO based on Energy Information Administration 1994. PM10 emission per kWh from Layton 2004.
- CO2, NOx, SO2, and CO emission per Btu for natural gas, propane and butane (average used to represent LPG), Fuel #4 and #6 (average used to represent fuel oil and kerosene) from Leonardo Academy 2011.
- CO2 emissions per Btu of wood from Energy Information Administration 2014.
- CO, NOx and SOx emission per Btu based on total emissions and wood burning (tons) from (British Columbia Ministry 2005; Georgia Forestry Commission 2009).

Appendix II. Relative Tree Effects

The urban forest in Town of Garrett Park provides benefits that include carbon storage and sequestration, and air pollutant removal. To estimate the relative value of these benefits, tree benefits were compared to estimates of average municipal carbon emissions, average passenger automobile emissions, and average household emissions. See Appendix I for methodology.

Carbon storage is equivalent to:

- Amount of carbon emitted in Town of Garrett Park in 64 days
- Annual carbon (C) emissions from 655 automobiles
- Annual C emissions from 268 single-family houses

Carbon monoxide removal is equivalent to:

- Annual carbon monoxide emissions from 0 automobiles
- Annual carbon monoxide emissions from 0 single-family houses

Nitrogen dioxide removal is equivalent to:

- Annual nitrogen dioxide emissions from 8 automobiles
- Annual nitrogen dioxide emissions from 4 single-family houses

Sulfur dioxide removal is equivalent to:

- Annual sulfur dioxide emissions from 188 automobiles
- Annual sulfur dioxide emissions from 0 single-family houses

Annual carbon sequestration is equivalent to:

- Amount of carbon emitted in Town of Garrett Park in 1.4 days
- Annual C emissions from 0 automobiles
- Annual C emissions from 0 single-family houses

Appendix III. Comparison of Urban Forests

A common question asked is, "How does this city compare to other cities?" Although comparison among cities should be made with caution as there are many attributes of a city that affect urban forest structure and functions, summary data are provided from other cities analyzed using the i-Tree Eco model.

I. City totals for trees

City	*% Tree Cover*	*Number of Trees*	*Carbon Storage (tons)*	*Carbon Sequestration (tons/yr)*	*Pollution Removal (tons/yr)*
Toronto, ON, Canada	26.6	10,220,000	1,221,000	51,500	2,099
Atlanta, GA	36.7	9,415,000	1,344,000	46,400	1,663
Los Angeles, CA	11.1	5,993,000	1,269,000	77,000	1,975
New York, NY	20.9	5,212,000	1,350,000	42,300	1,676
London, ON, Canada	24.7	4,376,000	396,000	13,700	408
Chicago, IL	17.2	3,585,000	716,000	25,200	888
Baltimore, MD	21.0	2,479,000	570,000	18,400	430
Philadelphia, PA	15.7	2,113,000	530,000	16,100	575
Washington, DC	28.6	1,928,000	525,000	16,200	418
Oakville, ON , Canada	29.1	1,908,000	147,000	6,600	190
Boston, MA	22.3	1,183,000	319,000	10,500	283
Syracuse, NY	26.9	1,088,000	183,000	5,900	109
Woodbridge, NJ	29.5	986,000	160,000	5,600	210
Minneapolis, MN	26.4	979,000	250,000	8,900	305
San Francisco, CA	11.9	668,000	194,000	5,100	141
Morgantown, WV	35.5	658,000	93,000	2,900	72
Moorestown, NJ	28.0	583,000	117,000	3,800	118
Hartford, CT	25.9	568,000	143,000	4,300	58
Jersey City, NJ	11.5	136,000	21,000	890	41
Casper, WY	8.9	123,000	37,000	1,200	37
Freehold, NJ	34.4	48,000	20,000	540	22

II. Totals per acre of land area

City	*Number of Trees/ac*	*Carbon Storage (tons/ac)*	*Carbon Sequestration (tons/ac/yr)*	*Pollution Removal (lb/ac/yr)*
Toronto, ON, Canada	64.9	7.8	0.33	26.7
Atlanta, GA	111.6	15.9	0.55	39.4
Los Angeles, CA	19.6	4.2	0.16	13.1
New York, NY	26.4	6.8	0.21	17.0
London, ON, Canada	75.1	6.8	0.24	14.0
Chicago, IL	24.2	4.8	0.17	12.0
Baltimore, MD	48.0	11.1	0.36	16.6
Philadelphia, PA	25.1	6.3	0.19	13.6
Washington, DC	49.0	13.3	0.41	21.2
Oakville, ON , Canada	78.1	6.0	0.27	11.0
Boston, MA	33.5	9.1	0.30	16.1
Syracuse, NY	67.7	10.3	0.34	13.6
Woodbridge, NJ	66.5	10.8	0.38	28.4
Minneapolis, MN	26.2	6.7	0.24	16.3
San Francisco, CA	22.5	6.6	0.17	9.5
Morgantown, WV	119.2	16.8	0.52	26.0
Moorestown, NJ	62.1	12.4	0.40	25.1
Hartford, CT	50.4	12.7	0.38	10.2
Jersey City, NJ	14.4	2.2	0.09	8.6
Casper, WY	9.1	2.8	0.09	5.5
Freehold, NJ	38.3	16.0	0.44	35.3

Appendix IV. General Recommendations for Air Quality Improvement

Urban vegetation can directly and indirectly affect local and regional air quality by altering the urban atmosphere environment. Four main ways that urban trees affect air quality are (Nowak 1995):

- Temperature reduction and other microclimate effects
- Removal of air pollutants
- Emission of volatile organic compounds (VOC) and tree maintenance emissions
- Energy effects on buildings

The cumulative and interactive effects of trees on climate, pollution removal, and VOC and power plant emissions determine the impact of trees on air pollution. Cumulative studies involving urban tree impacts on ozone have revealed that increased urban canopy cover, particularly with low VOC emitting species, leads to reduced ozone concentrations in cities (Nowak 2000). Local urban management decisions also can help improve air quality.

Urban forest management strategies to help improve air quality include (Nowak 2000):

Strategy	*Result*
Increase the number of healthy trees	Increase pollution removal
Sustain existing tree cover	Maintain pollution removal levels
Maximize use of low VOC-emitting trees	Reduces ozone and carbon monoxide formation
Sustain large, healthy trees	Large trees have greatest per-tree effects
Use long-lived trees	Reduce long-term pollutant emissions from planting and removal
Use low maintenance trees	Reduce pollutants emissions from maintenance activities
Reduce fossil fuel use in maintaining vegetation	Reduce pollutant emissions
Plant trees in energy conserving locations	Reduce pollutant emissions from power plants
Plant trees to shade parked cars	Reduce vehicular VOC emissions
Supply ample water to vegetation	Enhance pollution removal and temperature reduction
Plant trees in polluted or heavily populated areas	Maximizes tree air quality benefits
Avoid pollutant-sensitive species	Improve tree health
Utilize evergreen trees for particulate matter	Year-round removal of particles

Appendix V. Invasive Species of the Urban Forest

The following inventoried tree species were listed as invasive on the Maryland invasive species list (Maryland Invasive Species Council 2014a; 2014b):

Species Name[a]	*Number of Trees*	*% of Trees*	*Leaf Area (ac)*	*Percent Leaf Area*
Acer platanoides	27	1.8	2.3	2.5
Pyrus calleryana	1	0.1	0.0	0.0
Total	**28**	**1.86**	**2.31**	**2.49**

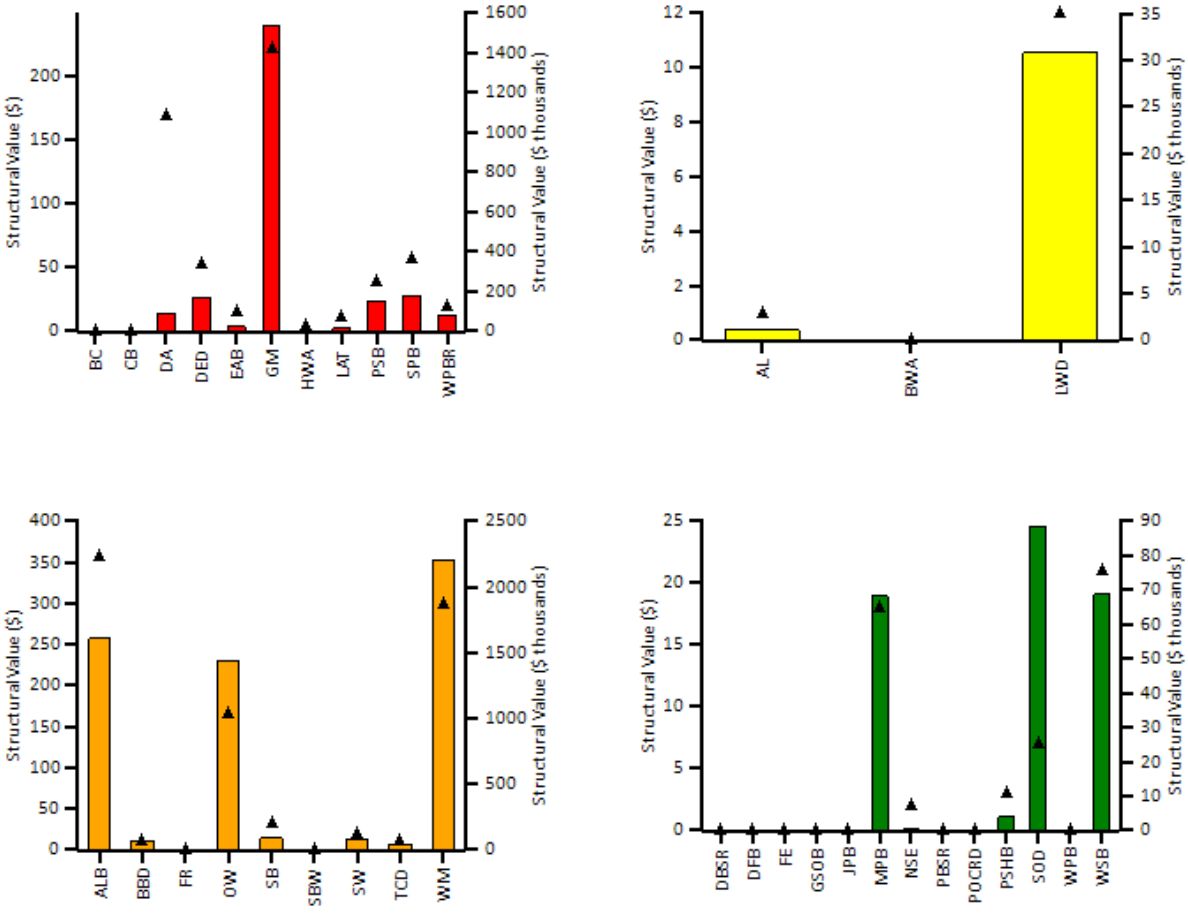
[a]Species are determined to be invasive if they are listed on the state's invasive species list

Appendix VI. Potential Risk of Pests

Thirty-six insects and diseases were analyzed to quantify their potential impact on the urban forest. As each insect/ disease is likely to attack different host tree species, the implications for {0} will vary. The number of trees at risk reflects only the known host species that are likely to experience mortality.

Code	Scientific Name	Common Name	Trees at Risk (#)	Value ($ thousands)
AL	Phyllocnistis populiella	Aspen Leafminer	1	1.06
ALB	Anoplophora glabripennis	Asian Longhorned Beetle	358	1,606.62
BBD	Neonectria faginata	Beech Bark Disease	10	72.30
BC	Sirococcus clavigignenti juglandacearum	Butternut Canker	0	0.00
BWA	Adelges piceae	Balsam Woolly Adelgid	0	0.00
CB	Cryphonectria parasitica	Chestnut Blight	0	0.00
DA	Discula destructiva	Dogwood Anthracnose	169	91.81
DBSR	Leptographium wageneri var. pseudotsugae	Douglas-fir Black Stain Root Disease	0	0.00
DED	Ophiostoma novo-ulmi	Dutch Elm Disease	53	170.91
DFB	Dendroctonus pseudotsugae	Douglas-Fir Beetle	0	0.00
EAB	Agrilus planipennis	Emerald Ash Borer	15	22.87
FE	Scolytus ventralis	Fir Engraver	0	0.00
FR	Cronartium quercuum f. sp. Fusiforme	Fusiform Rust	0	0.00
GM	Lymantria dispar	Gypsy Moth	222	1,539.80
GSOB	Agrilus auroguttatus	Goldspotted Oak Borer	0	0.00
HWA	Adelges tsugae	Hemlock Woolly Adelgid	4	1.65
JPB	Dendroctonus jeffreyi	Jeffrey Pine Beetle	0	0.00
LAT	Choristoneura conflictana	Large Aspen Tortrix	11	14.02
LWD	Raffaelea lauricola	Laurel Wilt	12	30.77
MPB	Dendroctonus ponderosae	Mountain Pine Beetle	18	68.27
NSE	Ips perturbatus	Northern Spruce Engraver	2	0.38
OW	Ceratocystis fagacearum	Oak Wilt	166	1,437.79
PBSR	Leptographium wageneri var. ponderosum	Pine Black Stain Root Disease	0	0.00
POCRD	Phytophthora lateralis	Port-Orford-Cedar Root Disease	0	0.00
PSB	Tomicus piniperda	Pine Shoot Beetle	39	152.60
PSHB	Euwallacea nov. sp.	Polyphagous Shot Hole Borer	3	4.05
SB	Dendroctonus rufipennis	Spruce Beetle	33	89.79
SBW	Choristoneura fumiferana	Spruce Budworm	0	0.00
SOD	Phytophthora ramorum	Sudden Oak Death	7	88.63
SPB	Dendroctonus frontalis	Southern Pine Beetle	57	176.55
SW	Sirex noctilio	Sirex Wood Wasp	19	81.91
TCD	Geosmithia morbida	Thousand Canker Disease	11	41.22
WM	Operophtera brumata	Winter Moth	299	2,205.76
WPB	Dendroctonus brevicomis	Western Pine Beetle	0	0.00
WPBR	Cronartium ribicola	White Pine Blister Rust	19	81.91
WSB	Choristoneura occidentalis	Western Spruce Budworm	21	68.71

In the following graph, the pests are color coded according to the county's proximity to the pest occurrence in the United States. Red indicates that the pest is within the county; orange indicates that the pest is within 250 miles of the county; yellow indicates that the pest is within 750 miles of the county; and green indicates that the pest is outside of these ranges.



Note: points - Number of trees, bars - Structural value

APPENDIX C

Based on the host tree species for each pest and the current range of the pest (Forest Health Technology Enterprise Team 2014), it is possible to determine what the risk is that each tree species in the urban forest could be attacked by an insect or disease.

Spp. Risk	Risk Weight	Species Name	AL	ALB	BBD	BC	BWA	CB	DA	DBSR	DED	DFB	EAB	FE	FR	GM	GSOB	HWA	JPB	LAT	LWD	MPB	NSE	OW	PBSR	POCRD	PSB	PSHB	SB	SBW	SOD	SPB	SW	TCD	WM	WPB	WPBR	WSB
	15	Pinus strobus																																				
	14	Betula nigra																																				
	13	Picea abies																																				
	13	Salix																																				
	11	Quercus rubra																																				
	11	Quercus falcata																																				
	10	Ulmus americana																																				
	10	Quercus phellos																																				
	10	Quercus alba																																				
	10	Quercus lyrata																																				
	10	Quercus bicolor																																				
	10	Quercus shumardii																																				
	10	Quercus macrocarpa																																				
	10	Quercus pagoda																																				
	10	Quercus prinus																																				
	10	Quercus oglethorpensis																																				
	10	Quercus muehlenbergii																																				
	10	Quercus michauxii																																				
	9	Picea glauca																																				
	8	Tsuga canadensis																																				
	8	Larix decidua																																				
	8	Quercus robur																																				
	8	Picea pungens																																				
	7	Quercus																																				
	7	Ulmus parvifolia																																				
	7	Quercus acutissima																																				
	7	Ulmus																																				
	7	Picea																																				
	7	Fraxinus americana																																				
	7	Fraxinus quadrangulata																																				

APPENDIX C

	7	Ulmus wilsoniana
	7	Quercus aliena
	7	Betula
	7	Acer negundo
	6	Acer saccharum
	6	Acer rubrum
	6	Acer platanoides
	6	Acer saccharinum
	6	Populus deltoides
	4	Cornus florida
	4	Cornus kousa
	4	Fraxinus
	4	Malus
	4	Liquidambar styraciflua
	4	Cornus mas
	4	Cornus alternifolia
	4	Cornus
	4	Tilia cordata
	4	Pyrus calleryana
	4	Ostrya virginiana
	4	Malus sargentii
	4	Tsuga
	4	Tilia tomentosa
	4	Alnus cordata
	4	Crataegus
	3	Acer japonicum
	3	Acer
	3	Juglans nigra
	3	Acer saccharum 'Green Mountain'
	3	Acer palmatum
	3	Prunus serotina
	3	Fagus grandifolia
	3	Fagus sylvatica
	3	Aesculus pavia
	3	Cercidiphyllum japonicum
	3	Acer griseum

	3	Acer x freemanii																																						
	3	Acer campestre																																						
	3	Acer tataricum																																						
	3	Acer buergerianum																																						
	3	Aesculus x carnea																																						
	3	Aesculus hippocastanum																																						
	3	Aesculus																																						
	3	Acer truncatum																																						
	3	Acer rubrum 'October glory'																																						
	3	Acer pseudosieboldianum																																						
	3	Acer palmatum 'Dissectum'																																						
	2	Sassafras albidum																																						

Note:
Species that are not listed in the matrix are not known to be hosts to any of the pests analyzed.

Species Risk:

- Red indicates that tree species is at risk to at least one pest within county
- Orange indicates that tree species has no risk to pests in county, but has a risk to at least one pest within 250 miles from the county
- Yellow indicates that tree species has no risk to pests within 250 miles of county, but has a risk to at least one pest that is 250 and 750 miles from the county
- Green indicates that tree species has no risk to pests within 750 miles of county, but has a risk to at least one pest that is greater than 750 miles from the county

Risk Weight:
Numerical scoring system based on sum of points assigned to pest risks for species. Each pest that could attack tree species is scored as 4 points if red, 3 points if orange, 2 points if yellow and 1 point if green.

Pest Color Codes:

- Red indicates pest is within Montgomery county
- Red indicates pest is within 250 miles county
- Yellow indicates pest is within 750 miles of Montgomery county
- Green indicates pest is outside of these ranges

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Appendix D. Invasive Plant Species

TABLE 1. INVASIVE PLANTS IN PORCUPINE WOODS

Species	Common Name
Alliaria petiolata	Garlic mustard
Arum italicum	Italian arum
Berberis thunbergii	Japanese barberry
Ficaria verna	Lesser celandine
Hedera helix	English ivy
Lonicera japonica	Japanese honeysuckle
Lonicera maackii	Amur honeysuckle
Perilla frutescens	Perilla, beefsteak plant
Phyllostachys sp.	Running bamboo
Rubus phoenicolasius	Wineberry
Viburnum sp.	Viburnum
Vinca minor	Vinca

TABLE 2. MARYLAND TIER 1 AND TIER 2 REGULATED ORNAMENTAL INVASIVE PLANTS. TIER 1 PLANTS CANNOT BE SOLD OR PLANTED IN MARYLAND. TIER 2 PLANTS CAN BE SOLD BUT MUST BE LABELED AS INVASIVE IN NURSERIES. AS OF DECEMBER, 2018 THIS LIST INCLUDES:

Latin name	Common Name	Tier
Iris pseudacorus	Yellow flag iris	1
Geranium lucidum	Shining geranium	1
Euonymus fortunei	Wintercreeper euonymus	1
Lonicera maackii	Amur shrub honeysuckle	1
Euonymus alatus	Burning bush	2
Ligustrum obtusifolium	Border privet	2
Wisteria sinensis	Chinese wisteria	2

Wisteria floribunda	Japanese wisteria	2
Wisteria x *Formosa*	*Floribunda* x *sinensis* wisteria	2
Cytisus scoparius	Scotch broom	2
Nandina domestica	Heavenly bamboo	2

TABLE 3. THESE PLANTS PRESENT THE MOST SERIOUS THREATS TO NATURAL AREAS IN MONTGOMERY COUNTY, INCLUDING PARKLAND OWNED AND MANAGED BY MONTGOMERY PARKS (MONTGOMERY PARKS, 2019):

- Autumn olive – Elaeagnus umbellata
- Beefsteak – Perilla frutescens
- Bush honeysuckles – Lonicera spp. (ex. Lonicera maackii)
- Callery or Bradford Pear – Pyrus calleryana
- Canada thistle – Cirsium arvense
- Chinese lespedeza – Lespedeza cuneata
- Common daylily – Hemerocallis fulva
- Crownvetch – Securigera varia
- Doublefile Viburnum – Viburnum plicatum var. tomentosum
- English ivy – Hedera helix
- Five-leaved akebia – Akebia quinata
- Fountaingrass – Pennisetum alopecuroides
- Garlic mustard – Alliaria petiolata
- Hairy jointgrass – Arthraxon hispidus
- Japanese honeysuckle – Lonicera japonica
- Japanese hops – Humulus japonica
- Japanese knotweed – Fallopia japonica
- Japanese or Vietnamese stiltgrass – Microstegium vimineum
- Japanese barberry – Berberis thunbergii
- Kudzu – Pueraria montana var. lobata
- Lesser celandine – Ficaria verna
- Linden Viburnum – Viburnum dilitatum
- Mahonia – Mahonia bealei and Mahonia aquifolium
- Mile-a-minute or Devil's tearthumb – Polygonum perfoliatum
- Multiflora rose – Rosa multiflora
- Norway maple – Acer platanoides
- Oriental bittersweet – Celastrus orbiculatus
- Periwinkle – Vinca minor
- Porcelainberry – Ampelopsis brevipedunculata
- Princess tree – Paulownia tomentosa
- Privets – Ligustrum spp.
- Purple loosestrife – Lythrum salicaria
- Spotted knapweed – Centaurea maculosa
- Teasel – Dipsacus fullonum
- Tree-of-heaven – Ailanthus altissima
- Wavyleaf basketgrass – Oplismenus undulatifolius
- Wineberry – Rubus phoenicolasius
- Winged burning bush – Euonymus alatus
- Wintercreeper or climbing euonymus – Euonymus fortunei
- Wisteria – Wisteria spp.
- Running bamboos – various species

Appendix E. Voluntary Codes of Conduct for Botanic Gardens and Arboreta

Endorsed by American Public Gardens Association, February 2002 (https://www.publicgardens.org/resources/invasive-plant-species-voluntary-codes-conduct-botanic-gardens-arboreta)

- Conduct an institution-wide review examining all departments and activities that provide opportunities to stem the proliferation of invasive species and inform visitors. For example, review or write a collections policy that addresses this issue; examine such activities as seed sales, plant sales, book store offerings, wreath-making workshops, etc.

- Avoid introducing invasive plants by establishing an invasive plant assessment procedure. Predictive risk assessments are desirable, and should also include responsible monitoring on the garden site or through partnerships with other institutions. Institutions should be aware of both direct and indirect effects of plant introduction, such as biological interference in gene flow, disruption of pollinator relationships, etc.

- Consider removing invasive species from plant collections. If a decision is made to retain an invasive plant, ensure its control and provide strong interpretation to the public explaining the risk and its function in the garden.

- Seek to control harmful invasive species in natural areas managed by the garden and assist others in controlling them on their property, when possible.

- Promote non-invasive alternative plants or, when possible, help develop non-invasive alternatives through plant selection or breeding.

- If your institution participates in seed or plant distribution, including through Index Seminum, do not distribute known invasive plants except for bona-fide research purposes, and consider the consequences of distribution outside your biogeographic region. Consider a statement of caution attached to species that appear to be potentially invasive but have not been fully evaluated.

- Increase public awareness about invasive plants. Inform why they are a problem, including the origin, mechanisms of harm, and need for prevention and control. Work with the local nursery and seed industries to assist the public in environmentally safe gardening and sales. Horticulture education programs, such as those at universities, should also be included in education and outreach efforts. Encourage the public to evaluate what they do in their own practices and gardens.

- Participate in developing, implementing, or supporting national, regional, or local early warning systems for immediate reporting and control. Participate also in the creation of regional lists of concern.

- Botanical gardens should try to become informed about invasiveness of their species in other biogeographic regions, and this information should be compiled and shared in a manner accessible to all.

- Become partners with other organizations in the management of harmful invasive species. Follow all laws on importation, exportation, quarantine, and distribution of plant materials across political boundaries, including foreign countries. Be sensitive to conventions and treaties that deal with this issue, and encourage affiliated organizations (plant societies, garden clubs, etc.) to do the same.

Appendix F. Grant Opportunities

In general, grants for community and urban forestry are targeted to projects on public lands. However, grants received by the Town for public lands stewardship could free up municipal funds and allow the Town to reallocate money to support programs for homeowners (rather than simply putting the savings back into the general fund).

Maryland Urban and Community Forestry Committee (MUCFC) Grants Program

Administered by the Maryland Department of Natural Resources, the MUCFC grants program helps community groups fund tree planting and education projects statewide to enhance Maryland's urban forest. Community tree projects may be organized via schools, service organizations, homeowner organizations or other volunteer- 55 3 Recommendations based groups. The tree planting/educational projects must be located on public lands in parks, metropolitan areas, cities, or towns. The maximum grant awarded per project is $1,500. Information is available at https://dnr.maryland.gov/forests/Pages/programs/urban/mucfcgrant.aspxJohn S. Ayton State

Forest Tree Nursery Seedling Program

Administered by the Maryland Department of Natural Resources, this program enables homeowners and landowners owning at least one quarter acre to purchase tree seedlings from the State Nursery for conservation purposes, including general reforestation, wildlife habitat enhancement, erosion control, windbreaks, wood production, and Christmas tree production. The minimum order is 250 pine or 100 hardwood seedlings. Prices vary by species. Orders are generally taken in the fall and winter and delivered in early spring. United Parcel Service shipment provides door to door delivery of the seedlings during March and April or orders can be picked up at the nursery in Preston. Information is available at https://dnr.maryland.gov/forests/Pages/nursery.aspx.

Chesapeake Bay Trust Community Greening Grant Program

The program is designed to help Maryland communities implement greening plans that increase tree canopy, reduce stormwater runoff, improve air quality, and enhance the quality of life in Maryland's communities. Grants will be awarded to local governments, nonprofit organizations, and neighborhood associations for on-the-ground restoration and other activities that support the implementation of an adopted plan to green communities in Maryland. The program seeks two types of applicants: 1. Those who are in the process of developing or who have developed a comprehensive greening program in conjunction with a local government. 2. Neighborhoods and communities who have prioritized tree planting and community greening as a goal. https://cbtrust.org/grants/green-streets-green-jobs-green-towns/

Maryland Department of the Environment State Revolving Fund – Water Quality Financing Administration (WQFA)

The Maryland Water Quality Financing Administration (WQFA) provides financial assistance in the form of low interest rate loans and/or grant funding for clean water and drinking water capital projects across the State. The program funds up to 50% of project costs as loan-forgiveness/grant. There is no maximum limit on funding requests. Interest on loans is 50% of market interest rate, with a 20-year term provided the Owner has a revenue stream for loan repayment. A number of projects are funded as grants, based on priority ranking, in each funding cycle. Eligible types of projects include:

- water quality point source projects
- drinking water projects
- non-point source pollution control projects
- septic system upgrade projects

Eligible green infrastructure projects include practices that manage and treat stormwater and that maintain and restore natural hydrology by infiltrating, evapotranspiring, and capturing and using stormwater, such as:

- green streets
- water harvesting and reuse programs or projects
- wet weather management systems for parking areas
- hydromodification to establish or restore riparian buffers, floodplains, wetlands and other natural features
- downspout disconnection
- comprehensive retrofit programs designed to keep wet weather out of all types of sewer systems using green infrastructure technologies and approaches;
- implementation of comprehensive street tree or urban forestry programs

Assistance with completing an application may be obtained from the State Revolving Fund Division, Water Quality Financing Administration, by calling 410-537-3119 and asking for an SRF Funding Coordinator.
https://mde.maryland.gov/programs/water/wqfa/pages/mission_statement.aspx

Appendix G. Sample Tree Protection Ordinances

The Town of Chevy Chase includes the following in a tree protection plan:

1. Existing and proposed property lines, structures, utility lines, driveways, sidewalks, and other paved surfaces.
2. The size (circumference at 4 ½ feet above the ground), species, state of health, estimated location of drip line, and accurate location of all trees on the project property, as well as trees on neighboring properties where their drip lines lie over the proposed construction zone.
3. A delineation of the Tree Protection Zones within which all construction activities, grading or drainage changes, trenching, heavy equipment, or storage of materials will be excluded. All Tree Protection Zones must be surrounded by chain link fences six feet in height with signage affixed, in English and Spanish, warning workers not to disturb the zones. Boundaries of Tree Protection Zones will be located to provide the maximum protection for tree roots. (4) The delineation of areas to be excavated, regraded, and/or disturbed, as well as mitigation measures to be used to protect remaining trees if substantial grading changes are proposed.
4. The location of any proposed trenching for underground utility lines.
5. The location of any temporary gravel construction access drives and where construction materials and equipment will be stored.
6. All trees proposed for removal. (Note: It is not reasonable to expect every tree to be able to survive a construction project. Sometimes, the tree will be too highly impacted to be retained. The consulting arborist can determine which trees should be removed prior to construction. There could be a requirement for replacing trees that were removed to ensure canopy coverage.)
7. All trees to be protected in Tree Protection Zones, including trees in the Town right-of-way.
8. The location, species, and diameter of each proposed replacement tree.
9. The methods by which tree branches and roots are to be protected before construction. Branch and root pruning must adhere to International Society of Arboriculture standards.
10. The maintenance program for trees to be protected during construction as well as for replacement trees for two years following construction.
11. Contact information for a designated individual who will ensure that all work adheres to the approved Tree Protection Plan.