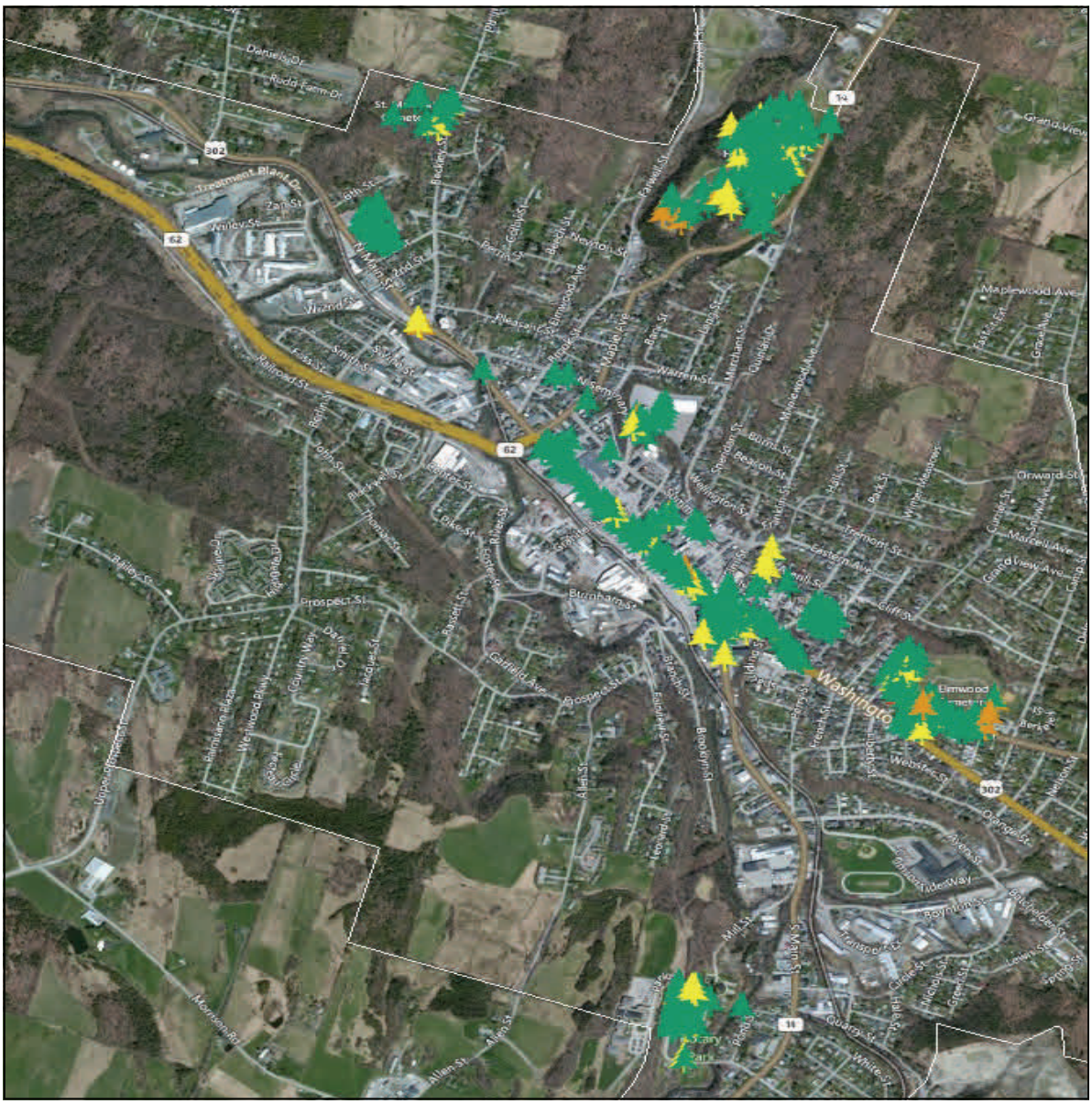
Barre City Public Tree Inventory Report



Prepared for the City of Barre and
the Barre City Tree Warden
by the Vermont Urban & Community Forestry Program
February 2016

FORESTS, PARKS & RECREATION VERMONT

UNIVERSITY OF VERMONT EXTENSION
CULTIVATING HEALTHY COMMUNITIES

PLANT LIVE GROW
VERMONT URBAN & COMMUNITY FORESTRY PROGRAM

FOREST SERVICE U.S. DEPARTMENT OF AGRICULTURE

VT ANR GIS

Acknowledgements

This report was developed by Vermont Urban & Community Forestry Program (VT UCF) staff based on field work conducted by VT UCF staff and State Lands Foresters from the Vermont Department of Forests, Parks, & Recreation (VT FPR) for the City of Barre, Vermont during the fall of 2015. We would like to thank the primary Barre contact for this project, Jeff Bergeron, the City's Director of Buildings and Community Services and active Tree Warden. Special thanks to seasonal employee Jordan Weaknecht as well as Lisa Wright and David Wilcox with VT FPR for leading the coordination of the on-the-ground data collection in Barre City. Additional thanks to Diana Jaramillo, ECO Americorps member with VT UCF, for her work in analyzing data and developing this document. This report was made possible with funding from the USDA Forest Service.

About the Vermont Urban & Community Forestry Program

The field of forestry management is not confined to the natural areas and forests of Vermont, but extends to the populated urban and rural spaces where trees play important roles. The trees in public parks, along roadsides, on town greens, and in municipal forests compose our urban and community forests and merit careful stewardship. VT UCF is a collaborative effort between the Vermont Department of Forests, Parks, & Recreation, the University of Vermont (UVM) Extension, and the USDA Forest Service. The program provides technical and financial assistance as well as educational programs and resources for the management of trees and forests in and around Vermont communities. The mission of VT UCF is ***to lead citizens, businesses, and governments in understanding the value of urban and community forests and promote civic responsibility for and participation in the stewardship of these resources for this and future generations***. Since 1991, the program has been guided by a small staff and a twenty-member advisory council. The council meets quarterly to share information and advise the program; its members come from various professional associations, non-profits, educational institutions, municipal tree boards and committees, and state agencies.

The trees in our communities offer a wide variety of environmental, social, and economic benefits to the surrounding community, including but not limited to: stormwater mitigation, carbon dioxide (CO_2) sequestration, air quality improvement, shade, wildlife habitat, and aesthetic value. VT UCF seeks to maximize these benefits by working with state and municipal officials, as well as dedicated volunteers and local organizations, to steward the urban forest's ecological integrity and diversity. VT UCF's programming and support reaches 100 Vermont communities annually. More information about VT UCF can be found at www.vtcommunityforestry.org.

VT UCF provides technical, financial, and educational services to VT communities like Barre City, pictured above, to promote and support vibrant urban and community forests.

Contents

Executive Summary

The goal of the Barre City public tree inventory was to accurately locate and assess City-owned trees within the public right-of-way (ROW) on streets in the Designated Downtown District and in select parks and public spaces so as to support tracking tree conditions, plantings, and removals. The information collected in the inventory and presented in this report provides residents and decision makers with a better understanding of the composition, condition, and benefits of Barre City's public tree population and will allow the Barre City Tree Warden to plan for tree maintenance and future tree planting using a map-based tree inventory tool.

This project was initiated in the spring of 2015, was coordinated with and approved by Jeff Bergeron, Barre City's Director of Buildings and Community Services and active Tree Warden. VT UFC and VT FPR staff completed an inventory of **555 trees** located within the public ROW of **11 streets**, in **3 cemeteries**, and on **6 other City-owned properties**. The data collected in the inventory were checked for quality, analyzed, and interpreted by VT UCF staff. This report was prepared in February 2016. It presents the results of the inventory and provides a basic assessment of the trees and urban canopy cover in Barre City.

Local government, town boards and committees, conservation agencies, and private landowners all play an important role in monitoring and maintaining urban forests. Public trees provide a number of benefits to a community, including reducing stormwater runoff, reducing air pollution, providing shade, sequestering carbon dioxide (CO_2), enhancing property values, and improving the aesthetics of the community. The 555 public trees that were inventoried provide an estimated **$46,090 in benefits annually** to the residents and businesses of Barre City. In addition to the public trees inventoried, an aerial tree canopy assessment was completed for the overall land area assessed in the inventory – encompassing both public and private land in the Designated Downtown District and select parks and cemeteries – that indicated an existing tree canopy cover of **26%** and an estimated long-term **stored CO_2 value of $761,916.**

Summary of Findings

Forest Diversity

- Of the 555 public trees, there are 42 different species in 22 different genera.
- The five most common tree genera by number of trees are *Acer* (maple) at 34%, *Malus* (crabapple) at 28%, *Picea* (spruce) at 6%, *Gleditsia* (honeylocust) at 6%, and *Ulmus* (elm) at 4%.
- *Acer* and *Fraxinus* species together represent 37% percent of Barre City's public trees. Invasive tree pests currently threaten both of these genera: the Asian long horned beetle (ALB) and the emerald ash borer (EAB), respectively.
- The five most common species are *Malus* species (crabapple) at 28%, *Acer saccharum* (sugar maple) at 18%, *Acer platanoides* (Norway maple) at 10%, *Gleditsia triacanthos* (honeylocust) at 6%, and *Acer rubrum* (red maple) at 5%.

Forest Structure

- One half of the inventoried public trees (51%) have a diameter at breast height (DBH) measurement between 3" and 12". Nearly one fifth (19%) of inventoried public trees has a DBH within the 12-18" size class. When combined, this means that 70% of inventoried public trees are between 3" and 18" in diameter.
- The remaining 30% of inventoried trees were represented in the following size classes: 0-3" (8%), 18-24" (6%), 24-30" (8%), 30-36" (4%), 36-42" (3%), and 42+" (2%).

Forest Cover

- There is an existing urban tree canopy (UTC) cover of 26% in Barre City. This aerial analysis was done for both public and private land over the full extent of the City's inventoried area.
- Trees could potentially cover an additional 45% of Barre City's land surface. These "possible UTC" areas include low-lying vegetation or grassland, agricultural fields, and impervious surfaces (e.g. parking lots, paved playgrounds, and the ROW).

- The remaining 29% of Barre City's land area is buildings, streets, water, and other permanent features and is generally unsuited to UTC improvement.

Forest Health

- Over four-fifths (478, or 86%) of Barre City's inventoried trees were assessed as being in "Good" condition. Of the remaining trees, 57 (10%) were considered to be in "Fair" condition, 19 (3%) were in "Poor" condition and 1 (1%) was "Dead".
- 97 trees (17%) were assessed to be in need of monitoring by a Certified Arborist, the City's Tree Warden, or another qualified individual.
- 61 trees were assessed to show signs of dieback, 48 trees were assessed to show signs of decay, 99 trees were assessed to have bark splits, 11 trees were assessed to have woodpecker damage/activity, and 17 trees were assessed to have visible root damage.
- 201 trees were assessed to be in need of pruning, 5 trees were assessed to show signs of stem-girdling roots, and 6 trees were assessed to be in need of mulch.

Summary of Recommendations

A healthy public tree population is contingent upon proper management, stewardship, and a municipality's commitment to understanding and maintaining its urban forest. A comprehensive public tree inventory is an important piece of a vibrant community tree program, along with other components described in the Discussion and Recommendations section of this report. Based on the results of the Barre City public tree inventory, our priority recommendations are:

- Promote longevity and integrity of the public tree population by establishing a systematic and routine structural pruning program.
- Advocate for an annual municipal tree budget that explicitly includes maintenance, pruning, and planting, in addition to the current line item for tree removals.
- Strive for an urban tree canopy cover percentage of 35-40% by working with private landowners, maintaining the integrity of existing large canopy shade trees, and prioritizing new tree plantings in continued urban development.

The Barre City public tree inventory was conducted by VT FPR State Lands Foresters and VT UCF staff and interns in the fall of 2015 and included streets within the Designated Downtown District, 6 City-owned parks and properties, and 3 cemeteries (above).

Introduction

Project Description

In 2013 VT UCF received a multi-year grant from the USDA Forest Service to assist twenty priority communities in Vermont in moving their public tree programs forward. The project, *Care of the Urban Forest*, is an effort that aims to support these communities in three specific ways, by: (1) conducting a public tree inventory to assess urban forest structure, diversity, and health; (2) helping the community in the development of an urban forest management plan or strategic action plan, using information from the inventory; and (3) providing technical training for municipal employees and citizen volunteers to increase in-house capacity to manage and promote the proper care of public trees.

Barre City leadership was interested in partnering with VT UCF on the *Care of the Urban Forest* project to conduct a full public tree inventory that would be map-based and in an electronic format. The intent of the public tree inventory was to enable Barre City staff to better understand, steward, and manage public trees more efficiently and cost effectively. The specific goal of Barre City's public tree inventory was to accurately locate and assess City-owned trees within the public ROW on streets in the Designated Downtown District and in select parks and public spaces to support tracking tree conditions, plantings, and removals. The complete public tree inventory was conducted over the course of approximately 100 hours in October, 2015 and will provide a foundation for future management decisions and regarding the urban forest. Additionally, benefits of tree canopy cover, such as the improvement of air and water quality and increased property value, will increase as the City is empowered and informed to manage and support a vibrant public tree population.

Barre has historically designated a municipal employee as the City's Tree Warden. In 2015 Jeff Bergeron, the City's Director of Buildings and Community Services, was appointed Barre City's Tree Warden. Barre City has a number of historic and notable cemeteries and the care of the large shade trees in these properties has long been important to city leadership. A number of Barre residents have participated in VT UCF's Stewardship of the Urban Landscape trainings and

have subsequently led tree planting and care efforts in the city; most recently, a group from the Universalist Unitarian Church received a grant from VT UCF to host a pruning workshop and plant native trees and shrubs on the church grounds. Recently, Barre City has collaborated with the Vermont Agency of Transportation on a major streetscape project along Main Street. Despite all of this, the City does not currently have a public tree management program or explicit budget for tree care and planting. The results of the 2015 public tree inventory – and the City's engagement in the *Care of the Urban Forest Project* – will support and advance Barre City's efforts to steward its public trees.

City Profile

The City of Barre is located in Washington County, and is surrounded by the Town of Barre. Located approximately 5 miles southeast of Montpelier, Barre City is the fourth largest city in Vermont (after Burlington, Rutland, and South Burlington). The City of Barre covers a land area of approximately 4 square miles, within the Town's approximate 31 square mile land area, and has a population of 9,052 people according to the 2010 U.S. Census. Chartered in 1780 to William Williams and originally part of the area called Wildersburgh, Barre City was established in 1895. Barre City's history and growth into the

Importance of Inventory and Urban Forestry in Vermont

A public tree inventory establishes a record of the City-owned trees present in a municipality. An inventory can provide information about the species, size, health, maintenance needs, and location of each tree. This detailed information allows municipal leaders to estimate the numerous contributions and management requirements of the trees of which it is in charge. In the event of a disease outbreak or invasive insect infestation, data from an inventory may assist in monitoring and preventing spread, as well as supporting the response to the disease or infestation. An inventory can also help build public support for expanding urban forests and to guide future urban planning.

Urban trees improve the quality of life for Vermont communities in a variety of ways. The most readily apparent benefit is the aesthetic value that trees provide a street, home, or public space. Along with this beauty is the functional benefit of providing shade along the streets in the summertime and blocking wind to reduce heating costs in the wintertime. The presence of trees has been shown to positively affect property values and boosts foot traffic in commercial areas. Parks and tree-lined sidewalks promote physical activity by creating shaded, comfortable outdoor spaces. Many types of urban wildlife depend on trees as sources of food and shelter. Unseen environmental benefits of urban trees include improvements in air quality and temperature regulation through reduction of the heat island effect. Trees can mitigate noise pollution common in an urban environment and can clean and conserve water by controlling run-off. Additionally, urban forests create opportunities for environmental education, community engagement, and in some instances can be related to crime reduction. Trees are an integral part of the green infrastructure of a place and contribute to keeping our communities healthier and our everyday lives more fulfilling.

twentieth century can be attributed to a booming granite industry, evidenced today by prominent granite architecture, major cemeteries full of intricately designed granite headstones, and the self-proclaimed nickname of "Granite Center of the World."[1]

Methodology

To plan for the public tree inventory, VT UCF staff coordinated with Jeff Bergeron, Barre City's Director of Buildings and Community Services, and Steve Mackenzie, the Barre City Manager. All streets within the Designated Downtown District, as well as 6 City-owned properties and 3 cemeteries were chosen to be included in the inventory; in total, the inventoried land area was about 1 square mile, comprising the most central downtown and densely populated area of Barre City. Jeff Bergeron and the City Engineer's Office decided that along the streets, the inventory should only include trees planted in tree pits on streets with sidewalks in the Designated Downtown District. The list of streets that had trees planted in tree pits along the sidewalk is included in Appendix A and GIS maps of the inventoried trees are in Appendix E.

VT UCF has developed a tree inventory tool in collaboration with the VT Agency of Natural Resources' (ANR) GIS team. The map-based tool uses the free application *Collector for ArcGIS*, developed by Esri (http://doc.arcgis.com/en/collector/), for data collection and is linked to the publicly-accessible ANR Atlas online mapping tool. All inventory data collected on public trees in Barre City is available for viewing on ANR Atlas and instructions are found in Appendix D.

Throughout October 2015, VT UCF staff and VT FPR State Lands Foresters and seasonal staff walked along Barre City streets, and in selected public spaces, recording specific data on the public trees. To ensure that only public trees were inventoried (as opposed to trees on private property) when on a street, the inventory team only inventoried trees planted in tree pits along the sidewalks in the Designated Downtown District.

[1] City of Barre. http://www.barrecity.org/; accessed 2/1/16

Each public tree identified was recorded into the *Collector for ArcGIS* application using an iPad, provided by VT UCF. The application is map-based and uses GPS and a base layer map to allow the user to input information about a tree, linking it to a particular geographic location. Data recorded for each public tree in Barre City included street or site name; overall condition; species; diameter class (using a measurement for diameter at breast height, or DBH); a recommendation for monitoring (yes/no); whether or not the tree showed signs of dieback, decay, bark splits, root damage, and woodpecker activity; whether or not the tree should be pruned or was in need mulch or removal of stem-girdling roots; additional comments; and the nearest house or building address. In most cases, a picture was also taken of each tree. A full list and description of the parameters used in data collection can be found in Table 1.

Staff from VT FPR assesses a sugar maple in one of Barre's cemeteries

The data were compiled and subsequently checked for quality, analyzed, and summarized using Microsoft Excel and QGIS, a free and open source geographic information system (www.qgis.org/en/site/). Data were also analyzed through i-Tree, a free software suite developed by the USDA Forest Service (www.itreetools.org). VT UCF staff used two applications in the i-Tree suite of tools to further assess Barre City's urban forest. i-Tree Streets uses sophisticated models to determine the monetary value and ecological benefits of trees. i-Tree Canopy uses aerial imagery and random point locations to produce an estimate of land cover of a defined area - including tree canopy cover - that encompasses both public and private property.

Table 1. Data collection parameters for the Barre City public tree inventory

Data Parameters	Description
Site ID	Street name or property name.
Species	Common name. Include in comments box if not listed.
Tree Condition	● *Good:* full canopy (75-100%), no dieback of branches over 2" in diameter, no significant defects, minimal mechanical damage ● *Fair:* thinning canopy (50-75%), medium to low new growth, significant mechanical damage, obvious defects/insects/disease, foliage off-color and/or sparse ● *Poor:* declining (25-50%), visible dead branches over 2" in diameter, significant dieback, severe mechanical damage or decay (over 40% of stem affected) ● *Dead:* no signs of life, bark peeling; scratch test on twigs for signs of life (green) ● *Vacant:* potential spot for a tree within the public ROW. Add "small", "medium", or "large" in the comments box - Small= max 30' at maturity, presence of overhead wires, minimum planting space 4' x 4' - Medium= 30-50' at maturity, green belts over 6' wide, no overhead wires - Large= 50'+ at maturity, parks and open space
Diameter (DBH)	Diameter taken at 4.5' above ground in classes of 0-3", 3-6", 6-12", 12-18", 18-24", 24-36", 36-42", 42"+. If on slope, uphill side measured. If abnormal growth, measured above or below growth. If multi-stemmed, each stem's DBH is squared, all squares summed, and the square root taken; indicate "multi-stemmed" in comments box.
Monitor	Yes: any one visible defect is affecting >40% of the tree, the tree poses a hazard to people/infrastructure/cars, the trunk or branches are growing into utility wires, the tree is dead or in poor condition, or the tree is an ash tree showing evidence of woodpecker flecking, blonding, epicormic branching/water sprouts, and/or suspicious exit holes No: no major defects, tree in good or fair condition
Crown dieback	Yes: noticeable presence of dieback in tree's crown No: no noticeable presence of crown dieback in tree
Decay	Yes: noticeable decay present on inventoried tree No: no noticeable decay apparent on inventoried tree
Bark splits	Yes: one or more vertical splits or cracks in tree's bark is present, and/or presence of sun scale evident No: no evidence of splitting bark or sun scale on inventoried tree
Woodpecker Activity	Yes: visually obvious woodpecker activity present on tree No: no visual evidence of woodpecker activity on the tree
Roots	Yes: The presence of visible root issues, including stem-girdling roots, compacted soil, exposed roots, or mechanical damage to roots. No: No visible root issues.
Prune	Yes: Flag trees for pruning if any of the following signs are present: broken branches, branches are overlapping /touching/growing on each other, the tree is overcrowded, branches are interfering with utility lines or other built infrastructures, the branches can interfere with pedestrians/vehicles/bikes, etc. No: No branch on the tree needs to the pruned
Mulch	Yes: tree is struggling, there is bare and compacted ground beneath the tree and/or there is mechanical damage from weed-whacker/mower. No: The tree roots are not exposed and adequately covered by mulch.
Remove Stem-Girdling Roots	Yes: the presence of roots visibly growing in circular manner around the trees, opposed to radially out of the tree, and/or are growing over larger anchoring roots No: the above was not present or noticeable on inventoried tree
Comments	Notes, elaborate on any existing conditions; max 255 characters.

House Number	Corresponding house address, numerical field. If a corner lot house is on a different street, enter house number and write "House located on X Street; corner tree" in comments box.
Collection Date/Time	Date and time.
Photo	Photo of full tree. Additional photos of any significant defects.

Inventory Results

Urban Forest Diversity

Of 555 trees inventoried within the public ROW or on City-owned land, there are a total of 42 different species in 22 different genera. The five most common tree genera, *Acer* (maple), *Malus* (apple), *Picea* (spruce), *Gleditsia* (honeylocust), and *Ulmus* (elm) make up 78% of Barre City's urban forest (Figure 1). The five most common species are *Malus* species (crabapple) at 28% *Acer saccharum* (sugar maple) at 18%, *Acer platanoides* (Norway maple) at 10%, *Gleditsia triacanthos* (honeylocust) at 6%, and *Acer rubrum* (red maple) at 5% (Figure 2). Complete species and genera lists can be found in Appendix B.

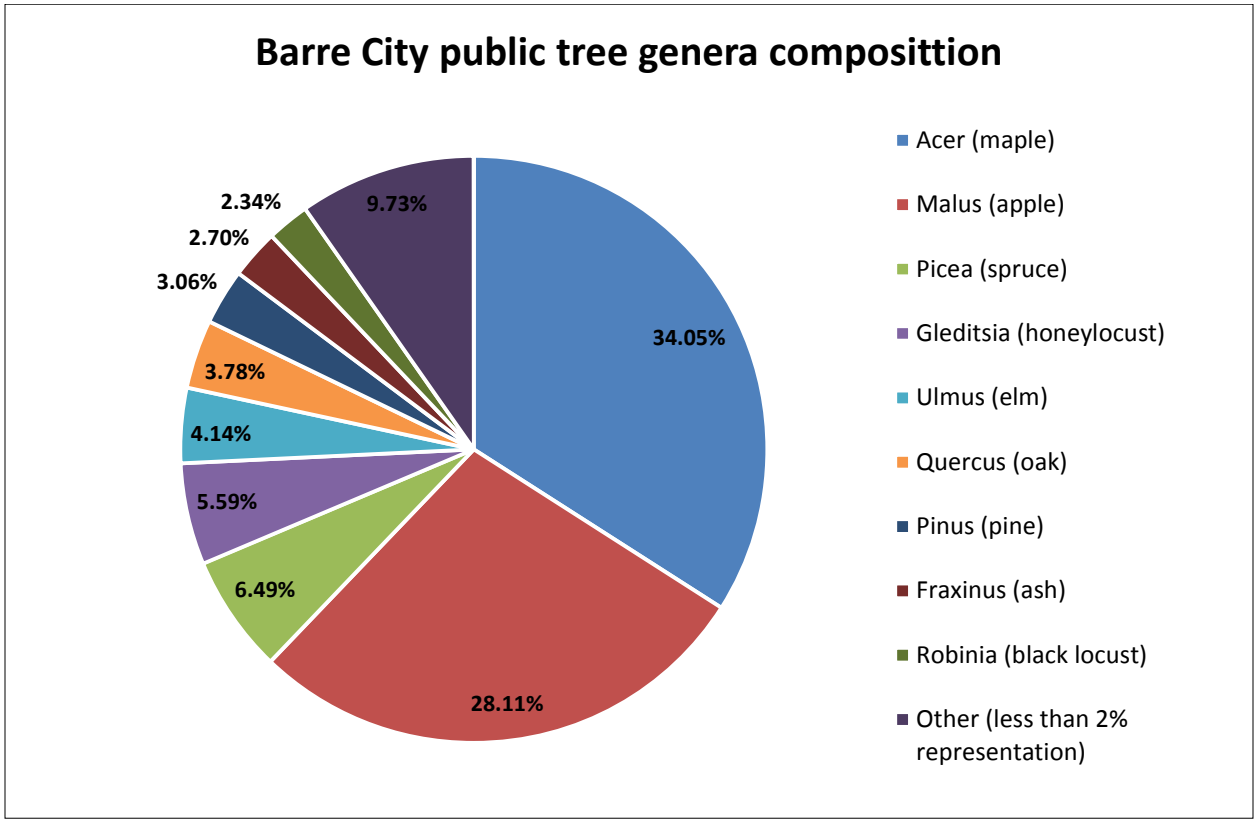


Figure 1. Tree genera by percent within the public tree population in Barre City.

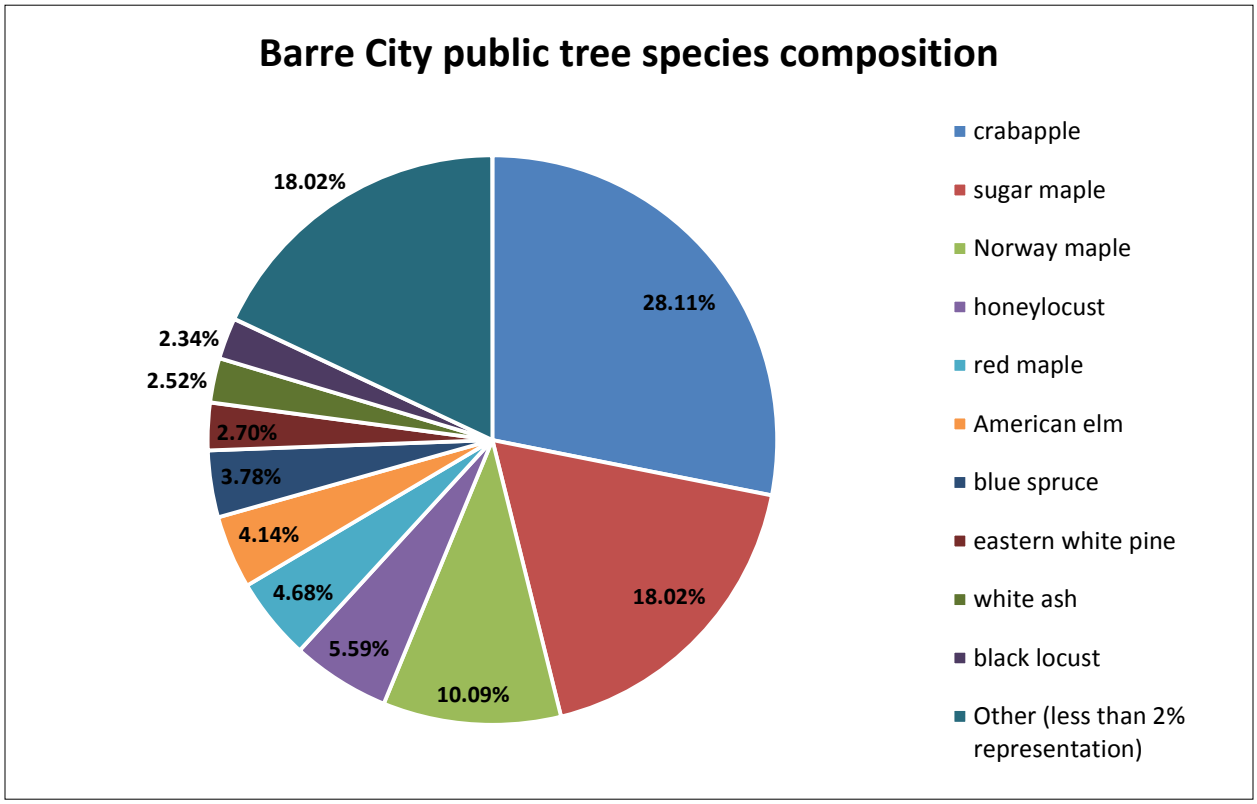


Figure 2. Species by percent within the public tree population in Barre City.

Urban Forest Structure

In descending order by percent size class, the diameter distribution represented by Barre City's public trees is: 27% (151) at 6-12", 24% (130) at 3-6", 19% (105) at 12-18", 8% (46) at 0-3", 8% (45) at 24-30", 6% (121) at 18-24", 4% (20) at 30-36", 3% (15) at 36-42", and 2% (9) at 42+" (Figure 3). Thus, approximately 79% of inventoried public trees are between 0 and 18 inches, with the majority of that clustered population between 3 and 12 inches. Size class distribution can somewhat be correlated to age structure of the urban forest.

The composition of genera and species within each of these size classes (Figures 4 and 5) indicates that *Acer* (maple) is most commonly represented in all size classes, and almost exclusively in the size classes above 30". These trees in the larger size classes, mostly native sugar maples, are growing within the public ROW or on public land and were likely not planted as street trees but left as remnants as the city has grown. Below 18", *Malus* (crabapple), the

most common species in Barre City's public tree population, is prevalent, particularly in the 3-12" size classes; crabapple is a small tree so, despite its age, it will never reach the higher DBH size classes.

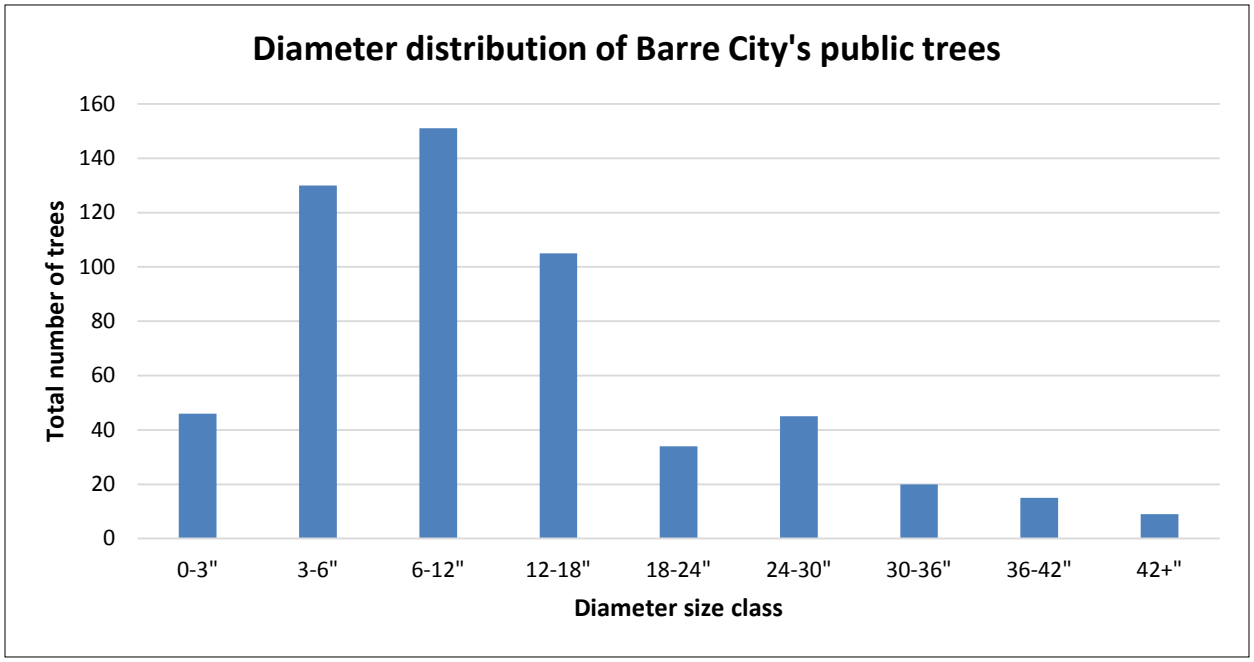


Figure 3. Percent of public trees represented in each diameter class (inches) in Barre City.

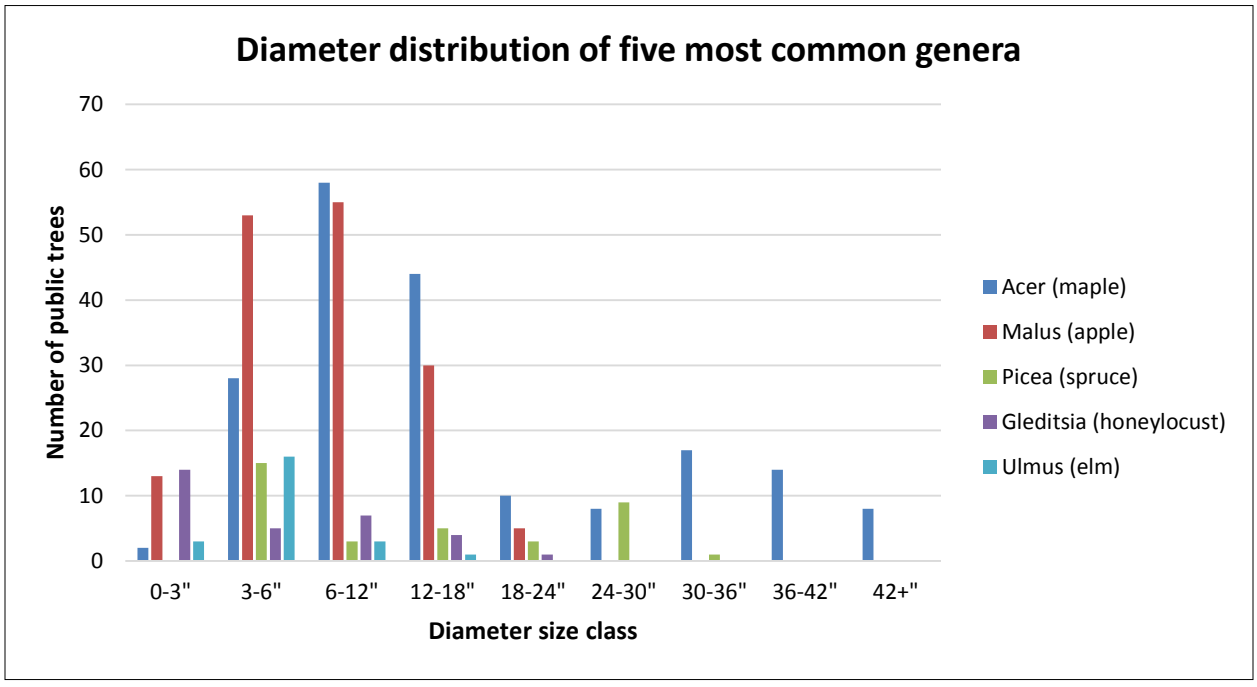


Figure 4. Diameter distribution for the five most common genera of Barre City's public trees.

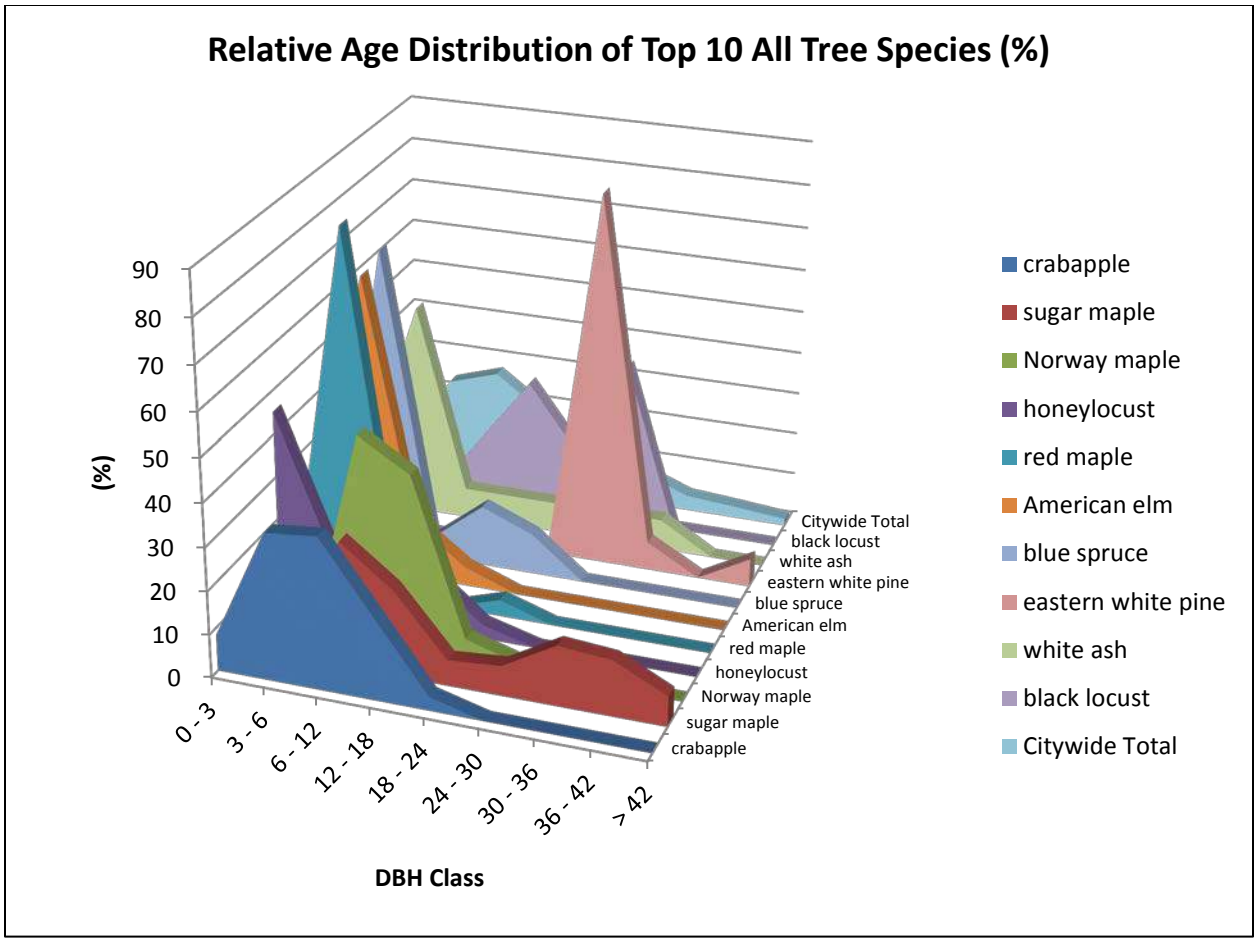


Figure 5. Diameter (and age) distribution of the ten most common species in Barre City's urban forest. Data from this figure were derived from i-Tree Streets urban canopy structure output.

Urban Forest Health

The vast majority (86% or478) of Barre City's inventoried public trees are assessed as being in "Good" condition. Of the remaining trees, 57 (10%) are considered to be in "Fair" condition, 19 (3%) are in "Poor" condition, and just 1 (1%) was found to be "Dead" (Figure 6). The one "Dead" tree is a 6-12" sugar maple at Elmwood Cemetery. *Acer* (maple) and *Malus* (crabapple) have the most trees in "Fair" or "Poor" conditions; however, these genera also comprise the highest percentage of inventoried trees. Appendix E includes maps detailing the location of inventoried trees by condition.

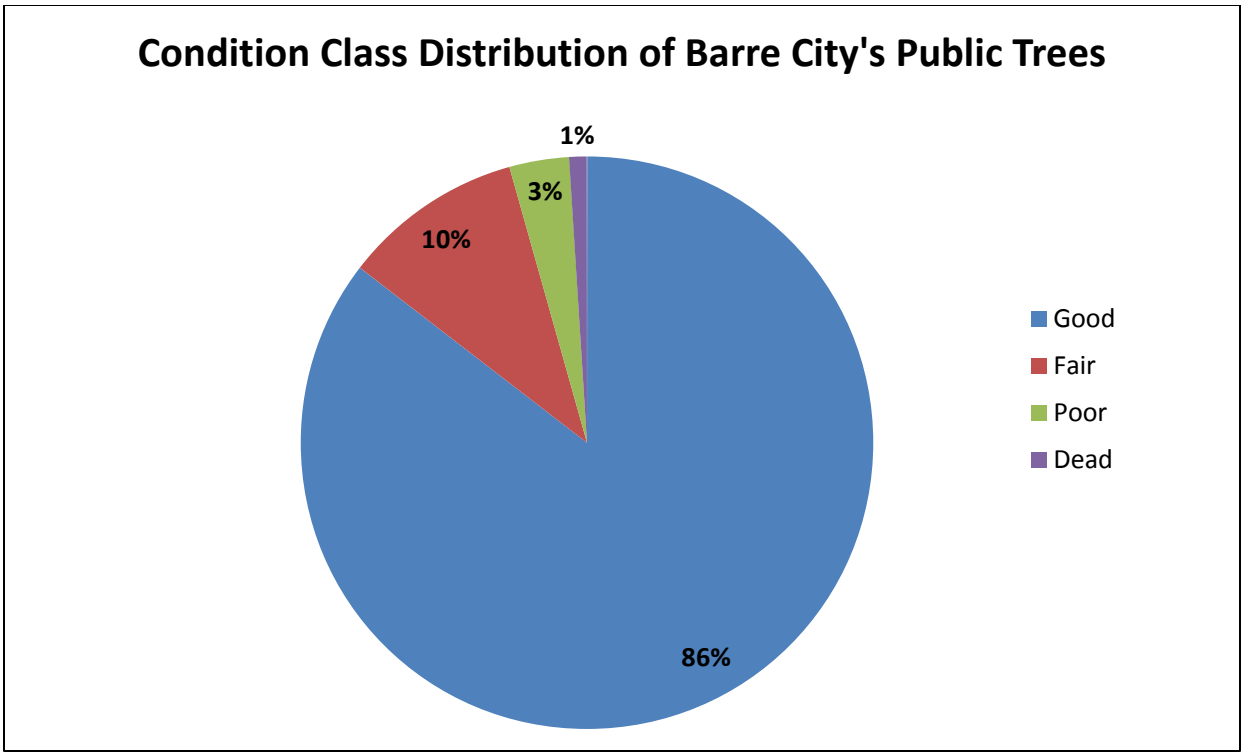


Figure 6. Percentage of Barre City's public trees in each condition class.

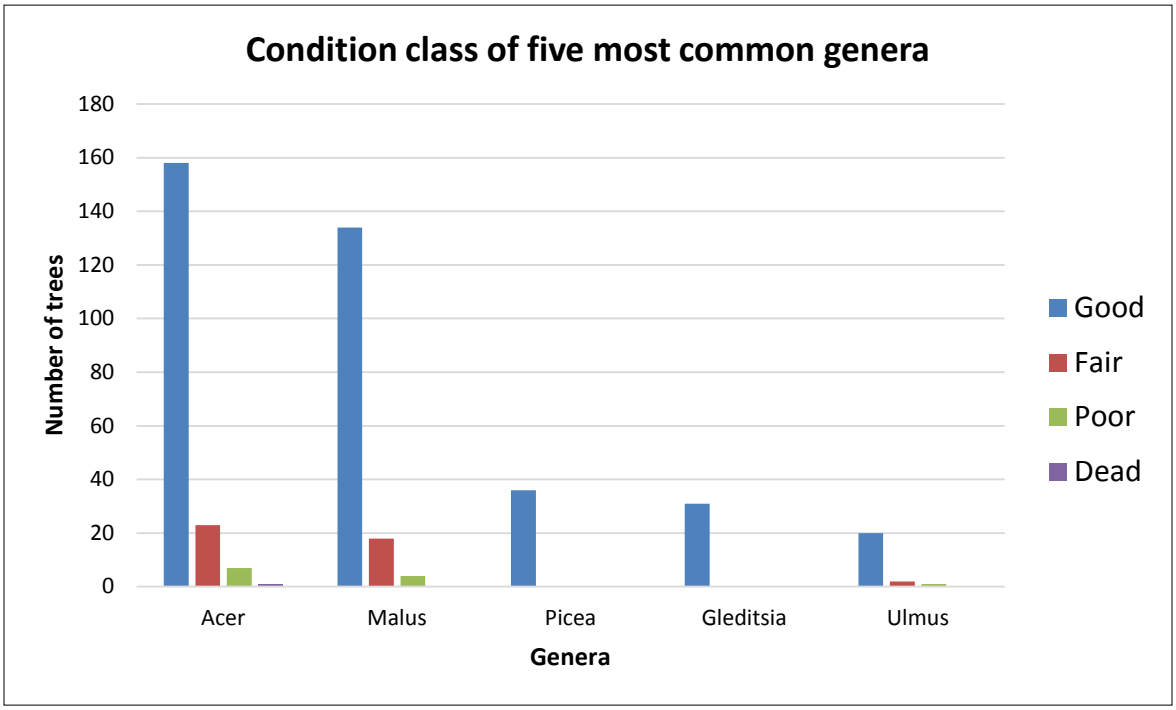


Figure 7. Number of Barre City's public trees within the five most common genera displayed according to condition.

In conducting the inventory, VT UCF and VT FPR staff assessed 97 trees (17%) as in need of monitoring. These trees should be reassessed by a Certified Arborist, the Barre City Tree Warden, or another qualified individual in a timely matter. Trees that were flagged as in need of monitoring expressed one or more of the following conditions:

- The tree has a visible defect affecting >40% of the tree,
- The tree poses a hazard to people/infrastructure/cars,
- The tree is growing into utility wires,
- The tree is dead or in poor condition, or
- The tree is an ash (*Fraxinus*) and shows evidence of a sign or symptom of infestation by EAB (extensive woodpecker flecking, bark blonding, epicormic branching/water sprouts, and/or suspicious exit holes).

Although Barre City's public trees are generally healthy (86% assessed as in "good' condition), proper maintenance and monitoring is required to promote the health, longevity, and benefits of Barre City's urban forest. Approximately a third of the 97 public trees assessed to be in need of monitoring are maple species and half of the elms inventoried require monitoring (Figure 8). A map indicating the location of the 97 trees in need of monitoring can be found in Appendix E of this report.

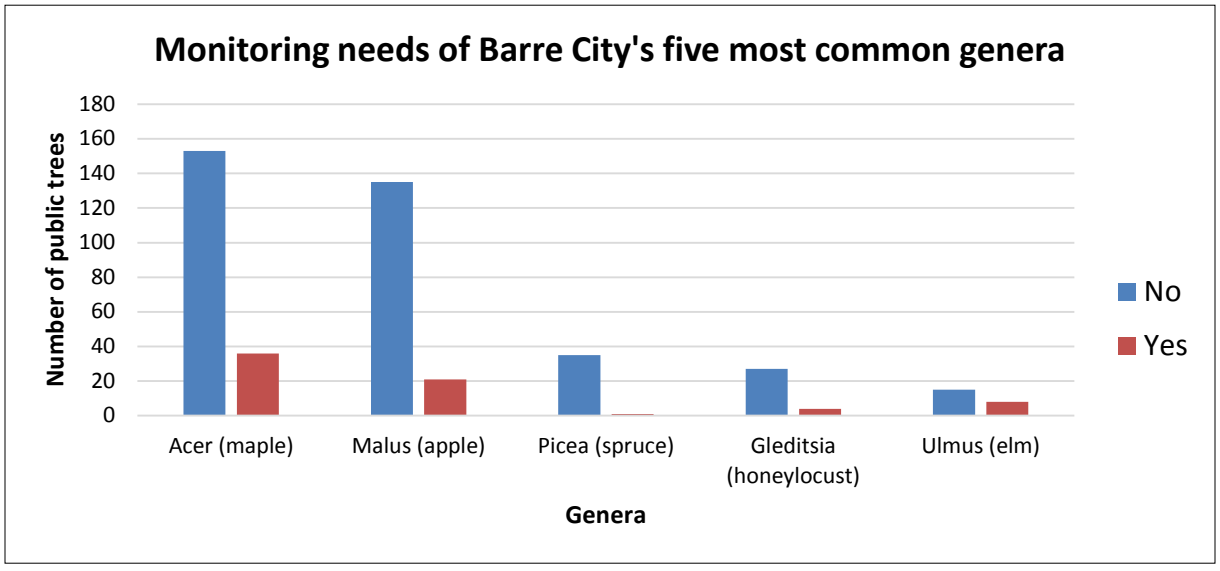


Figure 8. The number of Barre City's inventoried public trees assessed to require monitoring (yes) within the five most common genera.

Tree Health and Maintenance Indicators

To better understand the specific maintenance and monitoring needs of Barre City's public trees, City leadership requested that the inventory teams assess the visible presence (or absence) of crown dieback, decay, bark splits, woodpecker activity, and damaged roots and the need for pruning, removal of stem-girdling roots, and mulch application on each inventoried tree (Figure 9). The Barre City Tree Warden, a Certified Arborist, or a relevant public official should be aware and monitor the observed health (e.g., crown dieback, decay, bark splits, woodpecker activity, and root damage) or required maintenance (e.g., prune, remove stem-girdling roots, mulch application) characteristics.

Of the assessed tree health characteristics crown dieback was observed in approximately 11% of the inventoried public trees, visible decay was noted in 9% of inventoried public trees, and bark splits were observed in 18% of inventoried public trees. Woodpecker activity and visible root damage were both observed in less than 5% of inventoried public trees. Of the assessed tree maintenance characteristics, it was recorded that 37% – a significant portion – of the inventoried trees are in need of pruning; of these, over half (104) are in the genus *Acer* (maple) and over half (116) are 6-18" in diameter, indicating that much of the prescribed pruning is structural, to ensure stable branch architecture as the tree approaches maturity.

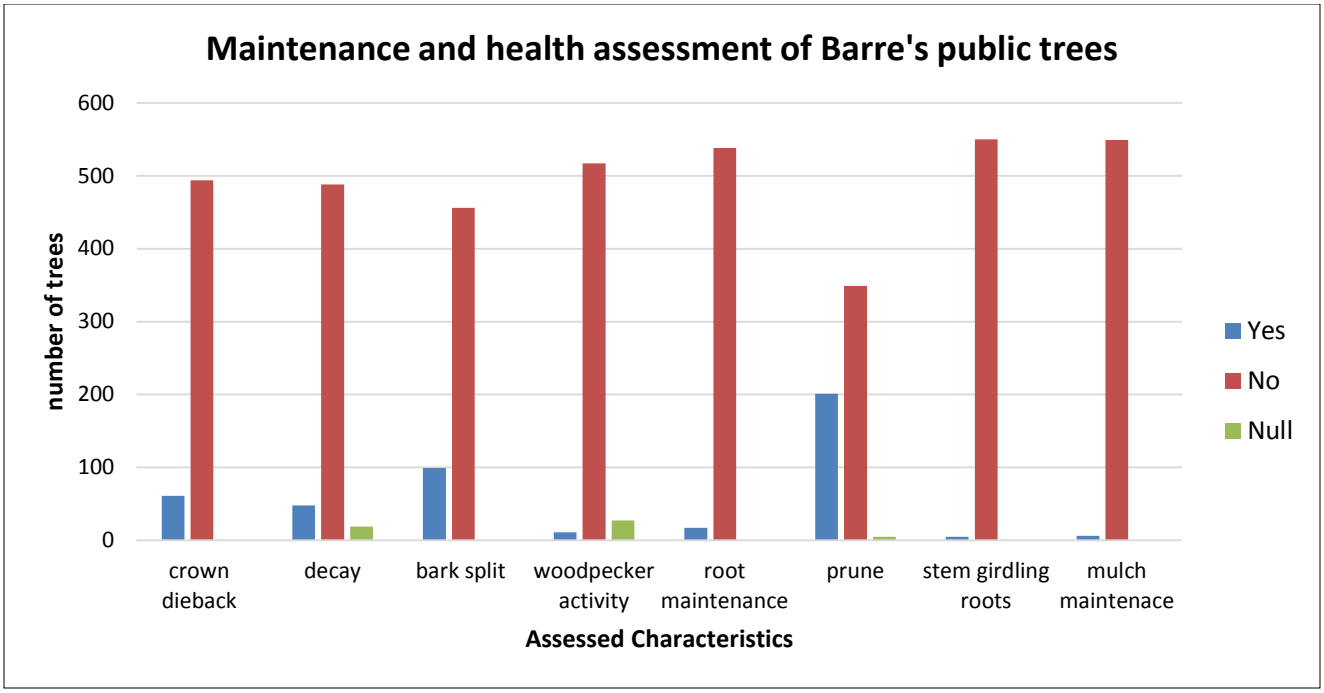


Figure 9. The number of Barre City's inventoried public trees assessed as having presence or absence of tree maintenance and health characteristics. Null values represent the number of unassessed trees, and thus indicate user error. Refer to Table 1 for descriptions of each assessed characteristic.

Economic Benefit and Ecosystem Services

The Barre City public tree inventory data were analyzed using i-Tree Streets software to determine the monetary value of the ecosystem services provided by the public trees. The 555 public trees provide a total of $46,090 in annual benefits by filtering air pollutants, mitigating stormwater runoff, sequestering carbon dioxide (CO_2), conserving energy, and increasing property values. On average, each public tree offers $83 annually in savings or services.

Figure 10 and Table 2 provide an overview of each ecosystem service provided by Barre City's public trees. The full reports produced through the i-Tree Streets program for Barre City will be provided to the city's Tree Warden. It is important to recognize that the trees inventoried through this project are located on the approximately 1 square mile of land in the Designated Downtown District and Barre City's parks and cemeteries; expanding the inventory in Barre City, or even into Barre Town's 31 total square miles of land area would increase these figures dramatically. It is also noteworthy that larger (mature) and long-lived trees provide

substantially more benefits than small and young trees. Regular maintenance and care are needed to provide for public tree health, longevity, and maximized urban forest benefits.

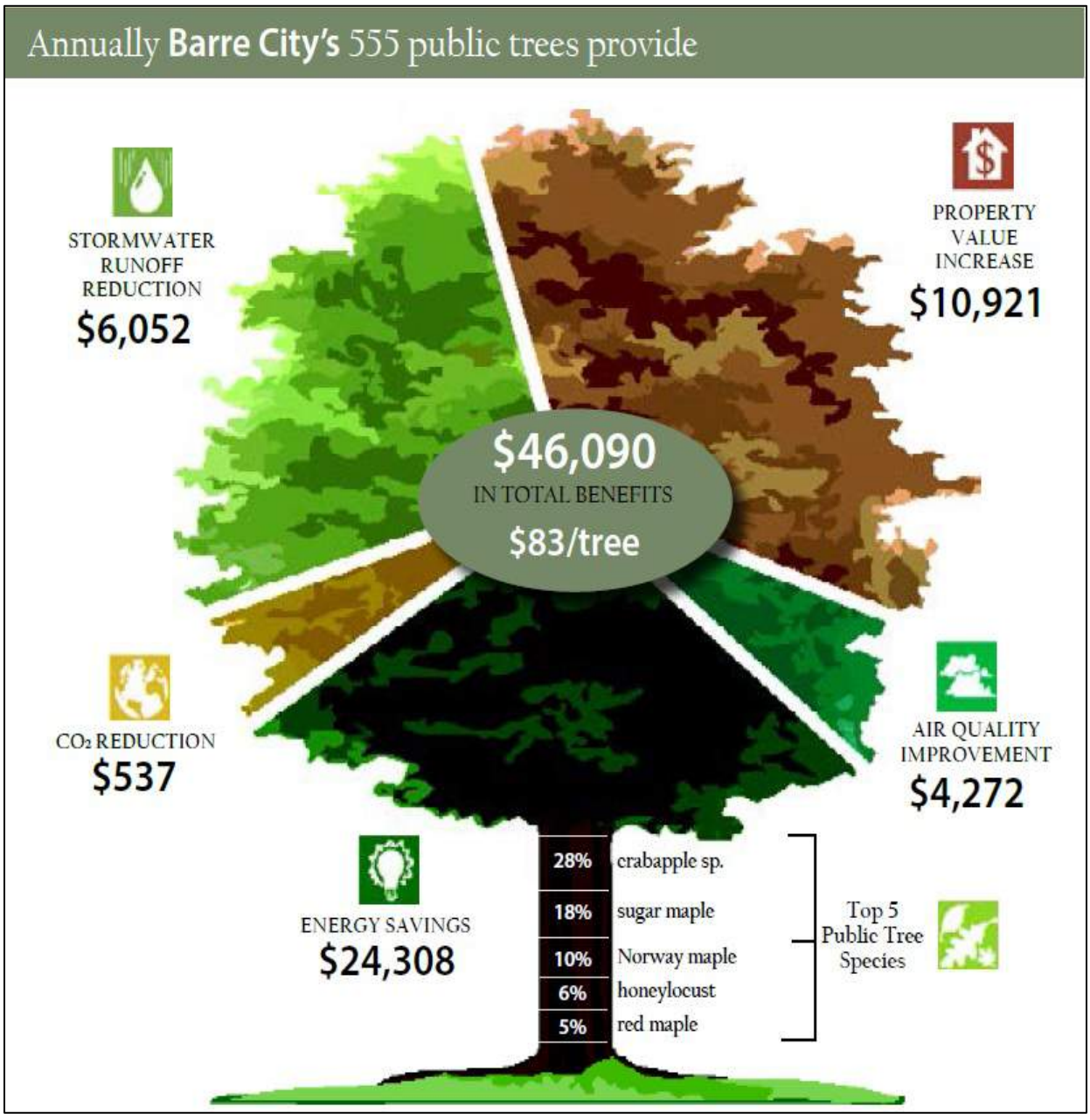


Figure 10. Summary of the benefits provided by Barre City's public trees inventoried through this project, according to the i-Tree Streets assessment. Tree graphic concept courtesy of City of New York Department of Parks & Recreation.

Table 2. Annual environmental and monetary benefits provided by Barre City's public trees.

Benefit Type	Benefit Description	Total Value of Trees Inventoried	Average Value/Tree
Energy conservation	Reduced natural gas use in winter and reduced electricity use for air conditioning in summer	$24,307.86	$43.80
Carbon dioxide	Annual reductions in atmospheric CO2 due to sequestration by trees and reduced emissions from power plants due to reduced energy use. The model accounts for CO2 released as trees die and decompose and CO2 released during the care and maintenance of trees.	$537.48	$.97
Air quality	Quantifies the air pollutants (O3, NO2, SO2, PM10) deposited on tree surfaces and reduced emissions from power plants (NO2, PM10, VOCs, SO2) due to reduced electricity use. Also reported are the potential negative effects of trees on air quality due to BVOC emissions.	$4,217.52	$7.70
Stormwater	Reductions in annual stormwater run-off due to rainfall interception by trees.	$6,052.26	$10.90
Aesthetic/other	Tangible and intangible benefits of trees reflected in increases in property values.	$10,921.24	$19.68
Stored carbon dioxide	Tallies all of the carbon dioxide stored in the urban forest over the life of the trees as a result of sequestration; *not an annual benefit but a cumulative benefit.	$7,713.82*	$13.90*

Saving the City an average of $24,308 annually in heating and cooling costs, Barre City's urban forest's most significant analyzed economic benefit is energy conservation (Figure 11). The greatest energy cost savings from the City's public trees is in the form of natural gas (versus electricity). Of all of Barre City's inventoried species, sugar maple, crabapple, and Norway maple provide the greatest *net* annual reduction in energy. This is likely because these species, the three most prevalent in Barre City's urban forest (Figure 2), also have the greatest net leaf area (ft^2, Appendix C), and thus provide the most shade and temperature regulation. Per tree, sugar maple, eastern white pine, and black locust are the most beneficial at over $70 each. It is important to note that these values are derived from species, diameter class (inches), and condition class inventory data.

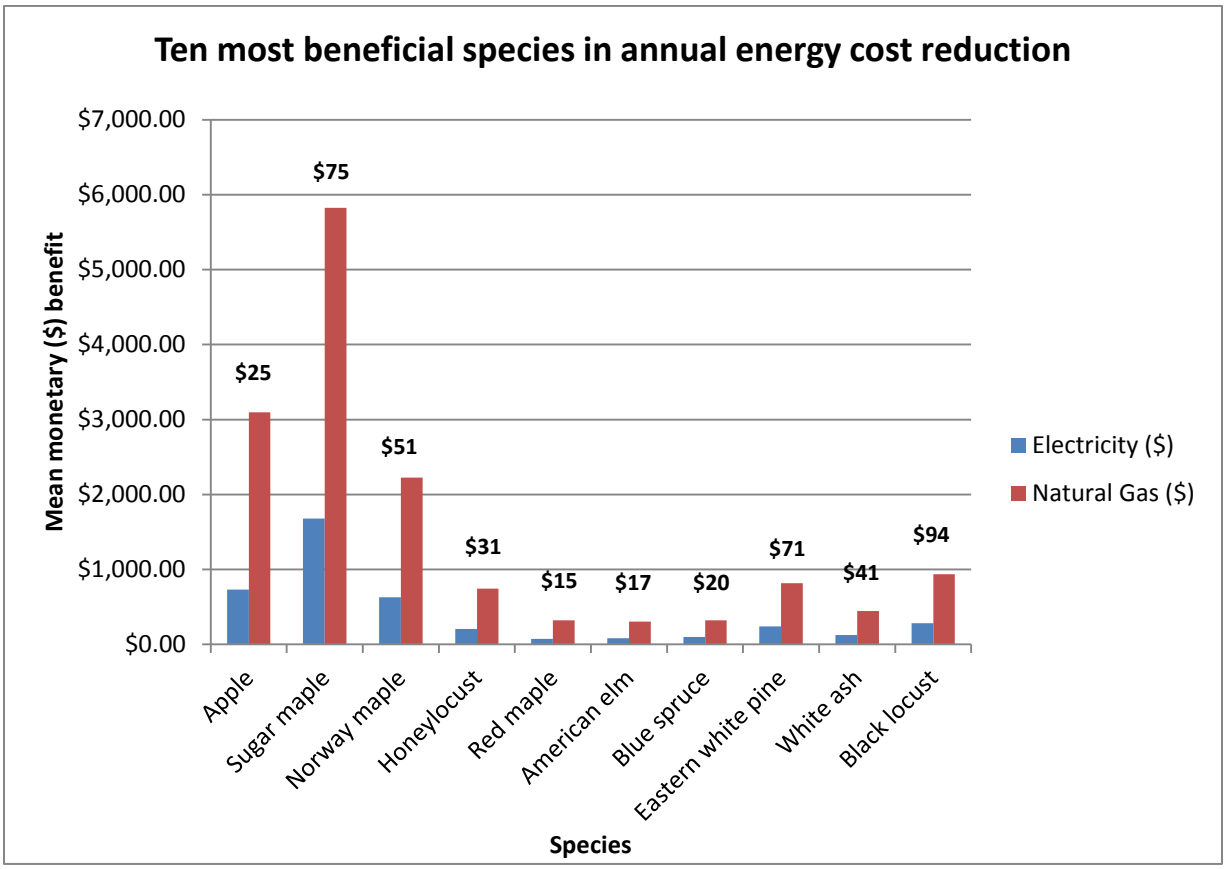


Figure 11. The average monetary value of the ten most beneficial species in annual energy cost reduction in Barre City's urban forest. The monetary values located above each species' bar represent the average annual energy reduction benefit ($) per tree. Monetary values were derived from tree species, diameter (inches), and condition inventory data through i-Tree Streets' urban canopy benefits output.

Barre City's Full Canopy Assessment

As a complement to the public tree inventory, VT UCF staff completed an urban tree canopy (UTC) assessment for Barre City. VT UCF staff used i-Tree Canopy, a free, easy-to-use online application that allows users to assess total tree cover over an area based on randomly generated map points and user-defined land cover types. Like i-Tree Streets, this tool also assigns dollar values to the benefits associated with the overall tree canopy cover. The aim of this type of assessment is to help citizens and decision-makers better understand the existing and potential tree canopy in their community. Based on Barre City's i-Tree Canopy assessment, approximately 26% of the land area is currently occupied by tree canopy (Figures 12 and 13). Currently 25% of the total area is occupied by buildings, and is not suitable for tree canopy enhancement. In consideration of the other land cover types present, Barre could potentially increase its total tree canopy cover by an additional 21% on open lands of low-lying vegetation. Less than 3% of the land is water or wetlands, which while not suitable for tree planting provides many other benefits. Approximately 24% is impervious surface (parking lots, playgrounds, roads and the ROW) and with strategic planning initiative, some of this could be converted to tree canopy. In total, there is currently potential to increase Barre City's overall tree canopy cover by 45%, though much of this land is privately-owned.

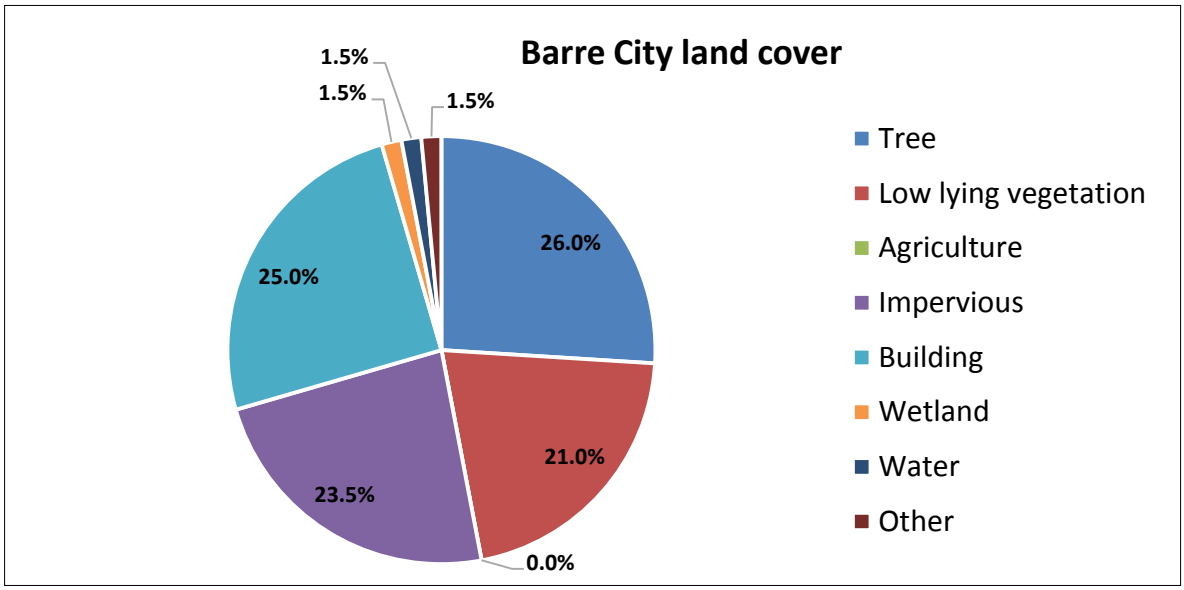
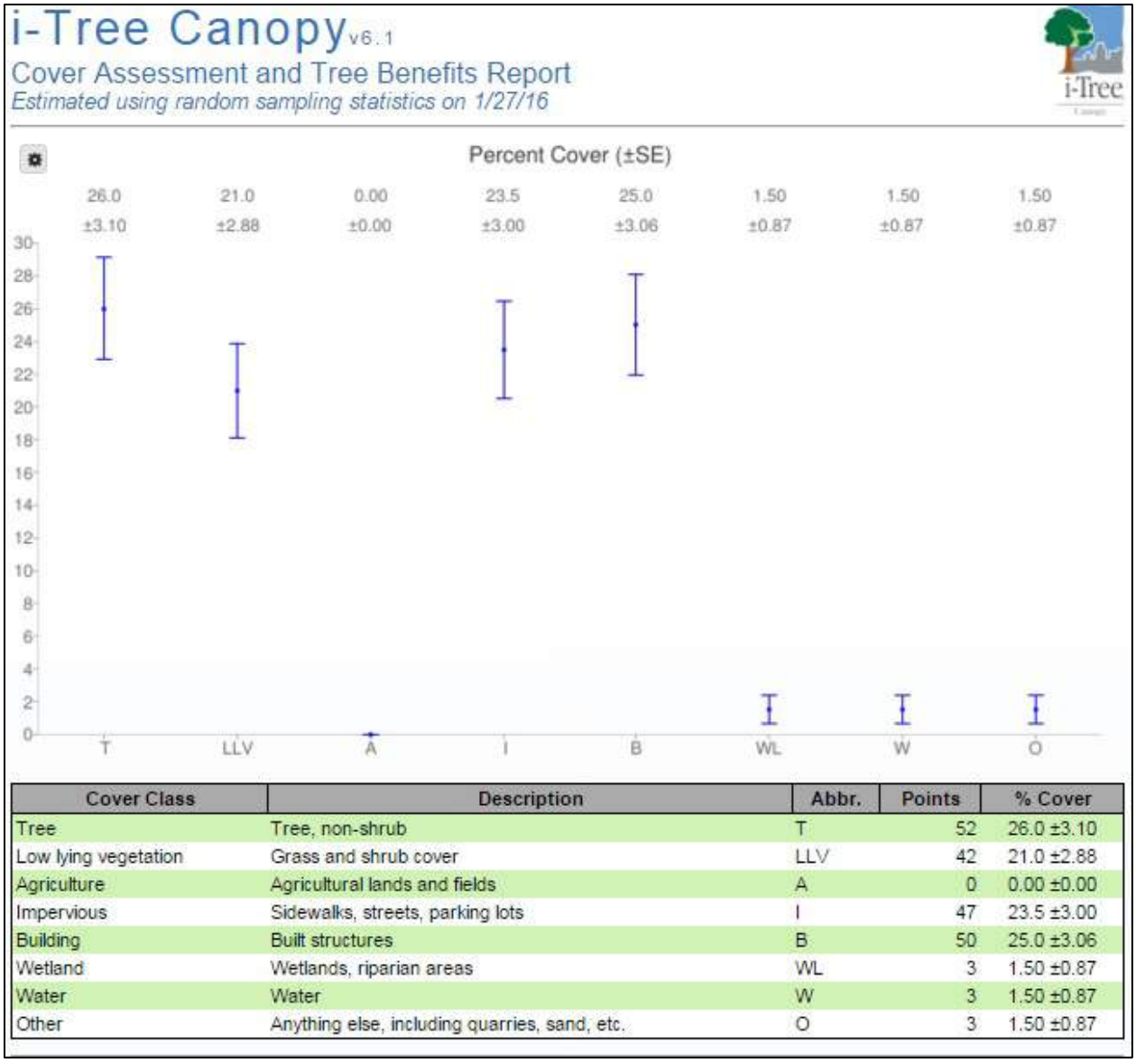


Figure 12. Land cover of Barre City (includes public and private land).



Cover Class	Description	Abbr.	Points	% Cover
Tree	Tree, non-shrub	T	52	26.0 ±3.10
Low lying vegetation	Grass and shrub cover	LLV	42	21.0 ±2.88
Agriculture	Agricultural lands and fields	A	0	0.00 ±0.00
Impervious	Sidewalks, streets, parking lots	I	47	23.5 ±3.00
Building	Built structures	B	50	25.0 ±3.06
Wetland	Wetlands, riparian areas	WL	3	1.50 ±0.87
Water	Water	W	3	1.50 ±0.87
Other	Anything else, including quarries, sand, etc.	O	3	1.50 ±0.87

Figure 13. i-Tree Canopy assessment for the inventory area of Barre City including both public and private land. The above image shows the ground cover composition distribution.

Figure 14 compliments the i-Tree Streets analysis of the monetary value of benefits provided by Barre City's public trees by estimating the air quality benefits and corresponding monetary value of the full urban forest canopy (both public and private land). Of note is an estimated $761,917 in CO_2 storage and $30,214 in annual CO_2 sequestration value.

Tree Benefit Estimates

Abbr.	Benefit Description	Value	±SE	Amount	±SE
CO	Carbon Monoxide removed annually	$6.40	±0.76	151.04 lb	±18.02
NO2	Nitrogen Dioxide removed annually	$11.02	±1.31	823.59 lb	±98.25
O3	Ozone removed annually	$574.06	±68.48	4.10 T	±0.49
PM2.5	Particulate Matter less than 2.5 microns removed annually	$1,186.68	±141.56	398.58 lb	±47.55
SO2	Sulfur Dioxide removed annually	$1.93	±0.23	519.00 lb	±61.91
PM10*	Particulate Matter greater than 2.5 microns and less than 10 microns removed annually	$416.75	±49.72	1.37 T	±0.16
CO2seq	Carbon Dioxide sequestered annually in trees	$30,215.44	±3,604.48	835.09 T	±99.62
CO2stor	Carbon Dioxide stored in trees (Note: this benefit is not an annual rate)	$761,916.68	±90,891.16	21,055.29 T	±2,511.74

i-Tree Canopy Annual Tree Benefit Estimates based on these values in lbs/acre/yr and $/T/yr: CO 0.902 @ $85.08 | NO2 4.917 @ $26.86 | O3 48.968 @ $140.47 | PM2.5 2.379 @ $5,975.67 | SO2 3.098 @ $7.45 | PM10 16.403 @ $304.43 | CO2seq 9,970.817 @ $36.31 | CO2stor is a total biomass amount of 251,395.359 @ $36.31*
Note: Standard errors of removal amounts and benefits were calculated based on standard errors of sampled and classified points.

Figure 14. i-Tree Canopy assessment estimates of air quality benefits provided by public and private trees in the area of the Barre City public tree inventory.

Discussion and Recommendations

Barre City's Public Tree Program

Barre City's participation in the *Care of the Urban Forest* demonstrates that there is local capacity and desire to enhance the municipality's public tree program. Barre City has an active Tree Warden, residents who are passionate about trees, and historic and public spaces that are enhanced by the presence of healthy, mature trees. The 2015 public tree inventory and this report lay a foundation for better understanding the management needs and value of Barre City's public trees, as well as the ways in which residents and City leadership can be engaged for tree stewardship.

Recommendations

We recommend that Barre City leadership and staff note the following considerations to continue to develop the public tree program:

- Develop a management plan or action plan based on the results of the inventory to prioritize goals and establish a timeline for Barre City's public tree program.
- Encourage the formation of a citizen tree committee or board to help coordinate and implement the City's tree program

- Advocate for an explicit annual maintenance budget for Barre City's trees; funds should be allocated not only for tree removals, but also for regular planting, maintenance, and monitoring of the public trees.
- Encourage citizens to participate in stewardship activities; particularly because of the trees in the *Acer* (maple) and *Fraxinus* (ash) genera, residents should be aware of the signs and symptoms of EAB and ALB and should be empowered to monitor for these invasive forest pests.
- Plan for the arrival of EAB by developing a community invasive forest pest preparedness plan, perhaps as a component of the overall plan for Barre City's public trees; this process will inform future planning efforts for other threats to the urban forest.
- Ensure that those who are caring for Barre City's public trees are trained in best tree care practices. Public trees should be structurally pruned to promote long-term integrity, newly-planted trees should be irrigated to promote proper establishment, mulch should be applied properly, and mechanical and compaction damage should be minimized during any construction or regular maintenance activities.
- Communicate the benefits of Barre City's public trees at local events and to local leadership, and encourage citizen participation in VT UCF educational programming, such as the Stewardship of the Urban Landscape course, winter webinar series, annual VT Tree Stewards Conference, and Forest Pest First Detector trainings.
- Encourage residents to plant trees on their private property to increase diversity, overall urban tree canopy cover, and the benefits provided by trees to citizens of Barre City.

Urban Forest Diversity and Structure

An important best management practice in urban forestry is to maintain a diverse range of species. It is recommended that communities work towards a goal of no more than 20% representation of a single genus (for example, *Acer*) in a tree population and no more than 10% of one species (for example, *Acer saccharum*). Resistance to disease and insect infestation is one of the many reasons that diversity of public trees is of paramount concern. A more diverse urban forest is more resistant to environmental stressors, and can therefore remain healthy

and resilient in the face of change. Furthermore, maintaining greater diversity can prevent a rapid loss of tree canopy due to insect and disease issues.

In Barre City, 42 species and 22 genera are represented as public trees. Approximately one fifth (18%) of the public trees is of species that represent less than 2% of the total tree population, indicating the diversity of the urban forest. However, one third (34%) of public trees inventoried is in the maple (*Acer*) genus, which is more than the recommended representation within the public tree population. Sugar, Norway, and red maple comprise 18%, 10%, and 5% of the total tree population, respectively. Of note, Norway maple is the third most prevalent individual species in Barre City but is now considered to be a non-native invasive species. Although an aesthetically pleasing and hearty tree, Norway maple can spread into nearby forests and out-compete native species such as sugar maple. In fact, Vermont's Plant Quarantine Rule prohibits the movement, distribution, and sale of Norway maple, as well as other invasive plant species. Based on its size class distribution in Barre City, it is evident that the planting of small, young Norway maple has ceased. Ash trees (*Fraxinus*) comprise just 3% of Barre City's public tree canopy. Both ash and maple trees are currently threatened by invasive tree pests; EAB and ALB, respectively.

Components of a Managed, Vibrant, and Resilient Public Tree Program

A successful urban forestry program requires a combination of organized leadership, comprehensive information about the tree population, dedicated personnel, and effective public relations. We recommend the following components for successful urban forest management.

Public Policies: A tree ordinance or policy provides authority for conducting forestry programs, defining municipal responsibility for public and private trees, passing regulations and setting minimum standards for urban forestry management.

Leadership: Define who is responsible for the oversight of the urban forest, including formulating policies, advising, administration, management, representation and/or advocacy.

Partnerships: A well-managed urban forest takes the work of many. Seek strategic partnership to meet a shared vision. At a minimum the tree warden, a local advisory committee like a tree board or conservation commission and municipal staff (parks, roads, planning) should collaborate.

Responsibility: A clear understanding of which trees and areas will be managed is an important first step. Street trees, parks and village greens, cemeteries and schools are typical areas of municipal responsibility.

Assessment: A complete public tree inventory, including tree locations, species, condition, and management needs provides the necessary information to manage the resource. An inventory is the foundation to developing a strategic management plan.

Management Plan: A management plan provides a vision for the long-term management of the urban forest. It should include strategies, budgets, and responsibilities for meeting that vision.

Staffing: The care of urban forest requires a certain skill set that can be found in-house with professional staff or through consultants. Whether creating a staff position for a Certified Arborist or urban forester, or contracting with them on an as-needed basis, professional assistance will have some of the greatest and most immediate impacts on an urban forestry program.

Tree Canopy Goals: Consider a community's entire tree canopy to reduce loss and maximize gains over time by protecting undeveloped forest and impacts of land development, enhance the health condition and function of forests, and reforest through active replanting or allowing regeneration.

While neither of these pests has been discovered to-date in Vermont, the largest ALB infestation in North America is just over 50 miles to our south in Worcester, MA and with the discovery of EAB in New Hampshire in 2013, Vermont is now surrounded on all sides by states or provinces with isolated infestations of EAB. See Appendix F for a map detailing the location of all public ash trees in Barre City. Large densities of sugar maple were observed in the 3 cemeteries, particularly Elmwood Cemetery and there are many Norway maples planted on the edge of Rotary Park.

Approximately 70% of the inventoried public trees are 3-18" in diameter, indicating a generally young public tree population that has not yet reached maturity. The distribution of size classes within that 70% tell a story of recent engagement in tree planting in the ROW and in public spaces in Barre City, perhaps peaking within the past decades, as 51% of the public trees are 3-12" in diameter. Just 16% of Barre City's public trees are over 24' in diameter; these large, mature shade trees are concentrated in the public parks and cemeteries, thriving in large grassy areas, and are essential to preserve for their aesthetic, environmental, and cultural value.

Recommendations:

We recommend that Barre City continues to develop its species and structural diversity by:

- Planting new species and increasing the number of lesser represented species in order to promote long-term health and resilience of individual trees and Barre City's overall public tree population. Refer to VT UCF's Tree Selection Guide at vtcommunityforestry.org/resources/tree-care/tree-selection.
- Due to the high number of existing maple (*Acer*) and crabapple *(Malus)* trees in Barre City, we suggest selecting non-maple and non-crabapple species for future plantings.
- Existing ash (*Fraxinus*) trees should be regularly monitored for signs and symptoms of EAB and new ash trees should not be planted.
- As Barre City's relatively young public trees mature, promote their health and integrity with a systematic structural pruning and maintenance cycle.

Urban Forest Health

Overall, Barre City appears to have a healthy population of public trees. A dedicated tree care budget and established maintenance program (opposed to explicit funds for the removal of trees) would bolster the support for the continued health of the urban forest. Approximately 15% (77) of Barre City's public trees are either considered to be in "Fair", "Poor", or "Dead" condition. There are high concentrations of "Fair" and "Poor" trees on North Main Street and at Rotary Park, Hope Cemetery, and Elmwood Cemetery. A total of 97 trees were assessed to be in need of continued monitoring by a Certified Arborist, the Tree Warden, or another qualified individual. Many of these trees overlap with those designated as in "Fair", "Poor", or "Dead" condition and others were likely noted because of conflict with City infrastructure. See Appendix E for a map detailing the locations of trees in Barre City by condition and a separate map indicating the location of the 97 trees that require monitoring. Low soil volume and fertility, soil compaction, exposure to road salt spray, root damage, mechanical damage to the trunk or branches, and improper pruning and planting are some of the contributing factors that may lead to decreased tree health in an urban setting. The full inventory data spreadsheet, with specific comments associated with the 97 trees requiring monitoring will be given to the Barre City Tree Warden.

Recommendations:

In order to ensure the long-term health and vibrancy of Barre City's public trees, we recommend the following activities:

- Prioritize the monitoring of the 97 trees that have been flagged for monitoring by a Certified Arborist or the Barre City Tree Warden.
- Develop a plan to remove – and replace, if appropriate – the 1 dead public tree (a 6-12" sugar maple in Elmwood Cemetery) in a timely fashion.
- Over 200 public trees were assessed to be in need of pruning. Establish a routine and systematic pruning cycle (multi-year) for all public trees to reduce the occurrence of branch failures due to poor structure, minimize conflicts with people and infrastructure, improve lines of sight, reduce storm damage, and protect public safety.

- Encourage a culture of continual monitoring and updating the tree inventory spreadsheet as necessary as regular tree management occurs in Barre City; consider assigning the responsibility of inventory database maintenance to one individual, or investing in a commercial inventory and management system.

Assessment Tools

Using free and accessible i-Tree software developed by the USDA Forest Service, VT UCF staff was able to assess the benefits, value, and extent of Barre City's urban tree canopy. i-Tree Streets allowed us to determine the economic value of the ecosystem services provided by the 555 inventoried trees in Barre City. The City's forest generates about $46,090 annually through the benefits of air quality improvement, carbon storage, electricity and natural gas, aesthetics, and storm water control; on average, each tree offers approximately $83 in service or savings every year. The trees of Barre City provide services to the city in the following ways:

- **Aesthetics**: Trees can make an urban or suburban environment a more pleasant and satisfying place to live, work, and spend leisure time (Dwyer et al. 1991[2]). In economic terms, presence of – particularly mature - shade trees can significantly increase property value. There are also numerous health benefits associated with the mere presence of trees. For example, hospital patients with window views of trees have been shown to recover faster than patients without such views (Ulrich 1984[3]).
- **Air quality**: Trees improve air quality by removing air pollutants through their leaves, altering emissions from building energy use, and by lowering air temperature.
- **Energy use**: Trees influence thermal comfort and energy use by providing shade, transpiring moisture, and reducing wind speeds, mitigating the need for heating of buildings in the winter and cooling in the summer.

[2] Dwyer, J.F., H. W. Schroeder, and P. H. Gobster. (1991). The significance of urban trees and forests: toward a deeper understanding of values. *Journal of Arboriculture,* 17: 276-284.

[3] Ulrich, R.S. (1984). View through a window may influence recovery from surgery. *Science*, 224:420-421.

- **Stored carbon and sequestered carbon dioxide**: Trees store carbon in their tissues as they accumulate biomass over time; an estimated 770 million tons of carbon, valued at $14.3 billion, is stored in the public forests in the contiguous United States store 770 million tons of carbon, (Nowak and Crane 2002[4]). Trees also mitigate greenhouse gas emissions by sequestering carbon dioxide through the process of photosynthesis.
- **Storm water run-off**: Trees and soil improve water quality and reduce costs associated with stormwater treatment by retaining or slowing flow of precipitation.

Using a random sample method and based on assessing land cover types, i-Tree Canopy allowed us to measure the overall tree canopy cover within the boundaries of the inventory area, capturing both private and public tree canopy totals.

Recommendations

We recommend that Barre City leadership explore the results of the two i-Tree assessments detailed in this report and:

- Use the information generated through i-Tree Streets and i-Tree Canopy to promote the understanding of tree benefits and the investment in urban forest management and local stewardship.
- Use the i-Tree Canopy UTC and land cover assessment to inform and promote efforts towards an overall urban canopy cover of 35-40% (up from the current 26%). This might include outreach to private property owners to communicate tree benefits and encourage tree planting on their land.
- Explore the other free assessment tools in the i-Tree tools suite (www.itreetools.org).

[4] Nowak, D.J.; D. E. Crane. (2002). Carbon storage and sequestration by urban trees in the USA. *Environmental Pollution* 116(3): 381-389.

Conclusion

Trees in our downtowns and densely populated landscapes contribute to environmental integrity, social cohesiveness, economic activity, cultural heritage, and overall well-being. This report is one component of a long-term effort by Barre City leadership to understand, manage, and steward the city's public tree population. The recommendations outlined in this report are based on VT UCF staff's observations and data analysis combined with their experience and evaluation; they should be considered by Barre City leadership and the Barre City Tree Warden based on long-term vision and capacity. Looking ahead, the Barre City should focus efforts on maintaining the quality of the urban trees, establishing a maintenance program, increasing its genera and species diversity, and increasing total urban canopy cover. With improved monitoring, regular maintenance, and an engaged and informed citizenry, the potential for a healthy, sustainable urban forest is attainable.

Appendices

Appendix A: Full Street and Site List of Barre City's Public Tree Inventory

Street/Site name	ROW Extent (feet)	Number of Trees
Barre City Auditorium	All planted landscape trees	15
Barre City Fire & Police Department	All planted landscape trees	42
Barre City Library	All planted landscape trees	10
Church Street	Full road ROW	4
Cottage Street	Full road ROW	8
Currier Park	All planted landscape trees	19
Elmwood Cemetery	All planted landscape trees	100
Hope Cemetery	All planted landscape trees	168
Jefferson Street	Sidewalk trees; Full road ROW	7
Maple Avenue/Rt. 14	Sidewalk trees; Full road ROW	1
Merchant Street	Sidewalk trees; From 302/Main (S) to intersection with Summer Street (N); ROW	8
North Main Street	Sidewalk trees; From 6th Street (NW) to end/City Park (SE)	56
Prospect Street	Sidewalk trees; From Merchants Row (W) to end/intersection with Main (E); ROW	6
Rotary Park	All planted landscape trees	52
Seminary Street	Sidewalk trees; From 302/Main Street to Summer Street (N); ROW	2
South Main Street	Sidewalk trees; From start/Vermont City Park (N) to railroad crossing/45 S. Main Street (S); ROW	3
St. Monica Cemetery	All planted landscape trees	14
Summer Street	Sidewalk trees; Full road ROW	5
Vermont City Park (on Church Street)	All planted landscape trees	23
Washington Street	Sidewalk trees; From start/Vermont City Park (W) Mount Street (E); ROW	12
The following streets were surveyed but had no trees located within its public ROW: Short Street, Bugbee Avenue, Gable Place, Granite Street, Enterprise Alley, Williams Lane, Metro Way, Merchants Row, Academy Street, Elm Street, Keith Avenue, Pearl Street, Buzzell Place, West Street, Campbell Place, Tomasi Street.		

Appendix B: Full Species and Genera List for Barre City's Public Trees

Common name	Scientific Name	Number of Trees	Percent of Total Population
Crabapple	*Malus sp.*	156	28.1%
Sugar maple	*Acer saccharum*	100	18.0%
Norway maple	*Acer platanoides*	56	10.1%
Honeylocust	*Gleditsia triacanthos*	31	5.6%
Red maple	*Acer rubrum*	26	4.7%
American elm	*Ulmus americana*	23	4.1%
Blue spruce	*Picea pungens*	21	3.8%
Eastern white pine	*Pinus strobus*	15	2.7%
White ash	*Fraxinus americana*	14	2.5%
Black locust	*Robinia pseudoacacia*	13	2.3%
White cedar	*Thuja occidentalis*	11	2.0%
Norway spruce	*Picea abies*	11	2.0%
Bur oak	*Quercus macrocarpa*	10	1.8%
Northern red oak	*Quercus rubra*	8	1.4%
Common chokecherry	*Prunus virginiana*	6	1.1%
Eastern hemlock	*Tsuga canadensis*	5	0.9%
Paper birch	*Betula papyrifera*	5	0.9%
Silver maple	*Acer saccharinum*	4	0.7%
Japanese tree lilac	*Syringa reticulata*	4	0.7%
Quaking aspen	*Populus tremuloides*	3	0.5%
Common juniper	*Juniperus communis*	3	0.5%
Red spruce	*Picea rubens*	3	0.5%
Northern hackberry	*Celtis occidentalis*	3	0.5%
Pin oak	*Quercus palustris*	3	0.5%
Freeman maple	*Acer xfreemanii*	2	0.4%
Black cherry	*Prunus serotina*	2	0.4%
Lilac	*Syringa vulgaris*	2	0.4%
American basswood	*Tilia americana*	1	0.2%
Eastern red cedar	*Juniperus virginiana*	1	0.2%
Scotch pine	*Pinus sylvestris*	1	0.2%
Persimmon	*Diospyros sp.*	1	0.2%
Engelmann spruce	*Picea engelmannii*	1	0.2%
Pin cherry	*Prunus pensylvanica*	1	0.2%
Saucer magnolia	*Magnolia sp.*	1	0.2%
Ash	*Fraxinus sp.*	1	0.2%
Serviceberry	*Amelanchier*	1	0.2%
Pine	*Pinus sp.*	1	0.2%
Birch	*Betula sp.*	1	0.2%
Cottonwood	*Populus fremontii*	1	0.2%
Crack willow	*Salix fragilis*	1	0.2%
Boxelder	*Acer negundo*	1	0.2%
Little leaf linden	*Tillia cordata*	1	0.2%

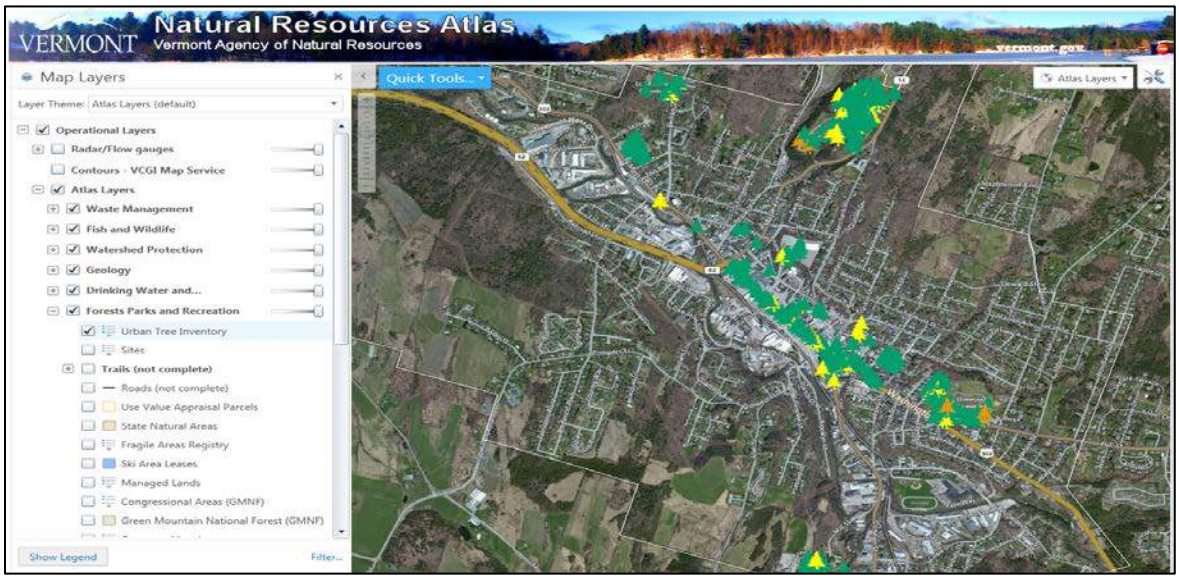
Appendix C: Leaf Area and Canopy Cover by Species Comprising Barre City's Urban Forest

Species	Number of Trees	% of Total Trees	Leaf Area (ft2)	% of Total Leaf Area	Canopy Cover (ft2)	% of Total Canopy Cover
crabapple	156	28.11	104,056.18	8.61	45,068.55	12.6
sugar maple	100	18.02	580,694.49	48.05	118,658.03	33.18
Norway maple	56	10.09	82,853.06	6.86	39,542.58	11.06
honeylocust	31	5.59	31,943.98	2.64	13,745.11	3.84
red maple	26	4.68	23,262.07	1.92	4,746.50	1.33
American elm	23	4.14	21,291.76	1.76	4,798.53	1.34
blue spruce	21	3.78	17,596.81	1.46	6,219.07	1.74
eastern white pine	15	2.7	39,545.19	3.27	16,974.43	4.75
white ash	14	2.52	26,832.74	2.22	9,021.25	2.52
black locust	13	2.34	67,022.12	5.55	20,088.16	5.62
northern white cedar	11	1.98	7,900.81	0.65	5,852.43	1.64
Norway spruce	11	1.98	27,139.90	2.25	11,617.95	3.25
bur oak	10	1.8	13,189.43	1.09	4,616.65	1.29
northern red oak	8	1.44	14,912.21	1.23	5,875.96	1.64
common chokecherry	6	1.08	3,045.45	0.25	1,733.73	0.48
paper birch	5	0.9	25,727.35	2.13	7,822.44	2.19
spruce	4	0.72	7,108.31	0.59	2,928.13	0.82
silver maple	4	0.72	34,156.82	2.83	8,607.69	2.41
Japanese tree lilac	4	0.72	6,006.27	0.5	2,479.70	0.69
pin oak	3	0.54	10,960.70	0.91	3,805.92	1.06
broadleaf deciduous	3	0.54	5,667.66	0.47	1,715.30	0.48
northern hackberry	3	0.54	5,999.41	0.5	2,220.71	0.62
broadleaf evergreen medium	3	0.54	5,809.66	0.48	2,222.58	0.62
broadleaf deciduous medium	3	0.54	1,134.82	0.09	751.5	0.21
quaking aspen	3	0.54	4,323.07	0.36	1,665.16	0.47
maple	2	0.36	477.69	0.04	267.67	0.07
boxelder	1	0.18	690.72	0.06	408.02	0.11
serviceberry	1	0.18	200.51	0.02	147.51	0.04
willow	1	0.18	1,629.58	0.13	419.32	0.12
little leaf linden	1	0.18	2,884.42	0.24	1,169.57	0.33
American basswood	1	0.18	6,670.61	0.55	1,659.58	0.46
eastern red cedar	1	0.18	1,743.07	0.14	1,543.94	0.43
broadleaf deciduous medium	1	0.18	2,803.45	0.23	848.97	0.24
pine	1	0.18	917.81	0.08	332.44	0.09
cottonwood	1	0.18	8,187.63	0.68	2,236.32	0.63
scotch pine	1	0.18	1,706.39	0.14	716.64	0.2
birch	1	0.18	1,629.58	0.13	419.32	0.12
ash	1	0.18	5,910.21	0.49	2,069.83	0.58
Total	**555**	**100**	**1,208,466.48**	**100**	**357,652.29**	**100**

Appendix D: Instructions for Accessing Public Tree Data in ANR Atlas

Anyone with Internet access can view all of Barre City inventoried public trees by using the Vermont Agency of Natural Resources' (ANR) Atlas mapping tool. Follow these simple steps:

1. Set your web browser (Internet Explorer works best, Chrome does not work) to http://anrmaps.vermont.gov/websites/anra/ (or search "VT ANR Atlas").
2. Zoom in to Barre City using the +/- scale navigation tool in the upper left portion of the map (the tree data layer won't show up unless you are zoomed in to the city-level so that you can see the street names on the map).
3. In the information pane on the left of the screen switch to the "map layers" tab at the bottom.
4. Expand the "Forests, Parks, & Recreation" heading,
5. Click on the box to the left of "Urban Tree Inventory" to load public tree data (it might take a moment for the layer to load).
6. Once you see all the trees on the map, you can zoom in and right-click on any individual tree and click on "What's here"; when you do this, the left information pane will change to give you the basic details for that specific tree.
    - To access all of the information collected on that specific tree, click on the grey text title of the tree in the left pane and a new window will open with the inventory data.
    - In this new window there are three tabs: "Details" and "Attributes" display the same information in different formats and if a photo was taken of the tree, it will show up in the "Attachments" tab.

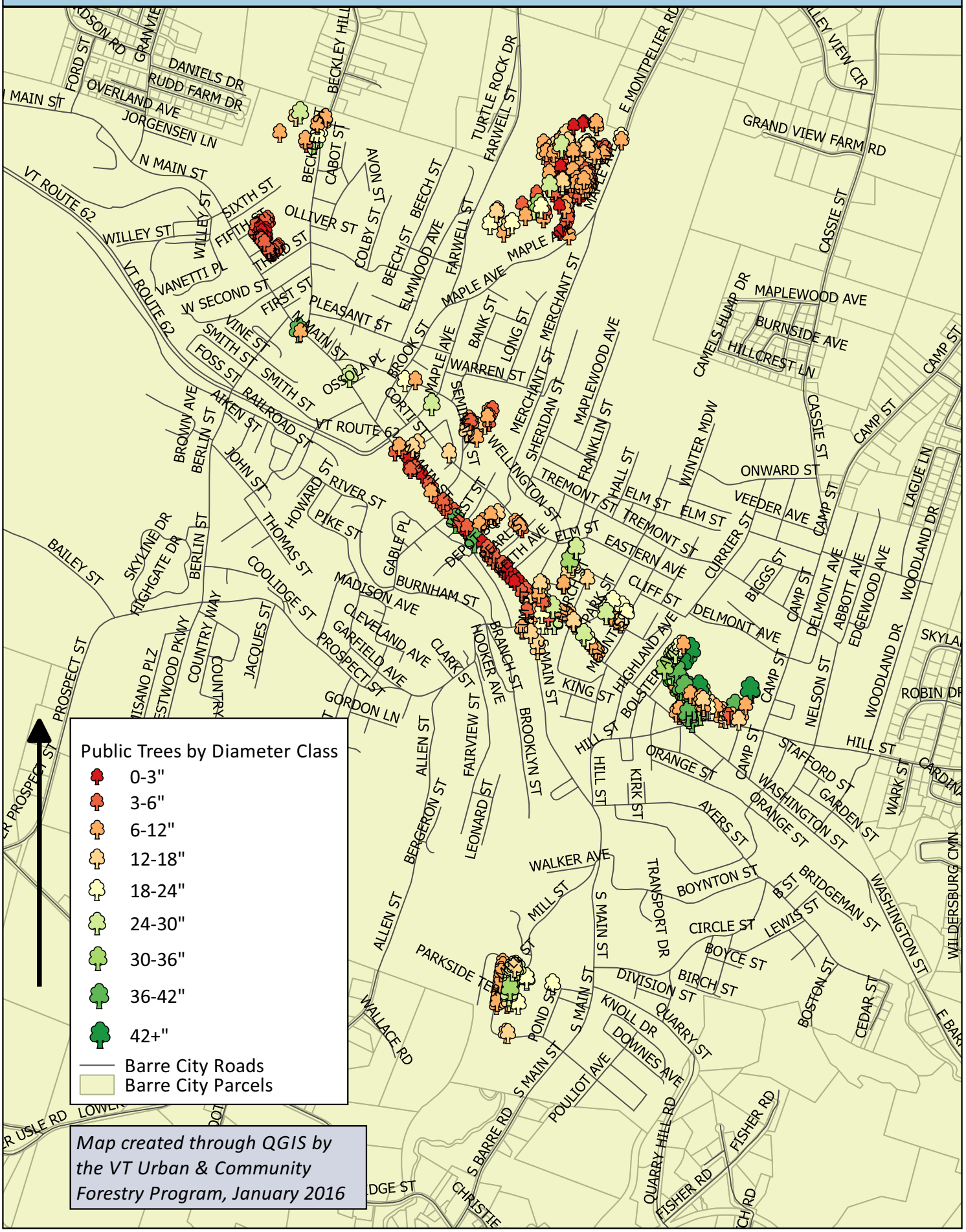


Appendix E: Maps

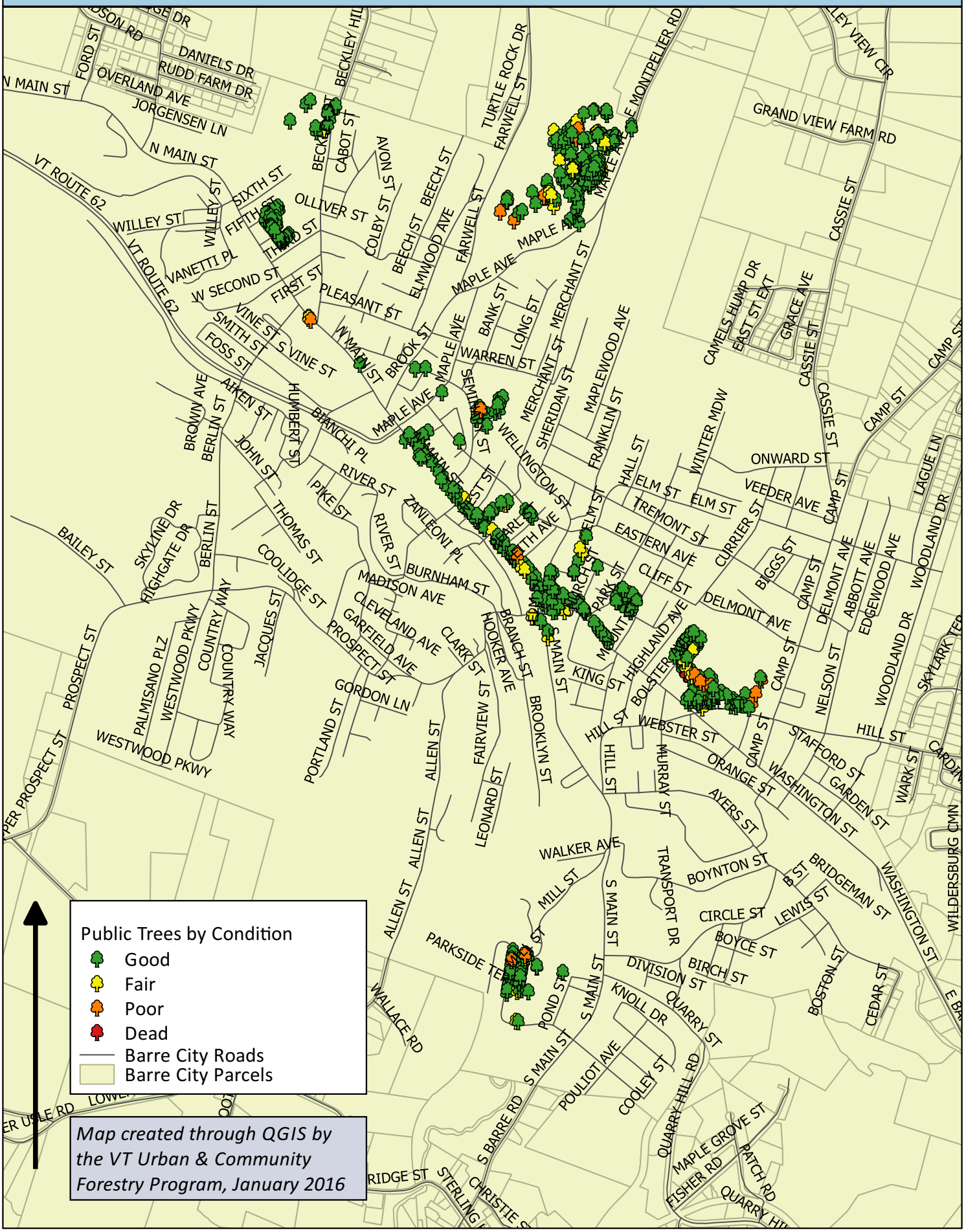
1. All Public Trees Inventoried in Barre City
2. All Public Trees Inventoried in Barre City by Diameter Class
3. All Public Trees Inventoried in Barre City by Condition Class
4. Public Trees in Need of Monitoring in Barre City
5. Barre City's Public Ash Trees

All Barre City Public Trees Inventoried

Barre City Public Trees Inventoried, by Diameter Class



Barre City Public Trees Inventoried, by Condition Class



Barre City Public Trees in Need of Monitoring

Barre City Public Ash Trees