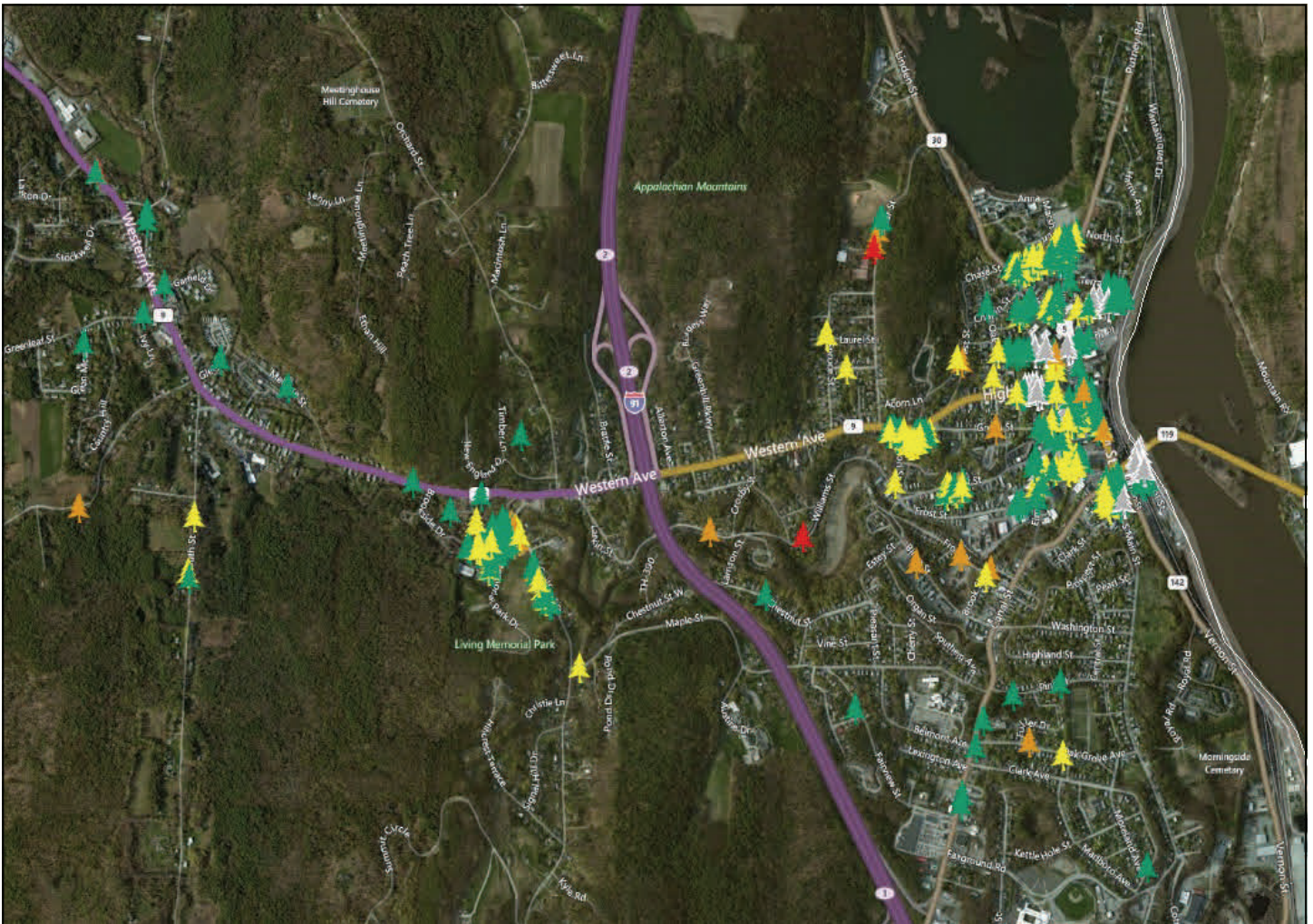


Brattleboro Public Tree Inventory Report



*Prepared for the Town of Brattleboro and
the Brattleboro Tree Advisory Committee
by the Vermont Urban & Community Forestry Program
December 2015*



VERMONT URBAN & COMMUNITY
FORESTRY PROGRAM



Acknowledgements

This report was developed by the Vermont Urban & Community Forestry Program (VT UCF) staff based on field work conducted by State Lands Foresters from the Vermont Department of Forests, Parks, & Recreation (VT FPR) for the Town of Brattleboro, Vermont and the Brattleboro Tree Advisory Committee during the summer of 2015. We would like to graciously thank the main contacts for this project: Dan Adams, Brattleboro's Tree Warden, and the members of the Brattleboro Tree Advisory Committee, particularly Rosamond Blake and Robert Clements. We would also like to thank Hannah O'Connell with the Brattleboro Department of Public Works for her work as Town liaison for the Brattleboro Tree Advisory Committee. Finally, thanks to Andrea Urbano, VT UCF intern, and Diana Jaramillo, ECO Americorps member with VT UCF, for their work in analyzing data and developing this inventory report. 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 and University of Vermont (UVM) Extension. 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 (CO₂) 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 community forest's ecological integrity and diversity. VT UCF's programming and support reaches 100 Vermont communities annually. More information about VT UCF and its programming can be found at www.vtcommunityforestry.org.

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Executive Summary

The goals of Brattleboro's public tree inventory were to update the Town's existing inventory information, accurately locate and assess town-owned trees within the public right-of-way (ROW) in Brattleboro's Downtown District, town's parks, and major roadways (*herein after referred to as the **full public tree inventory***) and encourage Brattleboro residents to be engaged in tree stewardship by better understanding the community's urban forest and its value. An additional priority goal of Brattleboro's inventory was to identify, locate, and assess the condition of the public ash trees beyond downtown and into the residential neighborhoods of the community (*herein after referred to as **the ash-only survey***); **the results of the ash-only survey are summarized in Appendix A, separately from the results of the full public tree inventory of the Downtown District, parks, and major roadways.** The information collected in the full public tree inventory and presented in this report will provide residents and decision-makers with a better understanding of the composition, health, and benefits of Brattleboro's urban forest, thus supporting the Brattleboro Tree Warden and Tree Advisory Committee in planning for tree maintenance and planting using a map-based tree inventory tool. The information collected through the ash-only survey and presented in this report will support community preparedness efforts in light of the threat of the arrival of the invasive forest pest, the emerald ash borer (EAB).

This project was initiated in the spring of 2015, was planned with the Brattleboro Tree Advisory Committee and the Brattleboro Tree Warden, Dan Adams, and was approved by Brattleboro's Town Manager, Peter Elwell. VT UCF coordinated the details of the inventory and VT FPR staff completed the on-the-ground data collection. In the full public tree inventory **362 trees** were inventoried within the public ROW of **27 downtown streets** and on **9 Town-owned properties** and **20 potential public tree planting locations** were identified. Additionally, in the ash-only survey **41 ash trees** were identified within the public ROW of **17 streets** in Brattleboro's residential neighborhoods. The data collected in the inventory were checked for quality,

analyzed, and interpreted by VT UCF staff. This report was prepared in December 2015, presents the results of the inventory efforts, and provides a basic assessment of the trees and urban canopy cover in the Town of Brattleboro.

Local government, town boards and committees, conservation agencies, and private landowners all play an important role in monitoring and maintaining urban and community forests. Public trees provide a number of benefits to a community, including reducing stormwater runoff, reducing air pollution, providing shade, sequestering carbon dioxide (CO₂), enhancing property values, and improving the aesthetics of the community. The 362 public trees that were inventoried in Brattleboro's full public tree inventory provide an estimated **\$41,254 in benefits annually** to the residents of Brattleboro. In addition to the public trees inventoried, an aerial tree canopy assessment was completed for the land area encompassed by the public tree inventory, which indicate an existing tree canopy cover of **45%** and an estimated long-term **stored CO₂ value of over \$1,144,918**.

Summary of Findings for the Full Public Tree Inventory

Urban Forest Diversity

- Of the 362 public trees, there are 48 different species in 29 different genera.
- The five most common tree genera by number of trees are *Acer* (maple) at 35%, *Malus* (crabapple) at 14%, *Gleditsia* (honeylocust) at 11%, *Fraxinus* (ash) at 8%, and *Quercus* (oak) at 4%.
- *Acer* and *Fraxinus* species together represent 43% percent of Brattleboro's public trees. Invasive tree pests currently threaten both of these genera: the Asian long horned beetle (ALB) and the EAB, respectively.
- The five most common species are *Malus* sp. (crabapple) at 14%, *Acer saccharum* (sugar maple) at 14%, *Acer platanoides* (Norway maple) at 11%, *Gleditsia triacanthos* (honeylocust) at 11%, and *Fraxinus* (ash) species at 8%.

Urban Forest Structure

- Over half of the inventoried public trees (64%) have a diameter at breast height (DBH) measurement between 3 and 18". 10% of inventoried public trees have a DBH within the 18-24" and 24-30" size classes.
- The remaining 16% of inventoried trees are represented in the following size classes: 0-3" (5%), 30-36" (4%), 36-42" (5%), and 42+" (2%).

Urban Forest Cover

- There is an existing urban tree canopy (UTC) cover of 45% across the extent of the Brattleboro public tree inventory. This analysis was done on both public and private land over the full extent of the inventory area.
- Trees could potentially cover an additional 38% of Brattleboro's land within the public tree inventory area. These "possible UTC" areas include low-lying vegetation or grassland and impervious surfaces (e.g. parking lots, paved playgrounds, and the ROW).
- The remaining 17% of Brattleboro's land cover within the public tree inventory area is buildings, streets, water, and other permanent features that are generally unsuited to UTC improvement.

Urban Forest Health

- The majority (234, or 65%) of Brattleboro's inventoried trees are assessed as being in "Good" condition. Of the remaining trees, 108 (30%) are considered to be in "Fair" condition, 20 (6%) are in "Poor" condition and 0 "Dead" trees were found in the public tree inventory.
- 125 trees (35%) were assessed to be in need of monitoring by a Certified Arborist, the Brattleboro Tree Warden, or another qualified individual.
- Over a third (44 or 35%) of Brattleboro's inventoried public maple trees were assessed as in need of monitoring, and it is recommended that in light of the threat of EAB, all (29 or 100%) of the public ash trees in the full public tree inventory area be monitored.

Summary of Recommendations for the Full Public Tree Inventory

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 both the full public tree inventory and the residential ash-only survey, our priority recommendations for the Brattleboro Tree Advisory Committee are:

- Continue to diversify across species and age class by protecting and promoting the health of larger-diameter trees, properly maintaining trees as they reach maturity (including routine structural pruning), and planting young trees.
- Prioritize the timely assessment and, if needed, maintenance of the 125 trees that were identified as in need of monitoring by a Certified Arborist or the Brattleboro Tree Warden.
- Regularly monitor the 29 public ash trees in the full public tree inventory area and continue to work towards developing a robust EAB community preparedness plan.



VT UCF provides technical, financial, and educational services to VT communities to promote and support vibrant urban and community forests, such as Montpelier's, pictured 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 municipal 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 key volunteers to increase in-house capacity to manage, and promote the proper care, of public trees.

The Brattleboro Tree Warden and members of the Brattleboro Tree Advisory Committee were interested in partnering with VT UCF on the *Care of the Urban Forest* project to conduct a full public tree inventory of the most populated areas of the Town that would be map-based and in a spreadsheet (opposed to on paper). The intent of the public tree inventory was to enable the Brattleboro Tree Advisory Committee and Town leadership to better understand, steward, and manage the community's public trees more efficiently and cost effectively. The specific goals of Brattleboro's public tree inventory were to update the Town's existing inventory information (which dates back to 1996), accurately locate and assess town-owned trees within the public ROW in Brattleboro's Downtown District, town parks, and major roadways, and encourage Brattleboro residents to be engaged in tree stewardship by better understanding the community's urban forest and its value. An additional goal of was to identify, locate, and assess the condition of the public ash trees beyond downtown and into the residential neighborhoods of the community. The public tree inventory was conducted in August and September over the course of approximately 200 hours and will provide a foundation for future management decisions and improvements to the urban forest. Additionally, benefits of tree canopy cover, such as the improvement of air and water quality and increased property value, will increase when the Town of Brattleboro is able to manage and support healthy public trees.

The Town of Brattleboro has had an active Tree Advisory Committee, Tree Warden, and citizen tree stewardship (e.g., Brattleboro Trees Please) for decades. The Brattleboro Planning Services Department developed a Streetscape Master Plan in 1996 based on a street tree inventory conducted that same year. The current Tree Advisory Committee is eager to update the full tree inventory for Brattleboro’s public trees and revisit the plan. A number of active Forest Pest First Detectors are also engaged in current tree stewardship efforts, including Bob Everingham, who is spearheading the effort to develop an EAB community preparedness plan for Brattleboro.

Town Profile and History

The Town of Brattleboro is located in Windham County in the southeast corner of Vermont, along the state line of New Hampshire. Brattleboro covers a land area of approximately 32 square miles, and has a population of 11,765 people, according to the 2014 U.S. Census. Brattleboro is the most populated municipality along Vermont’s eastern border, ranking seventh most populous statewide. Brattleboro is situated on the west bank of the. Brattleboro’s land and rivers are culturally and historically significant. The Abenaki people, for example, utilized the West River for transportation to and from their seasonal settlement and hunting

Importance of Inventory and Community Forestry in Vermont

A public tree inventory establishes a record of the community-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 community 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.

grounds¹. However, the landscape and resources began to change as tensions rose between natives and settling Europeans. During Dummer's War, which later transformed into the French and Indian War (1754-1763), the Massachusetts General Court voted to build a blockhouse and stockade on a site of the Connecticut River in what is now called Brattleboro. Lieutenant-governor William Dummer signed the measure, and construction of Fort Dummer began in 1724². By the end of the French and Indian War, the Abenaki were largely driven north or fled into Quebec. Following the Dummer War, King George's War broke out and lasted until 1748, and Fort Dummer was utilized throughout these wars. The township became one of the New Hampshire grants, and was chartered as such in 1753, by Governor Benning Wentworth. It was named Brattleboro after Colonel William Brattle, Jr. of Boston, a principal proprietor. Hostilities ceased after the Treaty of Paris, when France abandoned their claims to Vermont, and Brattleboro developed a peaceful reputation for business and wealth². By 1859, Brattleboro was an established mill town, and supported a woolen textile mill, a paper mill, a manufacturer of papermaking machinery, a factory making melodeons, two machine shops, a flour mill, a carriage factor, and four printing establishments². Connected by the Vermont and Massachusetts Railroad and the Vermont Valley Railroad, Brattleboro prospered as a regional center for trade in commodities including grain, lumber, turpentine, tallow, and pork³. Today, Brattleboro is a commercial and touristic gateway for the state of Vermont, as it is the first major town one encounters crossing northward by car from Massachusetts on Interstate 91. The Town offers a mix of rural atmosphere and urban amenities. Brattleboro is also one of two towns in the United States that is Fair Trade Certified⁴.

Methodology

To plan for the public tree inventory, VT UCF staff met and communicated with Brattleboro's Tree Advisory Committee and Tree Warden. Originally, 27 streets in Brattleboro's Downtown District and other major roadways were selected to be included in the full public inventory, as

¹ DeLorme (1996). *Vermont Atlas & Gazetteer*. Yarmouth, Maine: DeLorme. ISBN 0-89933-016-9.

² A. J. Coolidge & J. B. Mansfield, "A History and Description of New England;" Boston, Massachusetts 1859. Books.google.com.

³ Hayward's "New England Gazetteer of 1839". Newenglandtowns.org.

⁴ About, Fair Trade Campaigns USA. Retrieved 2015-06-28.

well as a number of priority Town-owned properties. In total, the full public tree inventory land area was about 0.75 square miles, representing less than 1% of Brattleboro's total land area, but encompassing the most densely populated section of town. When the full public tree inventory area is combined with the land area assessed for ash trees only, the total inventoried area was 1.86 square miles, or 6% of Brattleboro's total land area. The ROW boundaries for all streets were provided by the Brattleboro Tree Advisory Committee; it was decided that the greater of either the far edge of the sidewalk or 10' from the curb should be considered the ROW extent on each street. The list of inventoried streets and sites is found in Appendix B and GIS maps of the inventoried trees are in Appendix F.

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 website. All inventory data collected on public trees in Brattleboro is available for viewing on ANR Atlas and instructions are included in Appendix E.

Throughout August and September 2015 VT FPR State Lands Foresters walked along predetermined streets and on Town-owned sites in Brattleboro, recording specific data on the public trees and identifying appropriate potential planting locations or grass strips (recorded as "Vacant"). To ensure that only public trees were inventoried (as opposed to trees on private property) each inventory team had clear instructions from the Brattleboro Tree Advisory Committee for how to determine the ROW extent: for each given street, the greater of either the far edge of the sidewalk or 10' behind the curb was considered to be the ROW boundary and all trees within that boundary were considered to be public trees.

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 Brattleboro included street name, overall condition, species, diameter class (using a measurement for diameter at breast height, or DBH), a recommendation for monitoring (yes/no), 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.

The data were compiled and subsequently checked for quality, analyzed, and summarized using Microsoft Excel and QGIS (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 Brattleboro’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 Brattleboro 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	<ul style="list-style-type: none"> ● <i>Good</i>: full canopy (75-100%), no dieback of branches over 2” in diameter, no significant defects, minimal mechanical damage ● <i>Fair</i>: thinning canopy (50-75%), medium to low new growth, significant mechanical damage, obvious defects/insects/disease, foliage off-color and/or sparse ● <i>Poor</i>: declining (25-50%), visible dead branches over 2” in diameter, significant dieback, severe mechanical damage or decay (over 40% of stem affected) ● <i>Dead</i>: no signs of life, bark peeling; scratch test on twigs for signs of life (green) ● <i>Vacant</i>: potential spot for a tree within the public ROW. Add “small”, “medium”, or “large” in the comments box <ul style="list-style-type: none"> - 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, posing a hazard to people/infrastructure/cars, growing into utility wires, the tree is in dead or poor condition, the tree is an ash tree showing evidence of woodpecker flecking, blanding, epicormic branching/water sprouts, and/or suspicious exit holes No: no major defects, tree in good or fair condition
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 of Full Public Tree Inventory

Urban Forest Diversity

Of the 362 trees inventoried within the public ROW or on town-owned land, there are a total of 48 different species in 29 different genera. The five most common tree genera, *Acer* (maple), *Malus* (crabapple), *Gledistia* (honeylocust), *Fraxinus* (ash), and *Quercus* (oak), comprise 72% of Brattleboro's urban forest (Figure 1). The five most common species are *Malus* sp. (crabapple) at 14%, *Acer saccharum* (sugar maple) at 14%, *Acer platanoides* (Norway maple) at 11%, *Gleditsia triancanthos* (honeylocust) at 11%, and *Fraxinus* (ash) species at 8% (Figure 2). Complete species and genera lists can be found in Appendix C.

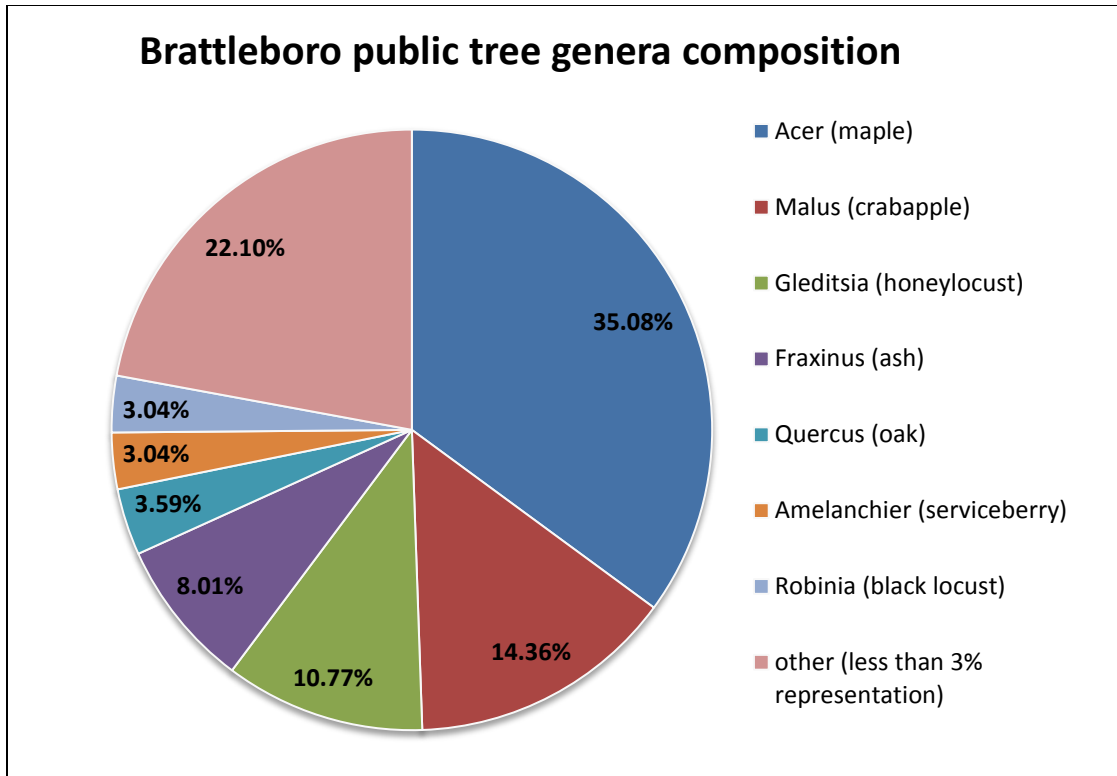


Figure 1. Most common tree genera by percent within the public ROW in Brattleboro's full public tree inventory area.

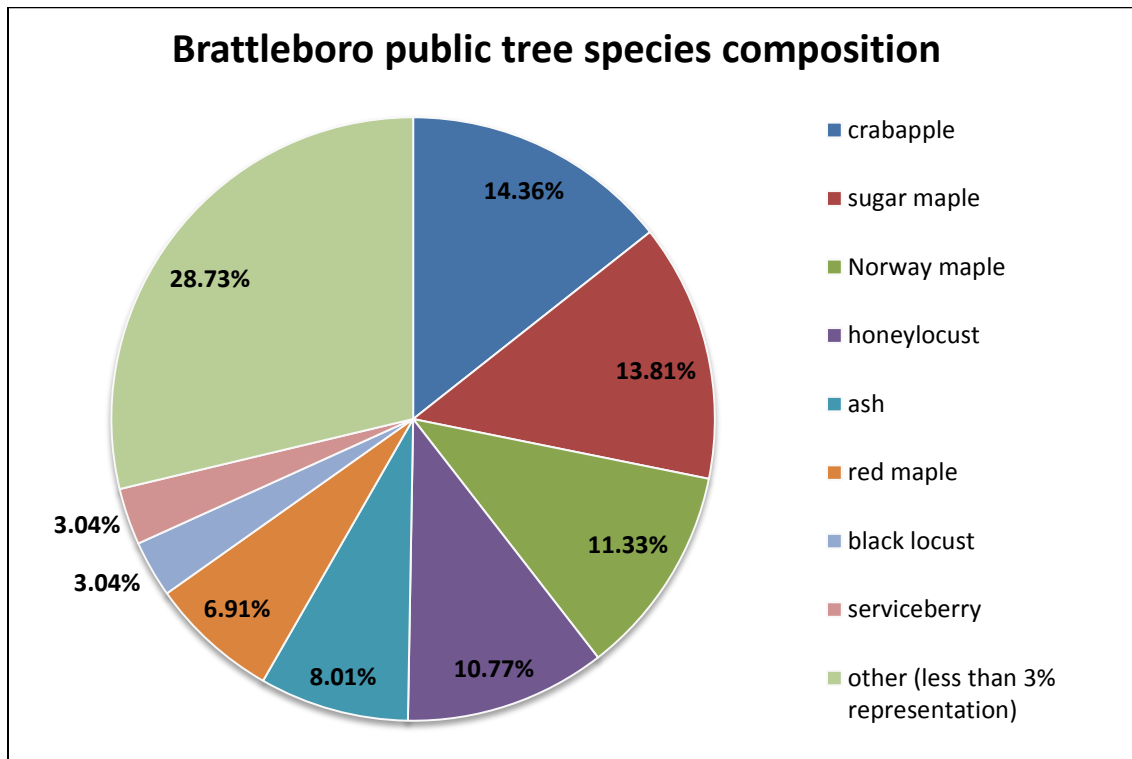


Figure 2. Most common species by percent within the ROW in the full public tree inventory area.

Urban Forest Structure

In descending order by percent size class, the diameter distribution represented by Brattleboro’s full public tree inventory population is: 30% (108) at 6-12”, 19% (67) at 12-18”, 15% (55) at 3-6”, 10% (36) at 24-30”, 10% (35) at 18-24”, 5% (19) at 0-3”, 5% (18) at 36-42”, 4% (14) at 30-36”, and 3% (10) at 42+” (Figure 3). Thus, approximately 69% of inventoried public trees are between 0 and 18 inches, indicating a relatively young but relatively well distributed urban forest age structure.

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, which is likely because the genus comprises over a third of all Brattleboro’s inventoried public trees. The three largest size classes represented, 30-36”, 36-42”, and 42+” contain a total of 42 trees (approximately 12% of the urban forest). The majority of inventoried trees within these large size classes are sugar maples (Figure 5). These trees are growing within the public ROW or on Town-owned land and were probably not planted as street trees but left as remnants as the community has grown. No sugar maples are represented within the 0-6” size classes (Figure 5).

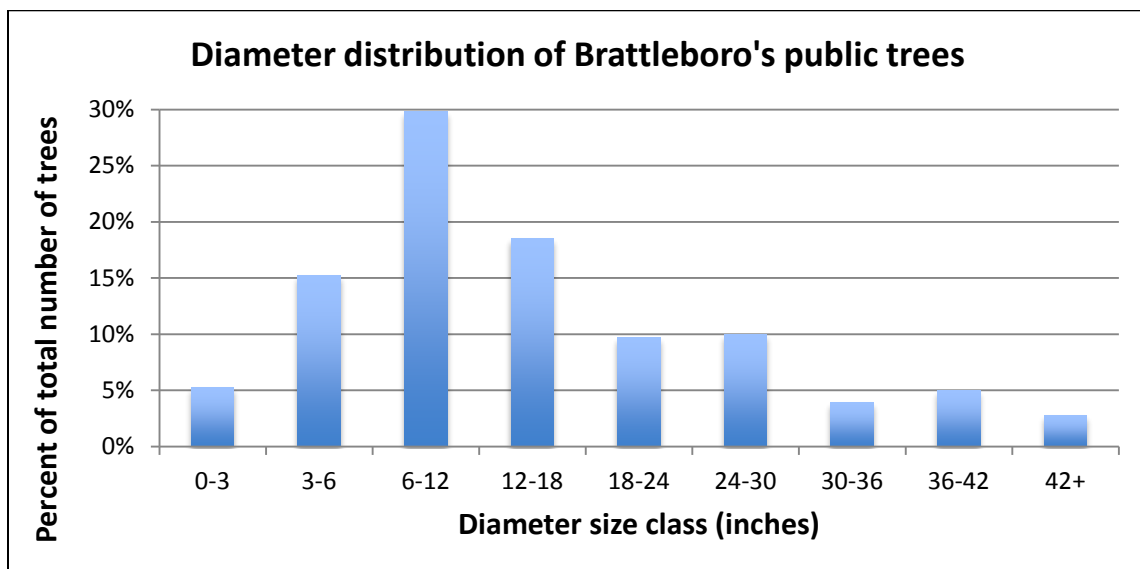


Figure 3. Percent of public trees within Brattleboro’s full public tree inventory area represented in each diameter class (inches).

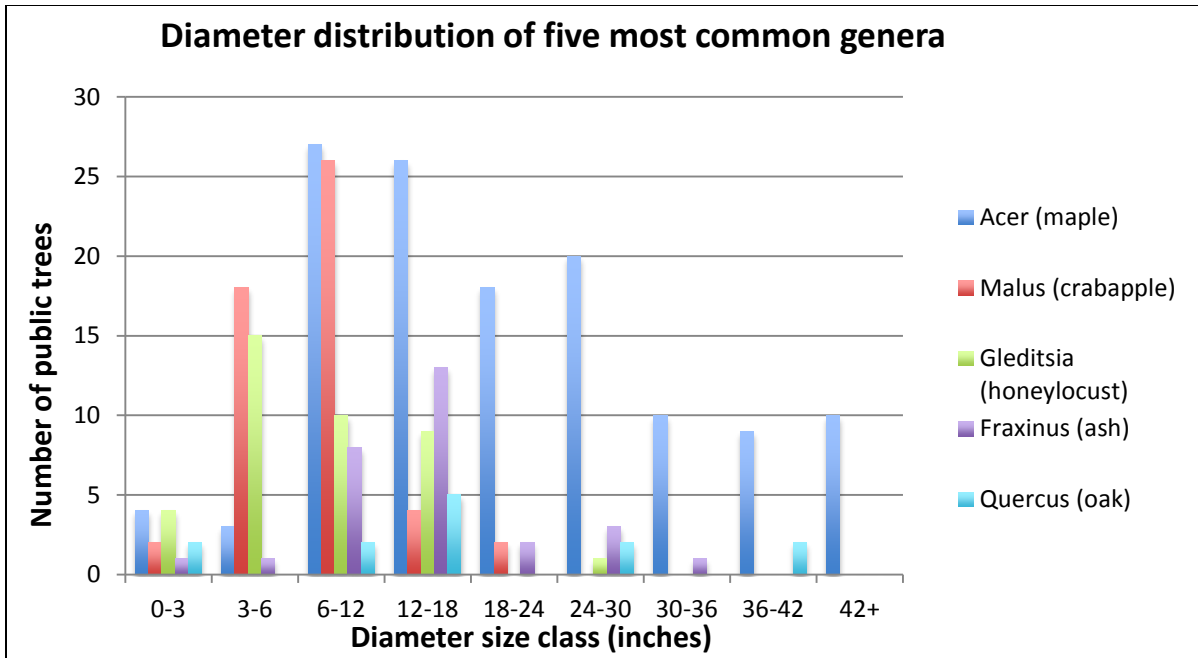


Figure 4. Diameter distribution for the five most common genera of Brattleboro’s full public tree inventory population.

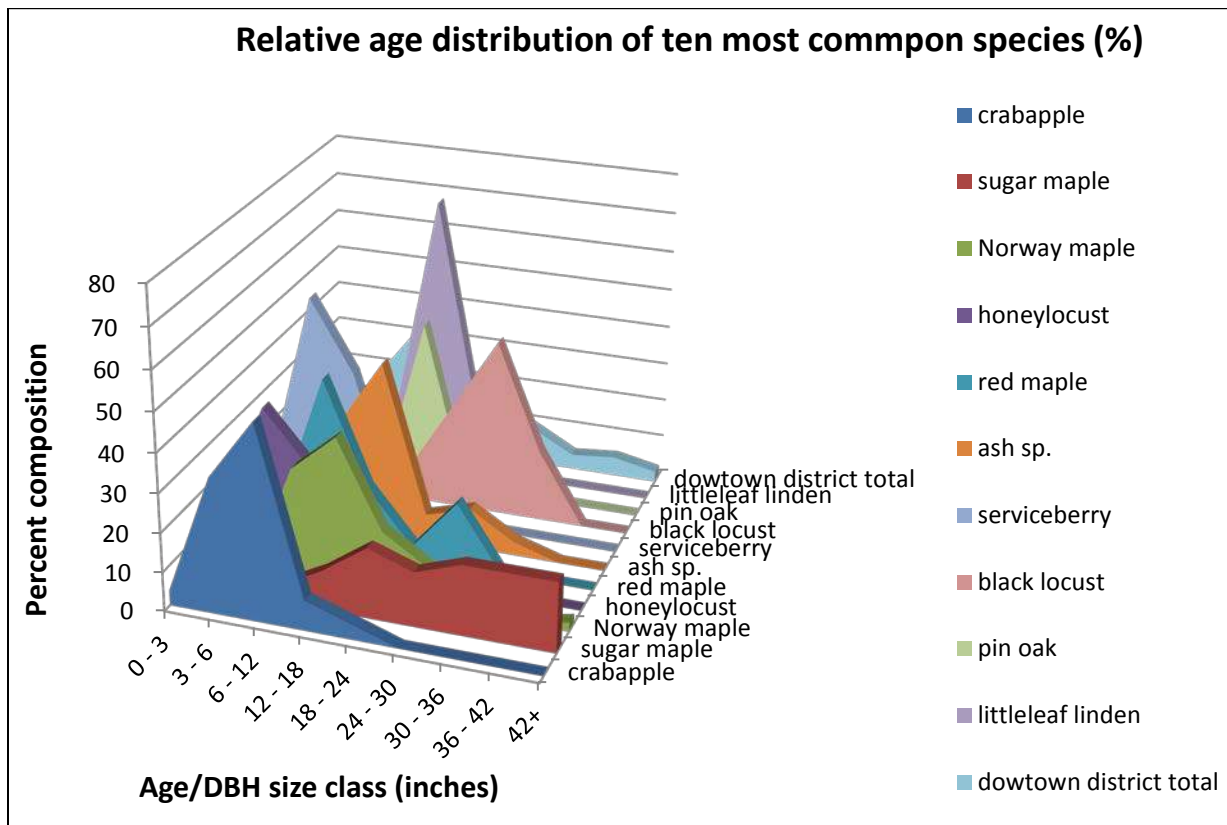


Figure 5. Diameter (and age) distribution of the ten most common species in Brattleboro’s full public tree inventory population. Data from this figure were derived from i-Tree Streets urban canopy structure output.

20 potential tree planting locations or strips were identified within the public ROW (recorded as “Vacant”) and are presented in Appendix B by street. Of the inventoried streets and sites, Depot Street offers the most vacant spots (10) for tree planting. Additional consultation of these sites is necessary to plant a tree of appropriate size and species.

Urban Forest Health

65% (640) of Brattleboro’s inventoried public trees are assessed as being in “Good” condition. Of the remaining trees, 108 (30%) are considered to be in “Fair” condition, 20 (6%) are in “Poor” condition, and 0 are “Dead” (Figure 6). *Acer* (maple) and *Gleditsia* (honeylocust) genera had the most trees in fair or poor conditions; however, *Acer* also comprises the highest percentage of inventoried trees. *Fraxinus* (ash) also comprise a relatively large portion of Brattleboro’s public trees in fair or poor condition (Figure 7). Appendix F includes maps detailing the location of inventoried trees by condition.

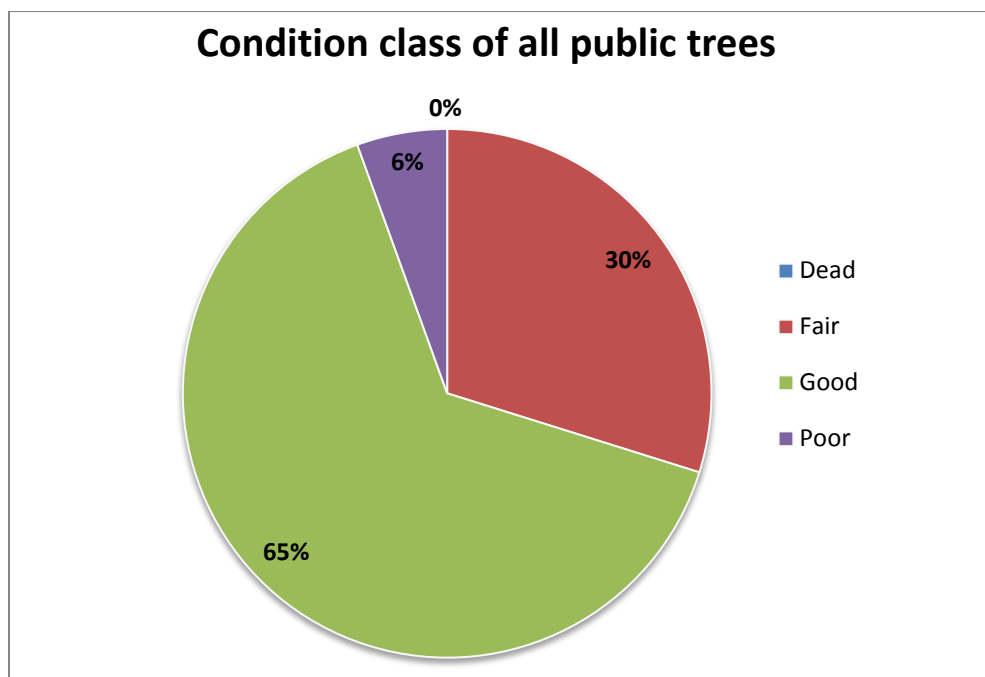


Figure 6. Percentage of public trees in each condition class within Brattleboro’s full public tree inventory area.

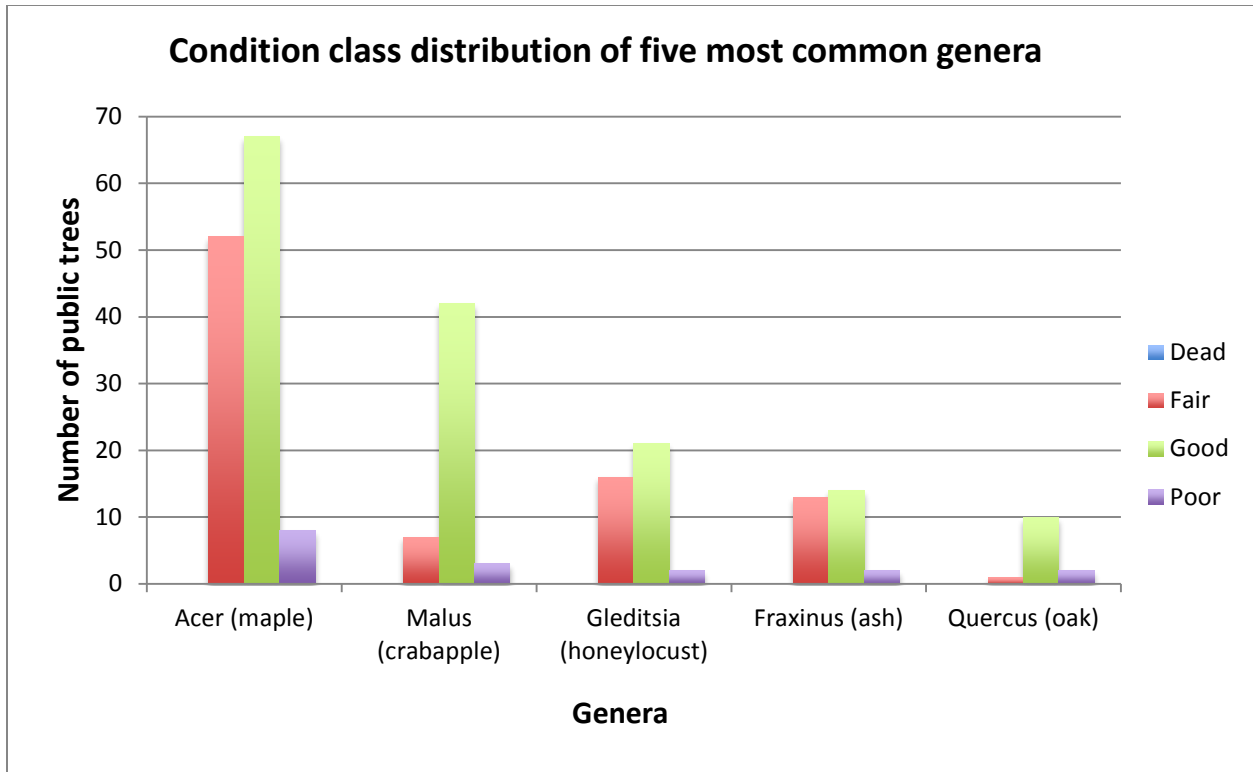


Figure 7. Number of public trees within the five most common genera displayed according to condition within Brattleboro’s full public tree inventory population.

In conducting the inventory, VT UCF and VT FPR staff assessed 125 trees (35%) to be in need of monitoring. These trees should be reassessed by a Certified Arborist, the Brattleboro Tree Warden, or another qualified individual in a timely matter. Trees 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 the emerald ash borer (extensive woodpecker flecking, bark blinding, epicormic branching/water sprouts, and/or suspicious exit holes).

Most of the 125 public trees requiring monitoring are maple species (Figure 8). All (29) inventoried public ash trees within Brattleboro’s full public tree inventory area require monitoring. In addition to the aforementioned reasons for flagging an inventoried tree as in need of monitoring, these ash trees should be watched as a measure for community preparedness for EAB.

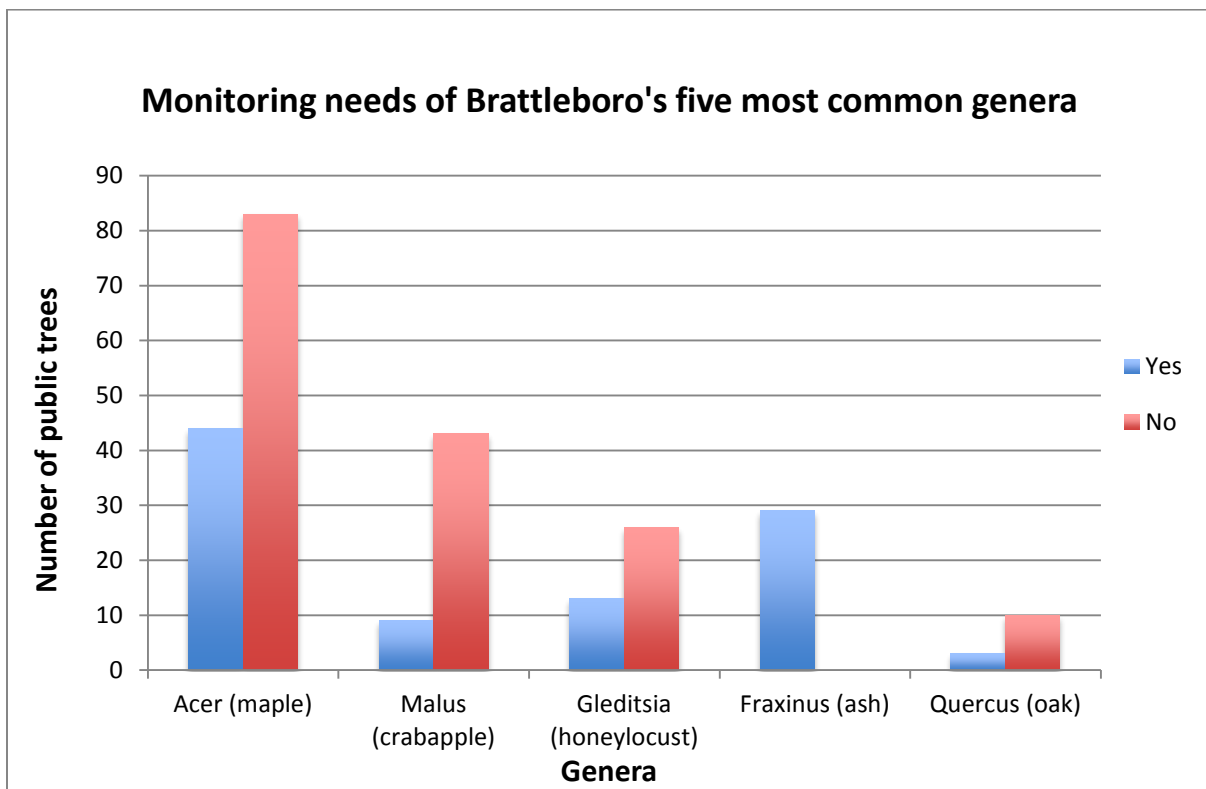


Figure 8. The number of Brattleboro’s inventoried public trees assessed to require monitoring (yes) within the full public tree inventory population’s five most common genera.

Economic Benefit and Ecosystem Services

The Brattleboro public tree inventory data were analyzed using i-Tree Streets software to determine the monetary value of the ecosystem services provided by the urban forest. The 362 trees provide a total of \$41,254 in annual benefits by filtering air pollutants, mitigating

stormwater runoff, sequestering carbon dioxide (CO₂), conserving energy, and increasing property values. On average, each public tree offers \$114 annually in savings or services.

Figure 9 and Table 2 provide an overview of each ecosystem service provided by the public trees in Brattleboro's full public tree inventory area. Energy conservation and property value increase are the most significant services provided by these trees in terms of their monetary value (Figure 9). The full reports produced through the i-Tree Streets program for Brattleboro will be given to the Brattleboro Tree Advisory Committee for further interpretation.

It is important to recognize that the trees inventoried through this project are located on approximately 0.75 square miles of Brattleboro's 32 square miles of total land area. Expanding the full public tree inventory to all of Brattleboro's roads would increase these figures dramatically. It is also noteworthy that larger 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.

Annually Downtown Brattleboro's 362 public trees provide

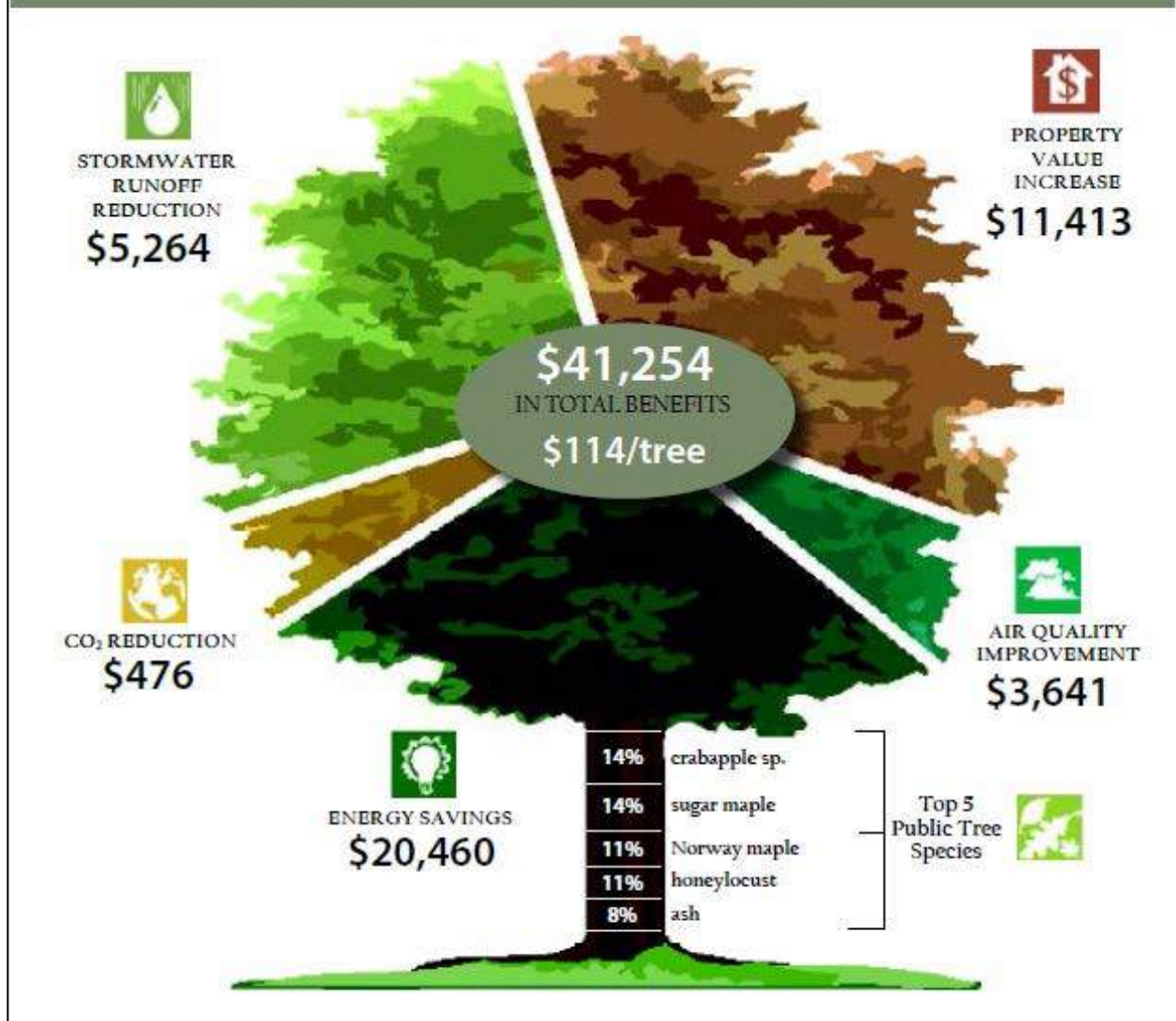


Figure 9. Summary of the benefits provided by Brattleboro's public trees inventoried through this project, according to the i-Tree Streets assessment. Tree graphic concept courtesy of City of New York Department of Parks & Recreation.

Table 2. Annual environmental and monetary benefits provided by Brattleboro’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	\$20,460.05	\$ 56.52
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.	\$476.13	\$ 1.32
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.	\$ 3,640.59	\$ 10.06
Stormwater	Reductions in annual stormwater runoff due to rainfall interception by trees.	\$5,264.00	\$ 14.54
Aesthetic/other	Tangible and intangible benefits of trees reflected in increases in property values.	\$ 11,413.30	\$ 31.53
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.	\$ 6,997.63*	\$ 19.33*

Saving the Town and its residents an average of \$20,460 annually in energy costs, the Brattleboro urban forest’s most significant analyzed economic benefit is energy conservation

(Figure 9). The greatest energy cost savings from the Town’s public trees is in the form of natural gas (versus electricity). Of all Brattleboro’s inventoried species, sugar and Norway maple provide the greatest net annual reduction in energy costs (Figure 9). Sugar and Norway maples are prevalent species in larger diameter (i.e., age) classes (Figure 5), have the greatest cumulative leaf area (ft², Appendix D), and are thus providing the greatest annual net reduction in energy costs for the Town of Brattleboro. Furthermore, the ten most beneficial energy conservation species are broadleaved (Figure 10), as their leaf area likely maximizes shade and energy regulation compared to needle-leaved species. Of all species identified in Brattleboro’s urban forest, sugar maple, black locust, and northern red oak provide the greatest annual reduction in energy costs per tree (Figure 12). It is important to note that these values are derived from species, diameter class (inches), and condition class inventory data and are related to the shade and temperature regulation services of the trees.

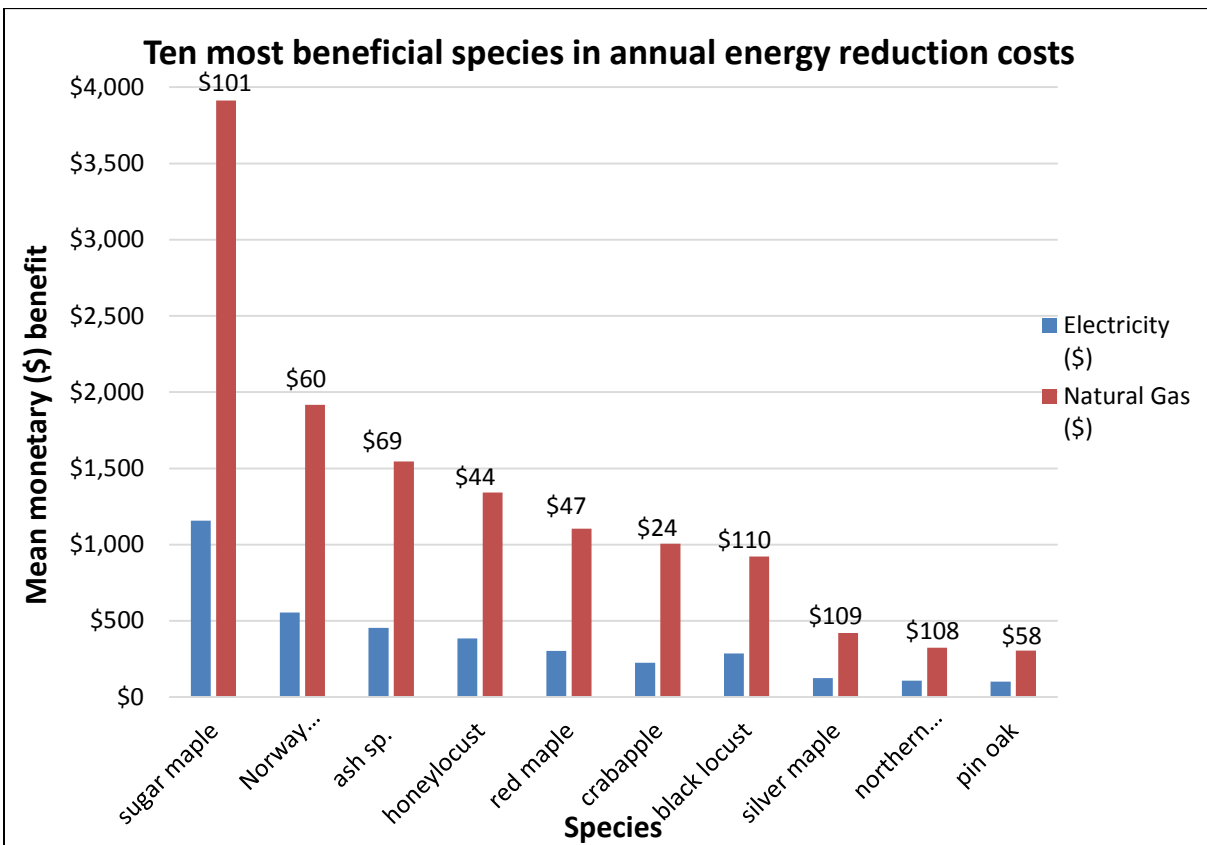


Figure 10. The average monetary value of the ten most beneficial species in annual energy reduction costs in Brattleboro’s urban forest. The monetary values above each species’ bar represents average annual energy reduction benefit (\$) per tree. Monetary values were derived from tree species, diameter (inches), and condition inventory data through i-Tree Streets’ urban canopy benefits output.

Of all the species inventoried in Brattleboro’s urban forest, sugar maples, black locusts, northern red oak, silver maple, and shagbark hickory all provide over \$30 per tree in annual reduction in stormwater (Figure 11). These estimates are again based on species-specific characteristics, size class, and condition of the inventoried trees. Over half of the sugar maples inventoried in Brattleboro’s full public tree inventory area are greater than 30” in diameter, so their high contribution to stormwater reduction is also likely attributable to their large size and therefore older age. Of the ten most beneficial species in reducing Brattleboro’s annual stormwater runoff, eight are deciduous trees and only two are coniferous (Figure 11).

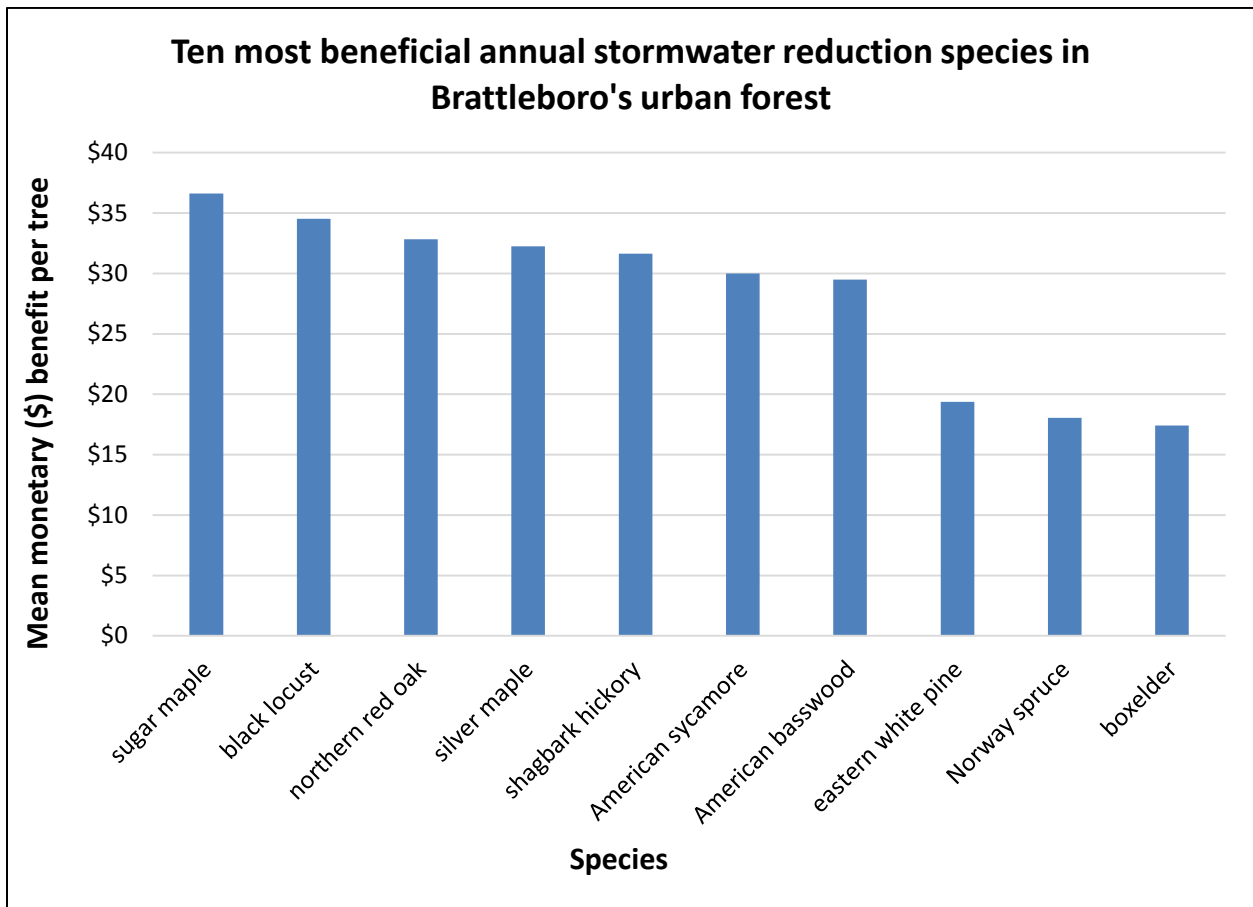


Figure 11. The average annual monetary value per tree of the ten most beneficial stormwater reduction tree species in the urban forest of Brattleboro’s full public tree inventory area. Monetary values were derived from tree species, diameter (inches), and condition inventory data through i-Tree Streets’ urban canopy benefits output.

Brattleboro Full Canopy Assessment

As a complement to the public tree inventory, VT UCF staff completed an i-Tree Canopy assessment for Brattleboro. i-Tree Canopy is a free, easy-to-use online application that allows users to assess total tree cover over a defined 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 Brattleboro's i-Tree Canopy assessment, which was done for the entire area encompassed by the public tree inventory project, approximately 45% of Brattleboro's land area is currently occupied by tree canopy (Figures 12 and 13). Currently 14% of the total area is occupied by buildings, and is not suitable for tree planting (although this is likely a higher percentage than in the rest of the town because it includes the Downtown District). In consideration of the other land cover types present, Brattleboro could potentially increase its total tree canopy cover by an additional 17% on open lands of low-lying vegetation. 1% of the land is water or wetlands, which while not suitable for tree planting provides many other benefits. The remaining 21% is impervious surface (parking lots, playgrounds, roads and the ROW), but with strategic planning initiative, some of this could be converted to canopy. In total, there is currently potential to increase Brattleboro's overall tree canopy cover by 38%, though a portion of this land is privately-owned and/or used for other purposes such as agriculture (Figure 13).

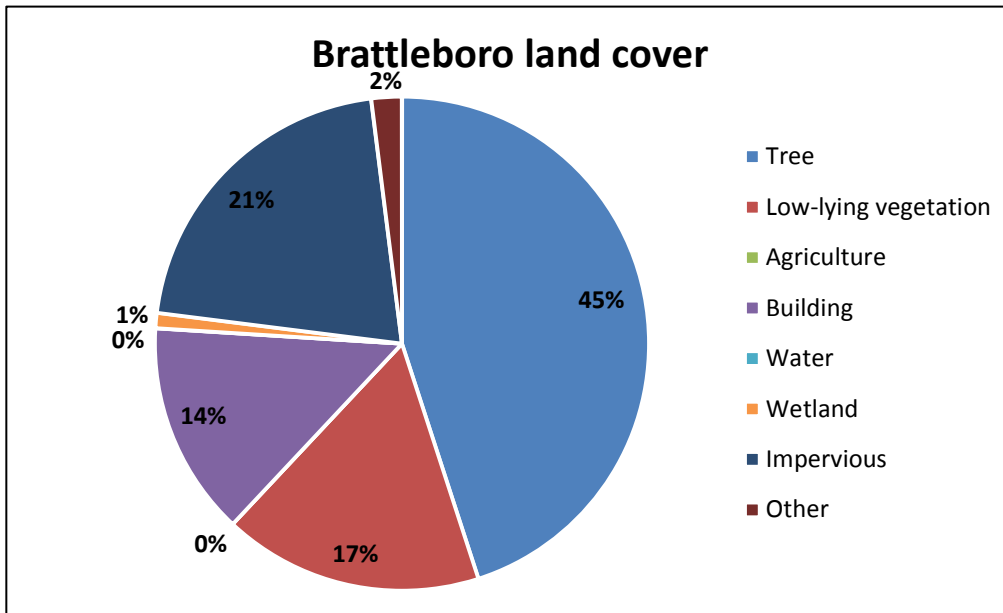


Figure 12. Land cover of Brattleboro (includes public and private land). Note that both water and agricultural land cover types had zero representation.

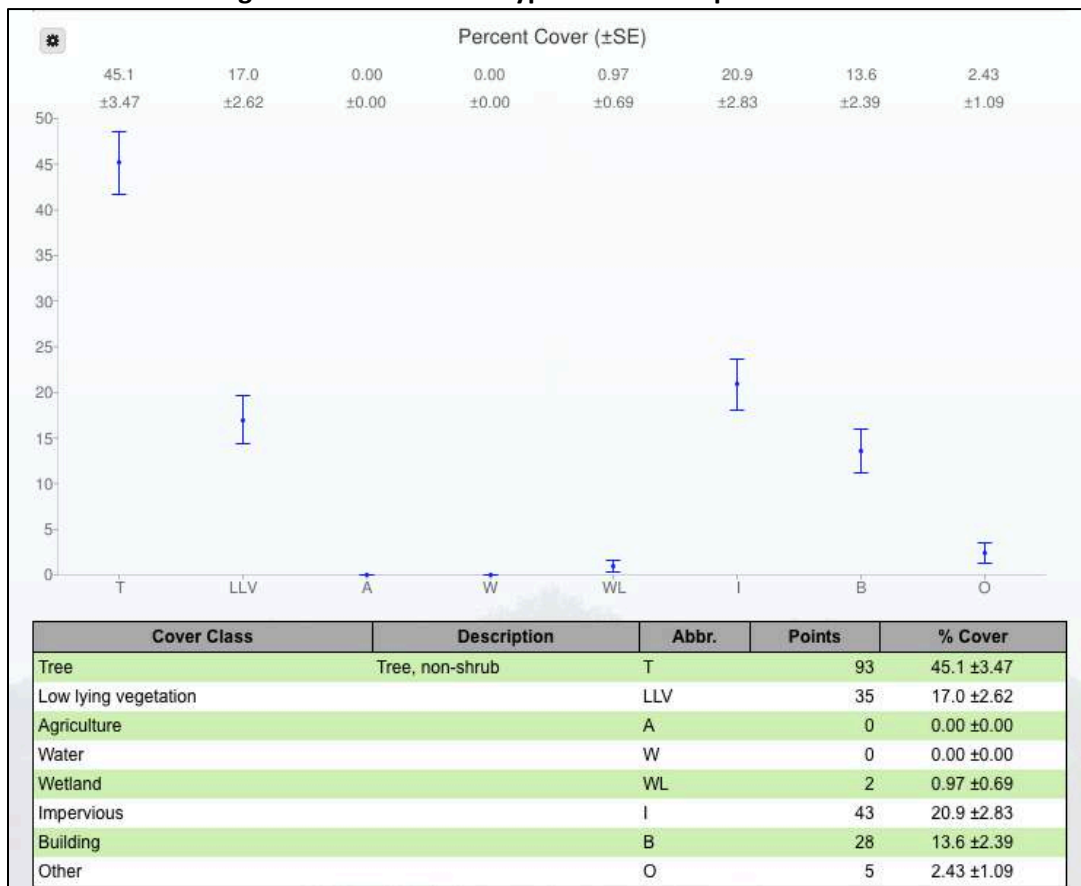


Figure 13. i-Tree Canopy assessment for the inventory area of Brattleboro, Vermont, including both public and private land. The above image shows the ground cover composition distribution.

Figure 14 (below) compliments the i-Tree Streets analysis of the monetary value of benefits provided by Brattleboro’s public trees by estimating the air quality benefits and corresponding monetary value of the full urban forest canopy. Of note is an estimated \$1,144,917 in CO₂ storage and \$45,404 in annual CO₂ sequestration value.

* Tree Benefit Estimates					
Abbr.	Benefit Description	Value	±SE	Amount	±SE
CO	Carbon Monoxide removed annually	\$9.62	±0.74	226.97 lb	±17.43
NO2	Nitrogen Dioxide removed annually	\$16.56	±1.27	1,237.59 lb	±95.05
O3	Ozone removed annually	\$862.62	±66.25	6.16 T	±0.47
PM2.5	Particulate Matter less than 2.5 microns removed annually	\$1,783.20	±136.95	598.93 lb	±46.00
SO2	Sulfur Dioxide removed annually	\$2.90	±0.22	779.90 lb	±59.90
PM10*	Particulate Matter greater than 2.5 microns and less than 10 microns removed annually	\$626.24	±48.10	2.06 T	±0.16
CO2seq	Carbon Dioxide sequestered annually in trees	\$45,404.17	±3,487.06	1,254.88 T	±96.38
CO2stor	Carbon Dioxide stored in trees (Note: this benefit is not an annual rate)	\$1,144,917.82	±87,930.28	31,639.38 T	±2,429.92

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

Discussion and Recommendations

Brattleboro’s Public Tree Program

Brattleboro’s participation in the *Care of the Urban Forest* demonstrates that there is local capacity and desire to enhance the community’s public tree program. Brattleboro has an active Tree Warden and Tree Advisory Committee, a long and strong history of an engaged citizenry that is passionate about trees, and support from Town leadership to actively manage its urban forest. The 2015 public tree inventory and this report lay a foundation for better understanding the management needs and value of Brattleboro’s public trees, as well as the ways in which residents and Town leadership can continue to be engaged in caring for and supporting the urban forest.

Recommendations

We recommend that Brattleboro consider the following points to continue to develop its public tree program:

- Develop a (or update the 1996) public tree management plan or action plan based on this inventory report to prioritize goals and establish a timeline for Brattleboro’s public tree program.
- Advocate for a transparent, explicit, and regular annual budget for maintenance, planting, and removal of Brattleboro’s public trees.
- Encourage citizens to participate in tree planting and other stewardship activities; particularly because of the high populations of trees in the *Acer* (maple) and *Fraxinus* (ash) genera, residents should be aware of the signs and symptoms of emerald ash borer (EAB) and Asian long horned beetle (ALB) and empowered to monitor for these invasive forest pests.
- Ensure that those who are caring for Brattleboro’s public trees are trained in best tree care practices. All 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.
- 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.
- Communicate the benefits of Brattleboro’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, the winter webinar series, the annual VT Tree Stewards Conference, and the Forest Pest First Detector trainings.
- Encourage residents to plant trees on their private property to increase diversity, overall canopy cover, and the benefits provided by trees in Brattleboro.

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 saccharinum*). Resistance to disease and insect infestation is one of the many reasons that diversity of public trees is of paramount concern. A more diverse forest is more resistant to environmental stressors, and can therefore remain healthy and resilient in the face of change. Furthermore, by maintaining greater diversity a community can prevent a rapid loss of canopy due to insect and disease issues.

In Brattleboro, 48 species and 29 genera are represented as public trees, indicating diversity in the community forest. Over a quarter of the public trees within Brattleboro's full public tree inventory area are of species that represent less than 3% of the total tree population. However, over a third (35%) of public trees inventoried is in the maple (*Acer*) genus, which is over the recommended representation within the public tree population. Sugar maple, Norway maple, and red maple comprise 13%, 11%, and 7% of *Acer* species diversity, respectively. Sugar maple is the second most prevalent species in Brattleboro. Norway maple is one of the most prevalent species in Brattleboro, and is considered to be a non-native invasive species. Although an urban-tolerant and aesthetically pleasing, Norway maple can spread into nearby forests and out-compete native species such as sugar maple. In fact, Vermont's Plant

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

A successful community 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.

Quarantine Rule prohibits the movement, distribution, and sale of Norway maple, as well as other invasive plant species. Ash trees (*Fraxinus*) comprise 8% of the public tree canopy in Brattleboro's full public tree inventory population. Both ash and maple trees are currently threatened by invasive tree pests; EAB and ALB, respectively. While neither of these pests have 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. High-density stands of ash were observed in Brattleboro's Harmony Parking Lot, and large densities of maple were found Brattleboro's greenspaces, such as Memorial Park, The Commons, and Crowell Park.

Over 20% of the inventoried public trees are 0-6" in diameter, and 64% of the inventoried public trees are between 0-18", indicating a smaller and presumably younger tree population in Brattleboro. However, it is also important to consider that crabapples, which are a small tree even at maturity, make up 14% of the public tree population. The history of Brattleboro's growth as a city and the pressures from development, road widening, and increased grey infrastructure may give context to the reasons for the absence of large, mature shade trees along the streets of Town. The large, mature shade trees (over 30" in diameter) that were inventoried are almost all located in Town parks – specifically Memorial Park, Crowell Park, and The Commons – and have not been exposed to the same developmental pressures as trees within the public ROW.

Recommendations:

We recommend that Brattleboro 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 Brattleboro's overall 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*) trees in Brattleboro, we suggest selecting non-maple trees 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.
- Refer to the list of 20 identified potential tree planting locations (“vacant” spots) within the public ROW in Appendix B to strategically increase tree species and structural diversity in Brattleboro.
- Over the past two decades the Brattleboro Tree Warden, the Brattleboro Tree Advisory Committee, and citizen volunteers have engaged in young tree planting in town; as these trees mature, promote their health with a systematic structural pruning and maintenance cycle.
- Preserve existing mature shade trees in Brattleboro with special attention and regular maintenance for the large diameter park trees.

Urban Forest Health

Overall, Brattleboro appears to have a healthy population of public trees; an established maintenance regime with a regular and dedicated budget would further increase the health of the urban forest. Approximately 36% (128), a significant portion of Brattleboro’s public trees, were either considered to be in “Fair” or “Poor” condition, and 0 trees were designated as “Dead”. There are high concentrations of “Fair” and “Poor” trees in Brattleboro’s inventoried greenspaces, such as The Commons, Crowell Park, and Memorial Park. 125 trees were flagged to be revisited by a Certified Arborist, the Tree Warden, or another qualified individual. Many of these trees overlap with those designated as in “Poor” condition, and others were likely noted because of conflict with utility wires or other infrastructure. See Appendix F for a map detailing the locations of trees in Brattleboro by condition and a map indicating the location of the 125 trees requiring monitoring. Low soil volume and fertility, soil compaction, exposure to road salt spray, root damage, mechanical damage to the stem, 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 125 trees requiring

monitoring will be given to the Brattleboro Tree Warden and the Brattleboro Tree Advisory Committee; some recurring themes from these comments are presented in the recommendations below.

Recommendations:

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

- Prioritize the monitoring of the 125 trees that have been flagged for monitoring by a Certified Arborist or the Brattleboro Tree Warden.
- Develop a plan to routinely monitor and manage the 20 public trees assessed as in “Poor” condition, as these trees are in decline and may require removal in the future.
- Become familiar with species-specific characteristics, regular issues, and maintenance needs. For example, crabapples comprise 14% of Brattleboro’s public tree population; crabapples are prone to epicormic sprouting, particularly after heavy pruning, and sprouts should be removed both for aesthetic and tree health reasons.
- Encourage a culture of continual monitoring and updating the tree inventory spreadsheet as necessary as regular tree maintenance occurs in Brattleboro. Consider assigning one Brattleboro Tree Advisory Committee member the responsibility of maintaining the inventory data and maintenance records.
- Develop a relationship with the Brattleboro Public Works Department focused on monitoring and maintaining the urban forest. Public trees should be considered part of the overall infrastructure of the town, providing value but also requiring maintenance, and proper management and buy-in from Town leadership are invaluable factors that contribute to the integrity of the urban forest.

Assessment Tools

Using free and accessible i-Tree software developed by the USDA Forest Service, we were able to assess the benefits, value, and extent of Brattleboro’s urban tree canopy. i-Tree Streets

allowed us to determine the economic value of the ecosystem services provided by the 362 inventoried trees in Brattleboro's full public tree inventory area. The Town's urban forest generates about \$41,254 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 \$114 in service or savings every year. The trees of Brattleboro 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. 1991⁵). In economic terms, presence of – particularly mature - shade trees can significantly increase property value. There are 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 1984⁶).
- **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.
- **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 2002⁷). 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.

⁵ 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.

⁶ Ulrich, R.S. (1984). View through a window may influence recovery from surgery. *Science*, 224:420-421.

⁷ Nowak, D.J.; D. E. Crane. (2002). Carbon storage and sequestration by urban trees in the USA. *Environmental Pollution* 116(3): 381-389.

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.

Recommendations

We recommend that Brattleboro 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 community forest management and local stewardship.
- Explore and utilize the other free assessment tools in the i-Tree tools suite (www.itreetools.org).

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 the Brattleboro Tree Advisory Committee and the Town of Brattleboro to understand, manage, and steward its public tree population. The recommendations outlined in this report are based on the VT UCF staff's observations and data analysis combined with their experience and evaluation; they should be considered by Brattleboro leadership, Tree Advisory Committee members, and the Town Tree Warden based on long-term vision and capacity. Looking ahead, the Town of Brattleboro should focus efforts on maintaining the quality of the urban trees. With improved monitoring, regular maintenance, and an engaged and informed citizenry, the potential for a healthy, sustainable community forest is attainable.

Appendices

Appendix A: Brattleboro Ash Tree Assessment

In addition to assessing the species composition, size class distribution, and condition of the public trees within Brattleboro's Downtown District, parks, and along major roadways, the Brattleboro Tree Advisory Committee and Brattleboro Tree Warden requested that VT FPR staff conduct an ash-only survey within the public ROW along residential streets radiating out of the downtown center of Brattleboro. VT FPR inventory teams walked miles and miles of Brattleboro neighborhood roads and ultimately identified **41 public ash trees** within the public ROW of **17 streets**. The specific species was not identified for these trees, but the majority is likely green ash, *Fraxinus pennsylvanica*, which is a popular urban street tree.

Approximately half (46% or 19) of these inventoried public ash trees are 6-12" in diameter (Figure 15). Over a quarter (27% or 11) public ash trees are 12-18" in diameter, and 10% (4 public ash trees) are 3-6", making 83% of Brattleboro's neighborhood public ash trees (excluding those inventoried within the full public tree inventory area) between 3 and 18 inches in diameter (Figure 15). No public ash trees are within the 0-3" or the 42+" size classes.

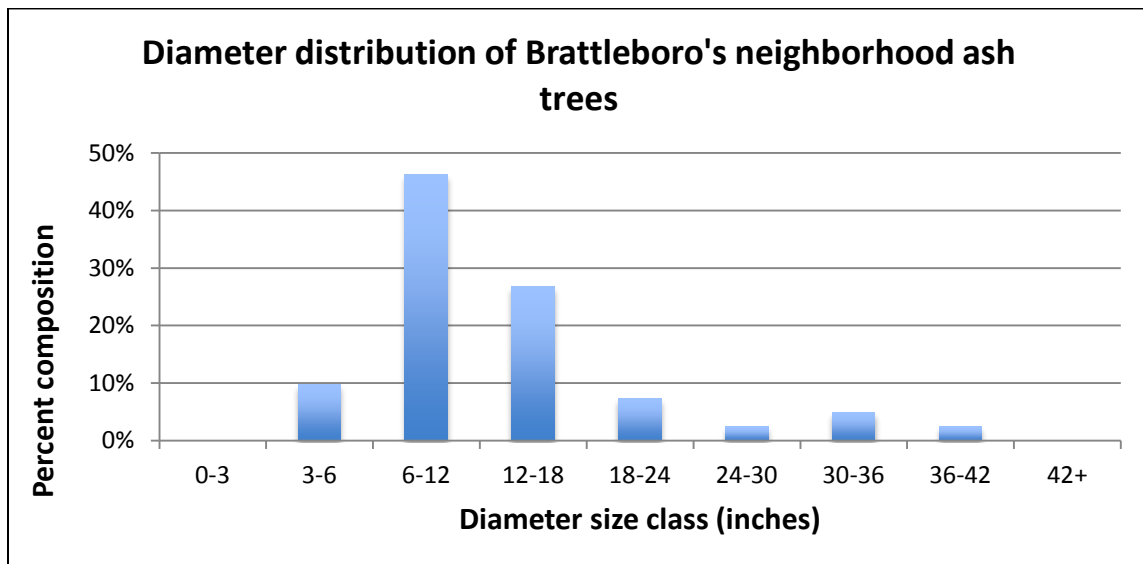


Figure 15. Percent of public ash trees within each diameter size class (inches). Note these results do not include the inventoried ash trees within Brattleboro's full public tree inventory area.

Approximately half (54% or 22) of the residential road public ash trees are in “Good” condition (Figure 16). 22% (9) of these public ash trees are in “Fair” condition, 17% (7) are in “Poor” condition, and 7% (3) are “Dead” (Figure 16). The tree dead public ash trees are located on Brannan Street, Route 9 East, and Cedar Street. In light of the threat of EAB, all (100%) of these inventoried trees were assessed as in need of monitoring.

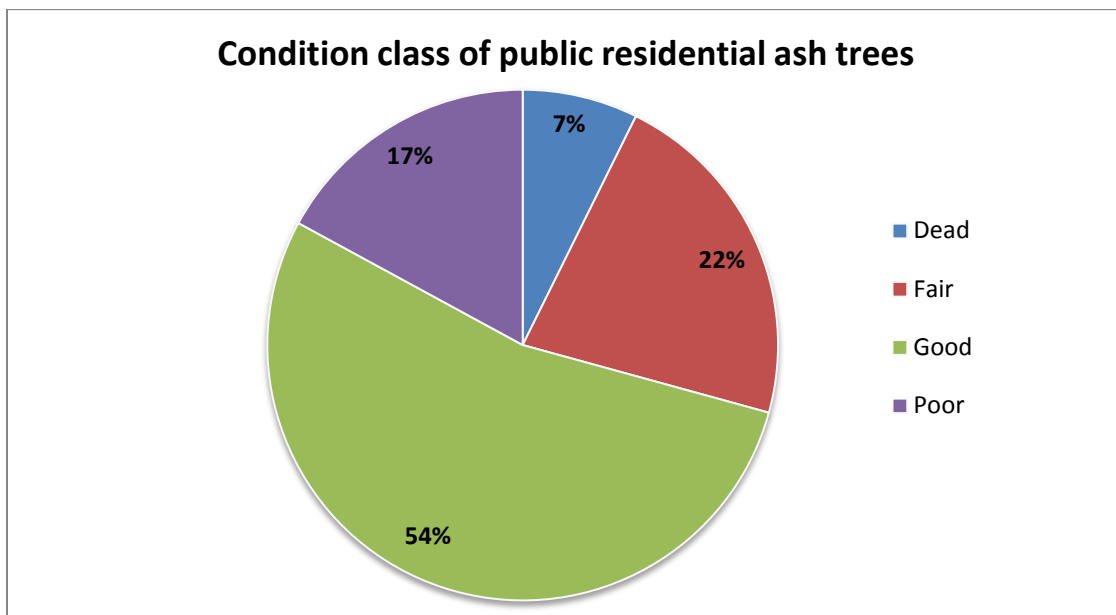


Figure 16. Percentage of public ash trees in each condition class. Note these results do not include the inventoried ash trees within Brattleboro’s full public tree inventory area.

Combined with the ash trees in the full public tree inventory area, 70 total ash trees were identified in Brattleboro’s public tree population. Appendix F contains maps indicating the location, condition distribution, and size distribution of all of the public ash trees inventoried in Brattleboro. Specific recommendations for ash tree management include:

- Remove – and replace if appropriate – the three dead public ash trees.
- Regularly monitor the 70 public ash trees in the inventory area.
- Use ash-specific information in this inventory report and in the inventory data spreadsheet to support the development of a robust EAB community preparedness plan.

Appendix B: Full Street and Site List of Brattleboro’s Public Tree Inventory, including trees in the Full Public Tree Inventory as well as Ash Trees Inventoried in Residential Neighborhoods.

Street/Site name	ROW extent	Number of trees	Number of vacant spots or strips
<i>Downtown District & Major Roadways</i>			
Bonnyvale Road	sidewalk greenstrip + trees within 10 feet of curb	1	0
Brook Street		2	0
Canal Street		3	0
Depot Street		7	10
Elliot Street		4	0
Elm Street		8	1
Flat Street		12	0
Garfield Drive		1	0
Glen Street		1	0
Green Meadow		1	0
Green Street		3	1
Grove Street		9	4
Harris Place		4	0
High Street		8	2
Hinesburg Road		1	0
Main Street		12	0
Meadowbrook Road		2	0
Melrose Street		1	0
Mountain View Avenue		1	0
Oak Grove Avenue		2	0
Oak Street		1	0
Reed Street		2	1
South Main Street		8	0
South Street		3	0
Terrace Street	12	0	
Walnut Street	5	1	
Williston Street	8	0	
Greenspaces: The Commons, Plaza Park, Crowell Park, Memorial Park, Pliney Park, Green Street Park, Elliot Street Park, Harmony Parking Lot, High Grove Parking Lot	N/A	240	0
<i>Ash Tree Inventory</i>			
Birge Street	sidewalk greenstrip +	1	N/A

Brannan Street	trees within 10 feet of curb	1	N/A
Canal Street		4	N/A
Cedar Street		5	N/A
Chestnut Street		1	N/A
Fairview Street		1	N/A
Frost Place		5	N/A
Maple Street		1	N/A
Myrtle Street		1	N/A
Oak Street		2	N/A
Pine Street		2	N/A
Putney Road		6	N/A
Route 9 East		5	N/A
Spruce Street		2	N/A
Union Street		1	N/A
Upper Forest Street		2	N/A
Williams Street		1	N/A

The following streets were either inventoried and had zero trees located within its public ROW, or were not inventoried due to time restraints and should be included in future tree inventory efforts: Rt. 30, Harmony Place, Guilford Street, Vernon Street, Church Street, Wells Fountain Park, Preston Parking Lot, Transportation Center, the Municipal Center, and all Brattleboro school grounds

Appendix C: Full Species and Genera List for Brattleboro’s Public Trees in the Full Public Tree Inventory Only

Common name	Scientific name	Number of Trees	Percent of total population
crabapple	<i>Malus sp.</i>	52	14.36%
sugar maple	<i>Acer saccharum</i>	50	13.81%
Norway maple	<i>Acer platanoides</i>	41	11.33%
honeylocust	<i>Gleditsia triacanthos</i>	39	10.77%
ash sp.	<i>Fraxinus sp.</i>	29	8.01%
red maple	<i>Acer rubrum</i>	25	6.91%
black locust	<i>Robinia pseudoacacia</i>	11	3.04%
serviceberry	<i>Amelanchier sp.</i>	11	3.04%
littleleaf linden	<i>Tilia cordata</i>	7	1.93%
pin oak	<i>Quercus palustris</i>	7	1.93%
black cherry	<i>Prunus serotina</i>	5	1.38%
eastern hemlock	<i>Tsuga canadensis</i>	5	1.38%
eastern white pine	<i>Pinus strobus</i>	5	1.38%
freeman maple	<i>Acer x freemanii</i>	5	1.38%
Norway spruce	<i>Picea abies</i>	5	1.38%
silver maple	<i>Acer saccharinum</i>	5	1.38%
mountain ash	<i>Sorbus aucuparia</i>	4	1.10%
northern red oak	<i>Quercus rubra</i>	4	1.10%
northern white cedar	<i>Thuja occidentalis</i>	4	1.10%
paper birch	<i>Betula papyrifera</i>	4	1.10%
blue spruce	<i>Picea pungens</i>	3	0.83%
broadleaf deciduous medium	N/A	3	0.83%
catalpa	<i>Catalpa speciosa</i>	3	0.83%
Japanese tree lilac	<i>Syringa reticulata</i>	3	0.83%
American elm	<i>Ulmus americana</i>	2	0.55%
black birch	<i>Betula lenta</i>	2	0.55%
cherry plum	<i>Prunus cerasifera</i>	2	0.55%
hickory sp.	<i>Carya sp.</i>	2	0.55%
peach	<i>Prunus sp.</i>	2	0.55%
shagbark hickory	<i>Carya ovata</i>	2	0.55%
willow sp.	<i>Salix sp.</i>	2	0.55%
yew	<i>Taxus sp.</i>	2	0.55%
American basswood	<i>Tilia americana</i>	1	0.28%
American sycamore	<i>Platanus occidentalis</i>	1	0.28%

American beech	<i>Fagus grandifolia</i>	1	0.28%
birch sp.	<i>Betula sp.</i>	1	0.28%
boxelder	<i>Acer negundo</i>	1	0.28%
black walnut	<i>Juglans nigra</i>	1	0.28%
broadleaf deciduous small	N/A	1	0.28%
broadleaf deciduous large	N/A	1	0.28%
common chokecherry	<i>Prunus virginiana</i>	1	0.28%
dogwood	<i>Cornus sp.</i>	1	0.28%
eastern redbud	<i>Cercis canadensis</i>	1	0.28%
elm sp.	<i>Ulmus sp.</i>	1	0.28%
horsechestnut	<i>Aesculus hippocastanum</i>	1	0.28%
magnolia sp.	<i>Magnolia sp.</i>	1	0.28%
shumard oak	<i>Quercus shumardii</i>	1	0.28%
white oak	<i>Quercus alba</i>	1	0.28%

**Appendix D: Leaf Area and Canopy Cover by Species Comprising Brattleboro's Urban Forest
(in the Full Public Tree Inventory Only)**

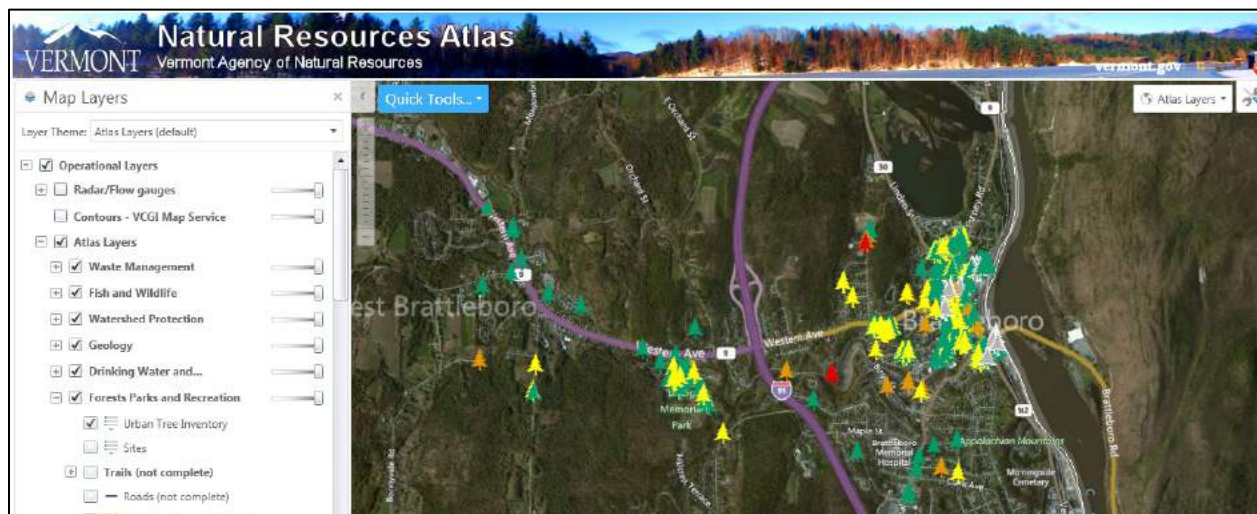
Species	Number of Trees	% of Total Trees	Leaf Area (ft ²)	% of Total Leaf Area	Canopy Cover (ft ²)	% of Total Canopy Cover
crabapple	52	14.36	31,306.72	2.86	14,434.97	4.57
sugar maple	50	13.81	456,500.54	41.71	85,439.76	27.02
Norway maple	41	11.33	85,388.20	7.80	36,401.09	11.51
honeylocust	39	10.77	60,788.21	5.55	25,285.67	8.00
red maple	30	8.29	68,579.47	6.27	20,092.46	6.35
ash sp.	29	8.01	81,638.40	7.46	29,728.53	9.40
serviceberry	11	3.04	3,131.16	0.29	2,127.02	0.67
black locust	11	3.04	83,317.32	7.61	22,889.47	7.24
pin oak	7	1.93	20,302.49	1.85	7,086.46	2.24
littleleaf linden	7	1.93	13,049.87	1.19	5,134.00	1.62
eastern white pine	5	1.38	12,251.78	1.12	5,243.16	1.66
eastern hemlock	5	1.38	5,233.59	0.48	4,634.40	1.47
silver maple	5	1.38	32,877.25	3.00	9,338.10	2.95
Norway spruce	5	1.38	11,463.19	1.05	4,858.95	1.54
black cherry	5	1.38	3,561.96	0.33	1,845.55	0.58
northern red oak	4	1.10	24,730.92	2.26	8,487.54	2.68
paper birch	4	1.10	11,365.64	1.04	3,897.73	1.23
northern white cedar	4	1.10	1,044.83	0.10	742.22	0.23
American mountain ash	4	1.10	2,060.39	0.19	1,225.63	0.39
blue spruce	3	0.83	3,973.30	0.36	1,562.29	0.49
northern catalpa	3	0.83	10,004.15	0.91	3,001.04	0.95
broadleaf deciduous medium	3	0.83	4,888.73	0.45	1,257.95	0.40
Japanese tree lilac	3	0.83	727.15	0.07	483.48	0.15
willow sp.	2	0.55	3,259.16	0.30	838.63	0.27
American elm	2	0.55	2,471.34	0.23	583.91	0.18
black birch	2	0.55	2,882.05	0.26	1,110.11	0.35
yew sp.	2	0.55	461.73	0.04	130.43	0.04
shagbark hickory	2	0.55	13,553.86	1.24	3,913.34	1.24
peach sp.	2	0.55	260.00	0.02	181.49	0.06
hickorysp.	2	0.55	5,925.72	0.54	1,861.27	0.59

cherry plum	2	0.55	526.64	0.05	335.98	0.11
shumard oak	1	0.28	2,700.95	0.25	1,130.04	0.36
black walnut	1	0.28	1,441.02	0.13	555.05	0.18
common chokecherry	1	0.28	467.16	0.04	302.00	0.10
white oak	1	0.28	1,318.10	0.12	420.58	0.13
broadleaf deciduous large	1	0.28	8,187.63	0.75	2,236.32	0.71
elm sp.	1	0.28	1,707.72	0.16	433.77	0.14
magnolia sp.	1	0.28	639.52	0.06	338.52	0.11
birch sp.	1	0.28	1,629.58	0.15	419.32	0.13
broadleaf deciduous small	1	0.28	59.49	0.01	33.98	0.01
American beech	1	0.28	559.49	0.05	184.25	0.06
American basswood	1	0.28	6,670.61	0.61	1,659.58	0.52
American sycamore	1	0.28	5,759.28	0.53	2,037.53	0.64
eastern redbud	1	0.28	59.49	0.01	33.98	0.01
boxelder	1	0.28	2,937.23	0.27	1,249.32	0.40
horsechestnut	1	0.28	2,686.52	0.25	849.91	0.27
dogwood sp.	1	0.28	200.51	0.02	147.51	0.05

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

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

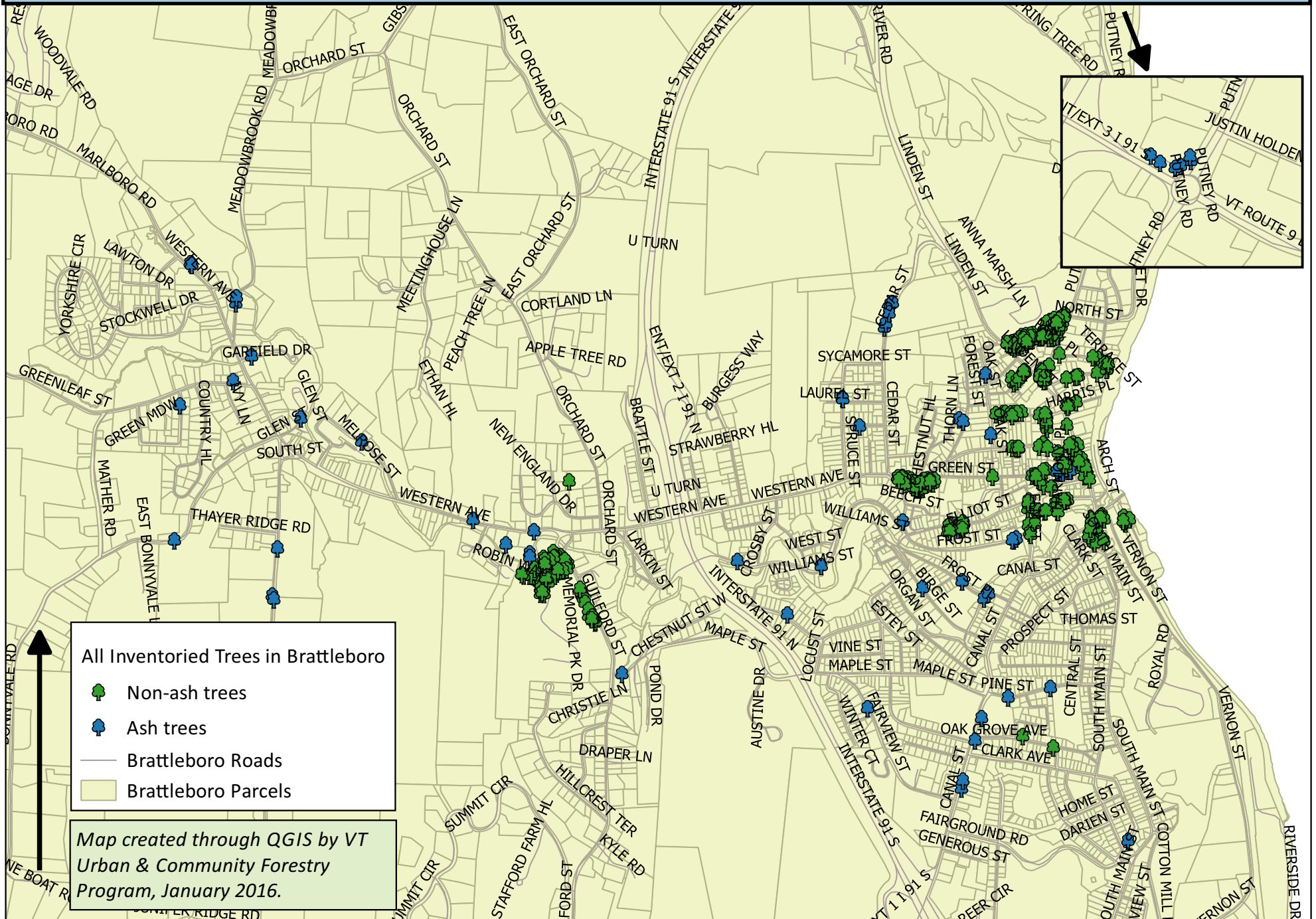
1. Set your web browser (Internet Explorer works best; Chrome does not work) to <http://anrmaps.vermont.gov/websites/anra/> (or search "VT ANR Atlas").
2. Zoom in to Brattleboro using the search feature or the +/- scale navigation tool in the upper left portion of the map (the tree data layer won't show up unless you are zoomed in to the town 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.
 - o 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.
 - o 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.



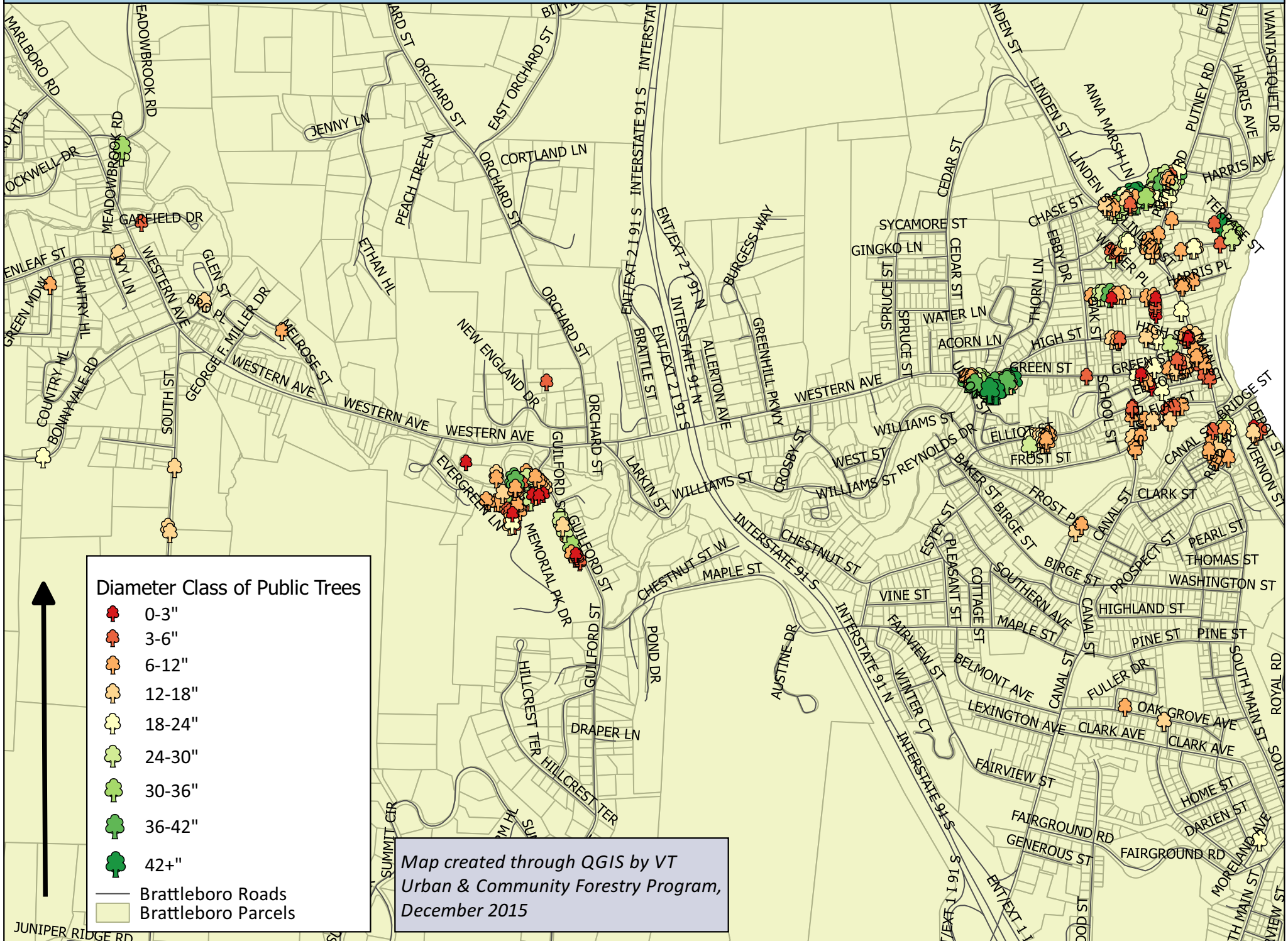
Appendix F: Maps

1. All Trees Inventoried in Brattleboro (Combined Full Public Tree Inventory and Ash-Only Survey)
2. Public Trees Inventoried in Brattleboro's Full Public Tree Inventory by DBH Class
3. Public Trees Inventoried in Brattleboro's Full Public Tree Inventory by Condition Class
4. Public Trees that Require Monitoring in Brattleboro's Full Public Tree Inventory
5. All Public Ash (Fraxinus) Trees Inventoried by DBH Class
6. All Public Ash (Fraxinus) Trees Inventoried by Condition Class
7. Potential Public Tree Planting Locations in downtown Brattleboro










All Trees Inventoried in Brattleboro





Brattleboro Public Trees by Diameter Class



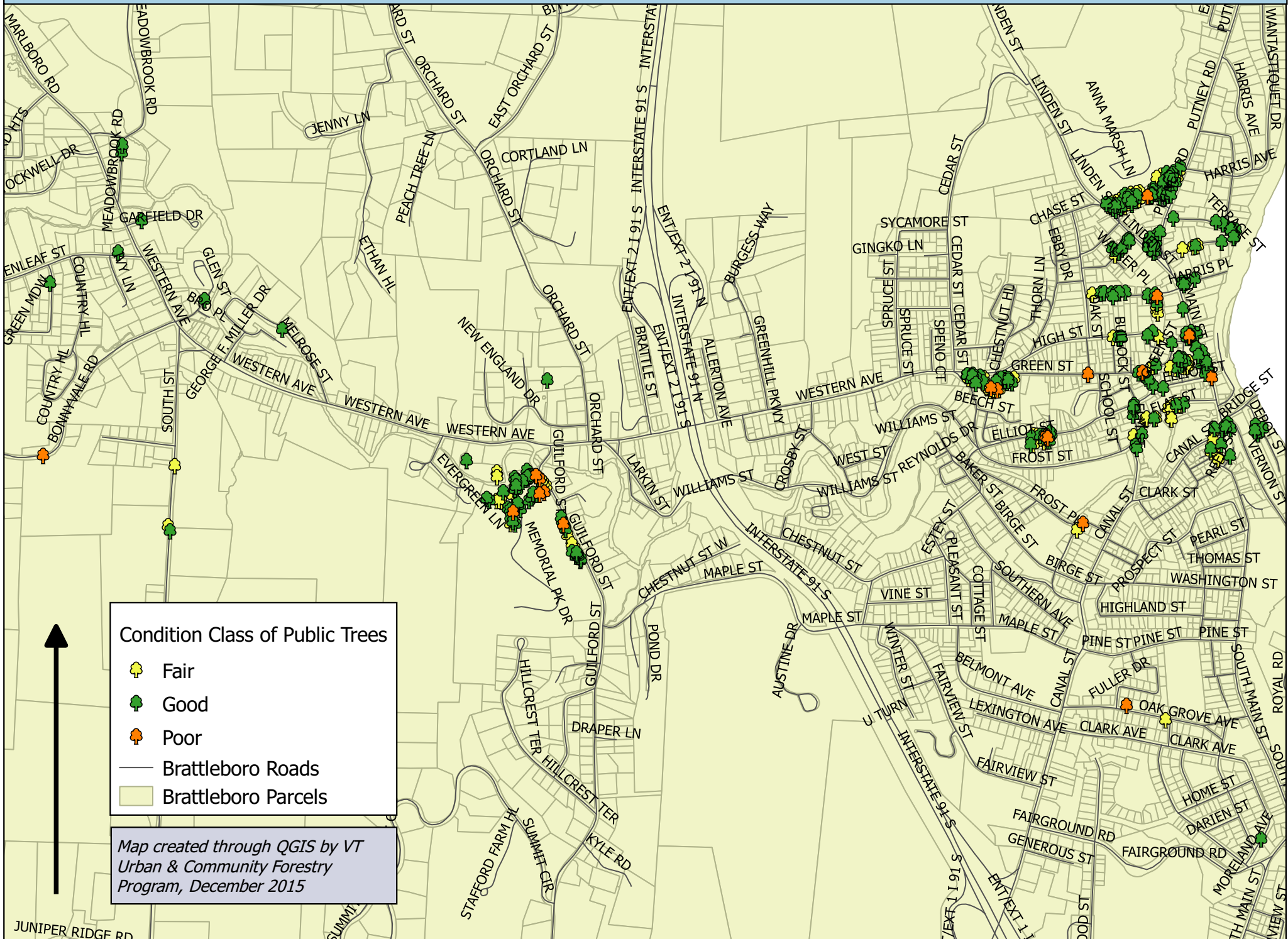
Diameter Class of Public Trees

-  0-3"
-  3-6"
-  6-12"
-  12-18"
-  18-24"
-  24-30"
-  30-36"
-  36-42"
-  42+"

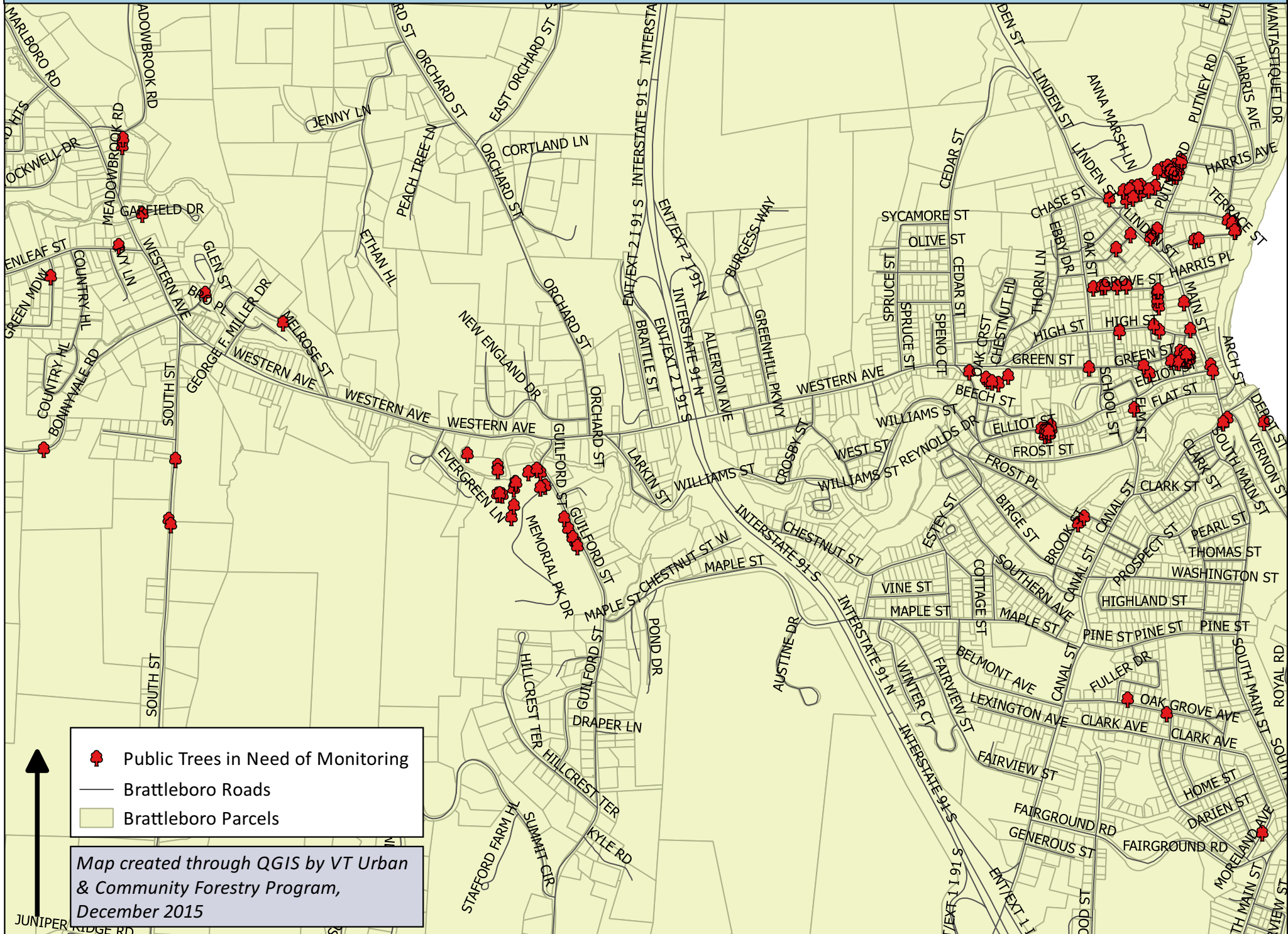
 Brattleboro Roads
 Brattleboro Parcels

Map created through QGIS by VT
 Urban & Community Forestry Program,
 December 2015

Brattleboro Public Trees by Condition Class

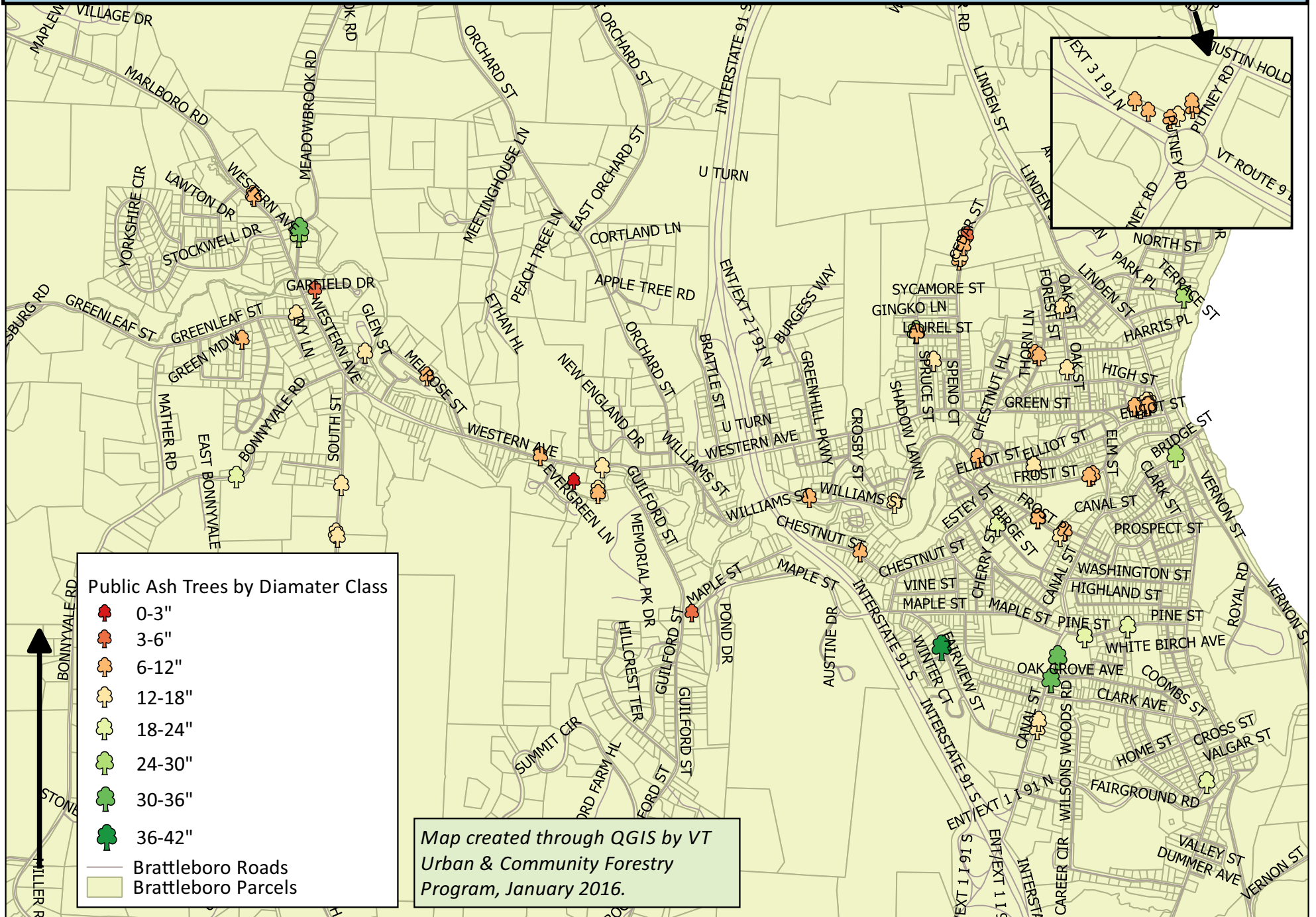


Brattleboro Public Trees in Need of Monitoring













JUNIPER

Brattleboro Public Ash Trees by Diameter Class



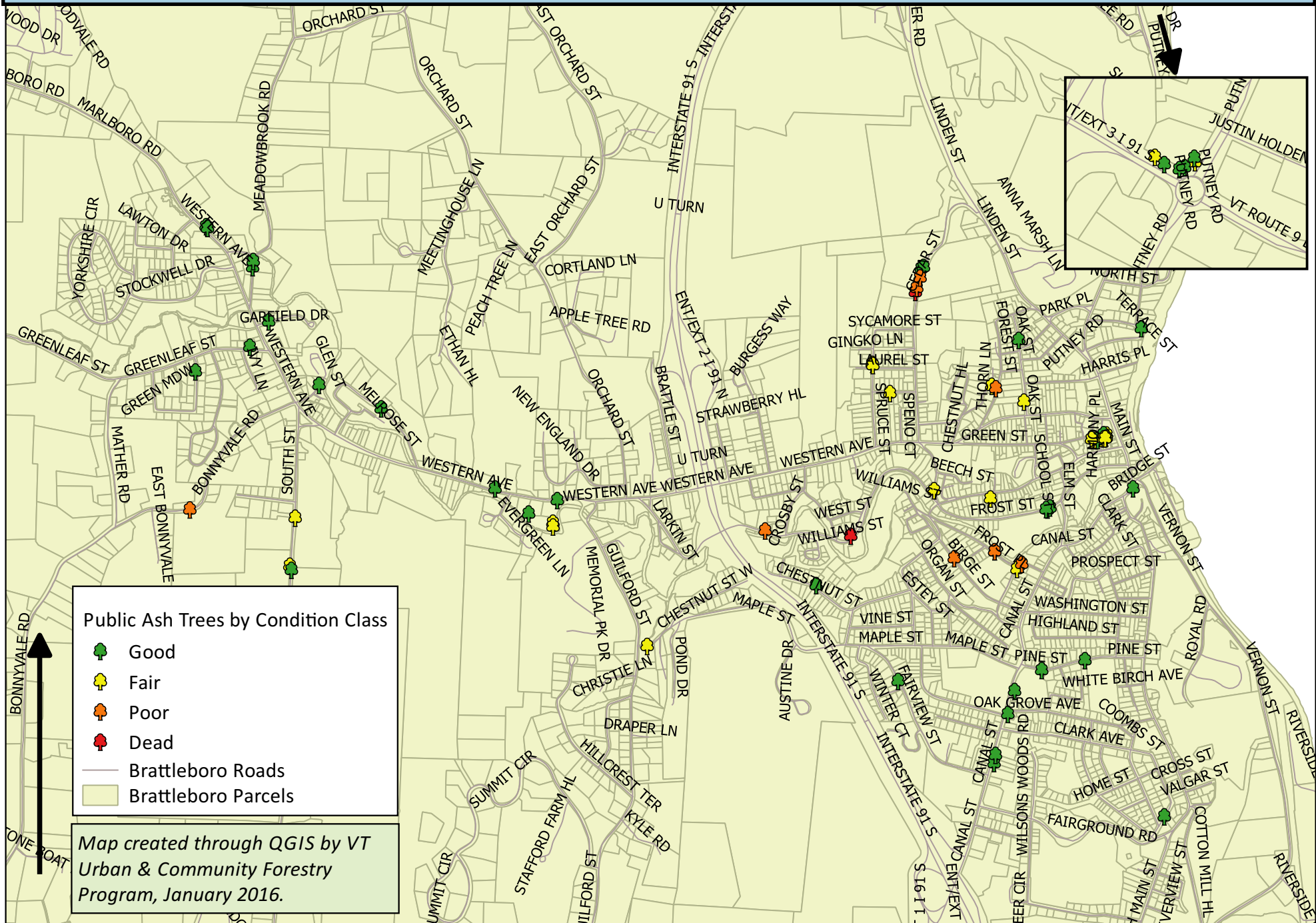
Public Ash Trees by Diameter Class

-  0-3"
-  3-6"
-  6-12"
-  12-18"
-  18-24"
-  24-30"
-  30-36"
-  36-42"

 Brattleboro Roads
 Brattleboro Parcels

Map created through QGIS by VT Urban & Community Forestry Program, January 2016.

Brattleboro Public Ash Trees by Condition



Potential Public Tree Planting Locations in Brattleboro

