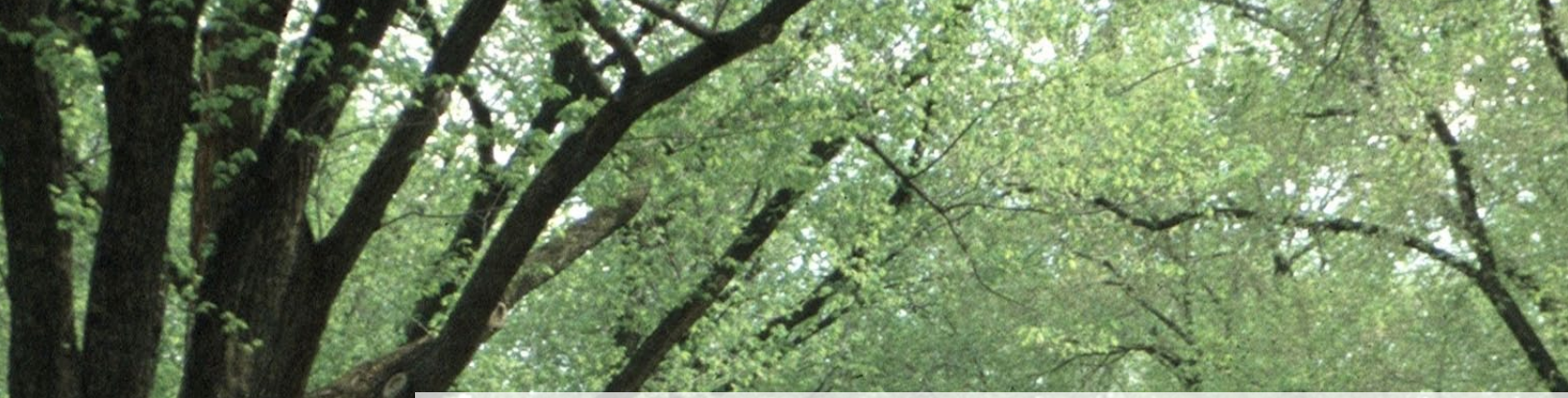

Street Tree Assessment Report

Richmond, Virginia

Overview

Street trees are a vital community asset that enhance our day-to-day lives and mitigate many of the negative impacts of urbanization. In 2009, a sample street tree inventory was conducted in Richmond, Virginia to assess tree abundance, composition, functional benefits, and monetary value. Trees residing within the right-of-way along 4% of public streets were surveyed to determine their species, size, condition, and placement. Inventory data were collected by Richmond and provided to Virginia Tech for this assessment report. The inventory data were analyzed using i-Tree Streets assessment software developed by the U.S. Forest Service.

Key Findings

- Richmond has an estimated 46,793 street trees.
- Richmond's five most abundant street tree species are sugar maple, willow oak, crapemyrtle, red maple, and pin oak.
- Each year, Richmond's street trees intercept over 165 million gallons rainfall and sequester over 20 million pounds of carbon dioxide.
- In total, Richmond's street trees provide nearly $5 million in benefits annually or roughly $105 per tree.
- The replacement value of Richmond's street trees is estimated at nearly $212 million.

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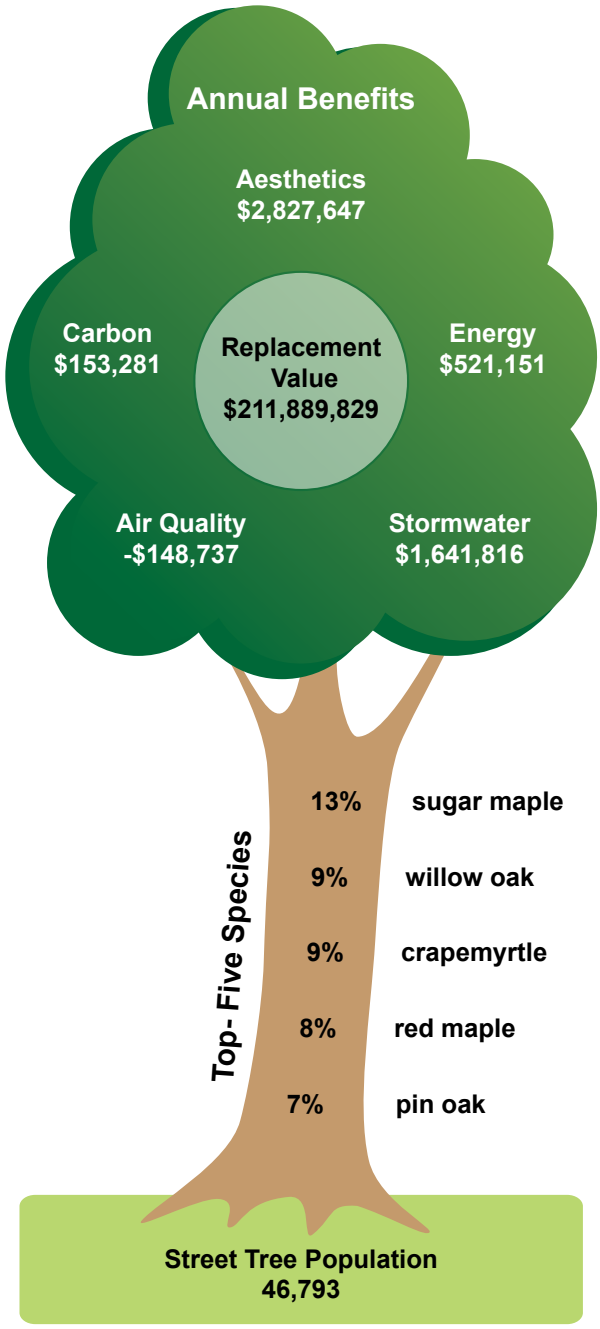
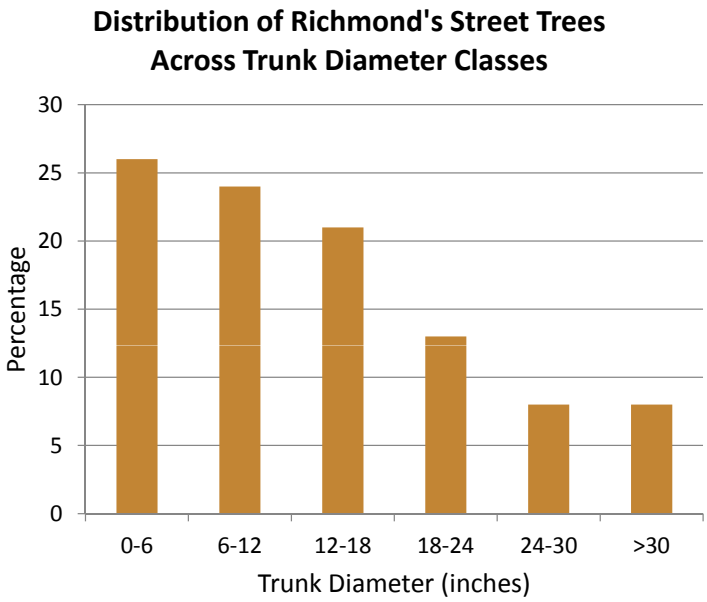
Street Tree Abundance and Composition

Richmond's estimated street tree population is 46,793. Richmond's street trees provide about 924 acres of canopy, which cover roughly 2.4% of Richmond's land area. The five most abundant species are sugar maple (13%), willow oak (9%), crapemyrtle (9%), red maple (8%), and pin oak (7%). The most important species (accounting for leaf area and canopy cover in addition to abundance) include willow oak (15%), pin oak (15%), sugar maple (13%), red maple (8%), and Japanese zelkova (6%).

Large-stature, broadleaf deciduous trees are the most common tree form amongst Richmond's street trees. About 50% of Richmond's street trees are smaller than 12 in. trunk diameter while nearly 10% are larger than 30 in. The majority of Richmond's street trees (~88%) were rated in fair to good condition.





Relative abundance of Richmond's street trees by foliage type and mature height class.

Foliage Type	Small (< 25')	Medium (25 - 45')	Large (> 45')	Total	% of Total
Broadleaf Deciduous	8,529	8,967	26,643	44,139	94
Broadleaf Evergreen	438	0	0	438	1
Conifer Evergreen	0	876	1,340	2,216	5
Total	**8,967**	**9,843**	**27,983**	**46,793**	**100**
% of Total	**19**	**21**	**60**	**100**	

Street Tree Benefits and Value

Gross annual benefits provided by Richmond's street trees are valued at $4,938,852. These benefits come from contributions that street trees make to real estate aesthetics, rainfall interception, energy conservation, air pollution reduction, and CO_2 sequestration. Each year, Richmond's street trees intercept roughly 166 million gallons of rainfall, conserve a combined 4,644 megawatt-hour of electricity and 161 thousand therms of natural gas for home cooling and heating, and remove about 20 million pounds of carbon from the atmosphere. In addition, Richmond's street trees currently store about 259 million pounds of carbon, which is valued at over $1.9 million. Richmond's current mix of tree species heavily emits biogenic volatile organic compounds (BVOCs), which interact with other air pollutants to create ground-based ozone. As a result, Richmond's street trees do not positively influence air quality in terms of pollution mitigation.

On a per-tree basis, the most beneficial tree species are American elm ($223 per year), pin oak ($212 per year), willow oak ($169 per year), American sycamore ($156 per year), and green ash ($146 per year). These values reflect the large size that these trees have attained, providing abundant leaf area and canopy cover. The average street tree provides $105 in gross benefits annually. Gross benefits do not account for annual costs associated with planting, maintenance, or removal, which were not available for this analysis.

The replacement value of Richmond's street tree population is estimated at $211,889,829. This is the value of street trees as a structural asset, and reflects the cost to replant trees in a quantity sufficient to replace their current level of functional benefits. Because a large street tree produces the same amount of benefits as numerous nursery-sized trees, replacing a large tree would require significant resources that may not be feasible due to both spatial and budgetary constraints.

Gross annual benefits provided by Richmond's street trees.

Benefit Type	Resource Units	Total $	Avg. $/Tree
Aesthetic enhancements	–	2,827,647	60.43
Rainfall Interception (gallons)	165,828,439	1,641,816	35.09
Energy Conservation[1]	–	521,151	11.14
Electricity (MWh)	4,644	325,500	–
Natural Gas (therms)	161,234	168,651	–
Air Pollution reduction (lb)[2]	-3,135	-148,737	-3.18
CO_2 sequestration (lb)[3]	20,437,448	153,281	3.28
Total Benefits	**–**	**4,938,852**	**105.56**

[1]Sum of electricity and natural gas conservation.

[2]Net pollution reduction (O3, NO2, PM10, and SO2) accounting for pollutant deposition, pollutant avoidance, and BVOC emissions. Note, if Resource Units value is negative, BVOC emissions exceeded pollution reduction. If only total $ is negative, then BVOC pricing exceeded pollutant pricing, but pollution reduction still occurred.

[3]Net sequestration accounting for gross tree sequestration, tree decomposition emissions, and tree maintenance machinery emissions.

Street Tree Opportunities

Richmond has a highly valuable street tree population. To sustain this resource and its benefits, the city should continue to focus on planting diverse, functional species and maintaining trees to ensure their health, safety, and appearance. Urban forestry experts generally recommend that a municipal tree population comprise no more than 10% of a single species and 20% of a single genus in order to minimize impacts of pest outbreaks and other species-specific disorders. At 13% of the street tree population, sugar maple is just above the species threshold. Collectively, maple species account for 26% of the street trees. Similarly, the oak genus is approaching the genus threshold at 19% abundance. Although they are proven performers, planting efforts should temper the use of maple and oak species to ensure the diversity and heath of Richmond's street trees.

One of the most noxious pests threatening Virginia's street trees is emerald ash borer, an insect introduced from Asia that has killed millions of native ash trees in the United States. Fortunately, native ash species comprise just 3.03% of Richmond's street trees and account for only 3.91% of the street tree canopy cover. However, Richmond must remain vigilant in managing street tree diversity because there is ongoing risk of unforeseen introduction of noxious tree pests into the United States.

About 80% of Richmond's street tree population comprises medium- and large-stature species such as maple and oak. This is a favorable distribution given that larger trees provide higher levels of benefits, yet presence of overhead utility lines may require planting of small-stature tree species in certain places to minimize power disruptions and pruning costs.

The size distribution of Richmond's street trees suggests a stable age structure. Because street trees inevitably grow old and die or must be removed to accommodate land use changes, an ample number of young trees must always exist in order to sustain street tree benefits. The fact that the two diameter classes that encompass the largest percentage of the total street tree population are the 0-6 and 6-12 inch diameter classes, respectively, is a source of optimism. However, ongoing planting efforts, with particular focus on large stature, highly functional tree species, should be taken to ensure a high level of benefits will be provided by Richmond's street trees for the future.

Richmond's street trees comprise a number of species that produce large amounts of BVOCs, which are precursors to ground-based ozone. Heavy emitters of BVOCs in Richmond include American elm, pin oak, and willow oak. Richmond should consider planting more low-BVOC street trees such as gingko, linden, and certain maples if maximizing air quality benefits is a key community objective. However, this planting strategy should not compromise efforts to maximize canopy cover or species diversity. Urban forestry experts generally believe that trees have a net positive impact on air quality, regardless of BVOC emissions, by lowering air temperature and reducing fossil fuel combustion in urban areas.

This assessment has reported gross benefits of Richmond's street trees, which may not fully reflect the true value of this vital resource. Direct and indirect costs of administering and managing street trees can vary considerably based on species composition, tree size distribution, and other local environmental and economic factors. Therefore, findings of this report should be carefully interpreted in the context of local circumstances that impact tree benefits and costs.

About This Report

This report was co-authored by Eric Wiseman and Julia Bartens with the Department of Forest Resources and Environmental Conservation at Virginia Tech. Report layout and design by Sarah Gugercin.

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Inventory data were analyzed using i-Tree Streets assessment software version 4.0.4. Benefit estimates were based on i-Tree modeling data from the Charlotte, North Carolina reference city in the South Climate Zone. The 2010 median home price, used to calculate street tree aesthetic benefits for Richmond was $201,800 as reported by the U.S. Census Bureau in http://quickfacts.census.gov/qfd/index.html. Additional information about methods used in this street tree assessment can be found on our website.

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