

A Report on Pawtucket, Rhode Island's Existing and Possible Tree Canopy

Why is Tree Canopy Important?

Tree canopy (TC) is the layer of leaves, branches, and stems of trees that cover the ground when viewed from above. In urban and suburban settings, this layer is called urban tree canopy (UTC). Tree canopy provides many benefits to communities, including improving water quality, saving energy, lowering city temperatures, reducing air pollution, enhancing property values, providing wildlife habitat, facilitating social and educational opportunities, and providing aesthetic benefits.

How Much Tree Canopy Does Pawtucket Have?

An analysis of Pawtucket, Rhode Island's tree canopy (TC) based on high resolution aerial imagery found that 1,315 acres of the city is covered by tree canopy (termed Existing TC). This corresponds to 24% of all land within the city (Figure 1). However, 47% (2,641 acres) of the city could theoretically be improved to support tree canopy (termed Possible TC). Possible TC includes non-canopy vegetation (e.g., grass/shrubs), bare earth, and certain paved surfaces (e.g., driveways, sidewalks) that, under the right circumstances, could be modified to increase tree cover. The city's largest patches of Existing TC generally occur along the Blackstone/Seekonk and Ten Mile Rivers (Figure 2). Wetlands adjacent to the Ten Mile River also contain contiguous wooded areas. However, street trees and backyard forest patches are also an important of the city's overall tree canopy.

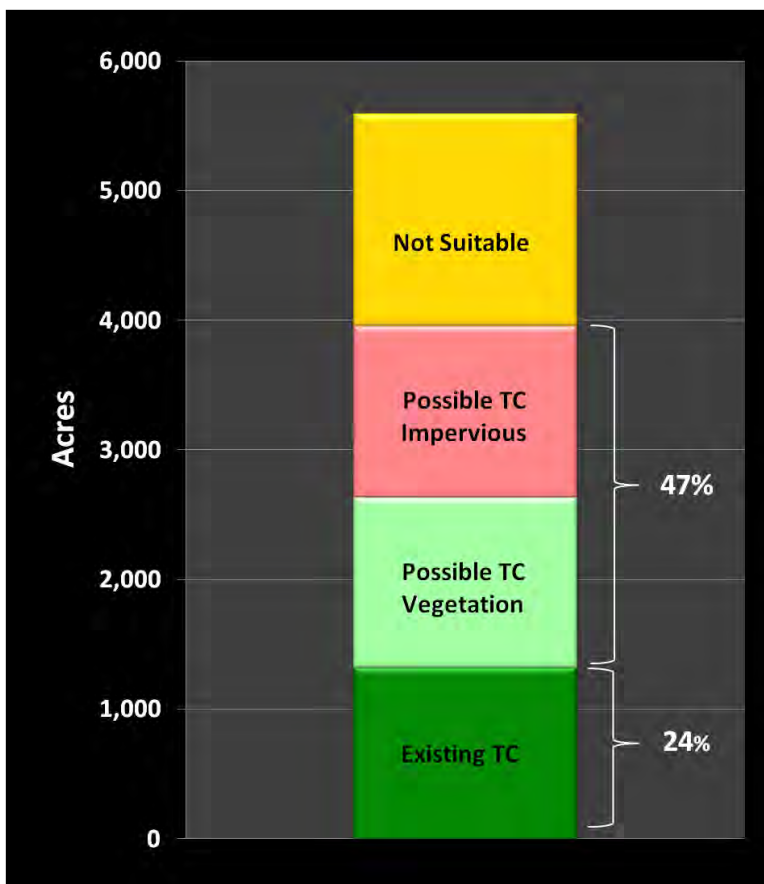


Figure 1: TC metrics for Pawtucket, RI. Percentages are based on % of land area.

Project Background

This analysis of Pawtucket's tree canopy was conducted as part of a multi-state UTC grant from the USDA Forest Service, in collaboration with the City of Pawtucket and the Rhode Island Department of Environmental Management. It was performed by the Spatial Analysis Laboratory (SAL) of the University of Vermont's Rubenstein School of the Environment and Natural Resources, in consultation with the USDA Forest Service's Northern Research Station.

The goal of the project was to apply the USDA Forest Service's UTC assessment protocols, methods successfully used and refined with a diverse set of cities and municipalities in the eastern United States, to Pawtucket, Rhode Island. The land-cover data are based on year 2009 satellite imagery.

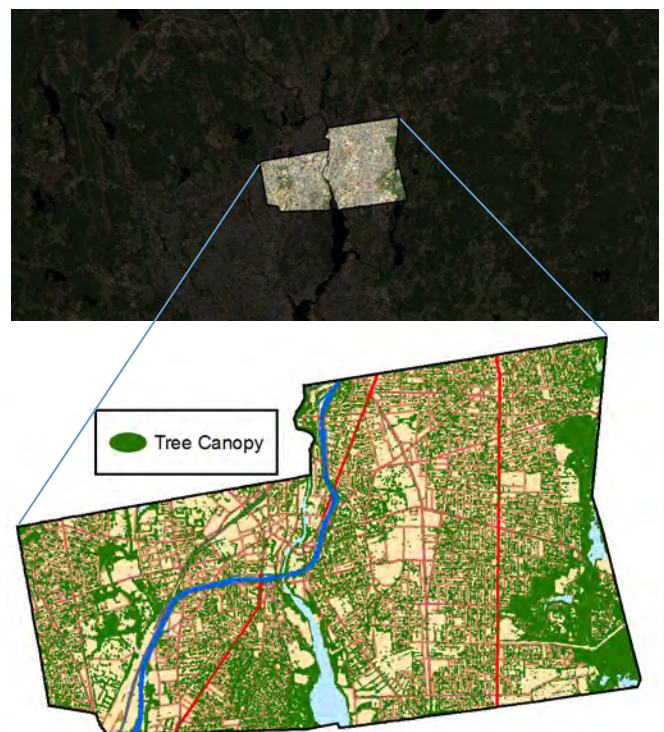


Figure 2: Tree canopy in Pawtucket, RI. Existing tree canopy represents 24% of the city's land area.

Key Terms

- TC:** Tree canopy (TC) is the layer of leaves, branches, and stems of trees that cover the ground when viewed from above.
- Land Cover:** Physical features on the earth mapped from aerial or satellite imagery such as trees, grass, water, and impervious surfaces.
- Existing TC:** The amount of tree canopy present when viewed from above using aerial or satellite imagery.
- Impervious Possible TC:** Asphalt or concrete surfaces, excluding roads and buildings, that are theoretically available for the establishment of tree canopy.
- Vegetated Possible TC:** Grass or shrub area that is theoretically available for the establishment of tree canopy.

Mapping Pawtucket's Trees

Previous estimates of tree canopy for Pawtucket, such as the 2001 National Land Cover Dataset (NLCD 2001), were derived from relatively coarse, 30-meter resolution satellite imagery (Figure 3a). Such data lack the spatial resolution needed for fine-scale mapping. Using high-resolution (0.5 meter/1.64 feet) satellite imagery acquired in the summer of 2009 (Figure 3b), in combination with advanced automated processing techniques, land cover for the city was mapped with such detail that single trees were detected (Figure 3c). NLCD 2001 estimated a mean percent tree canopy of 6% for Pawtucket, 18 percentage points below that of this study.

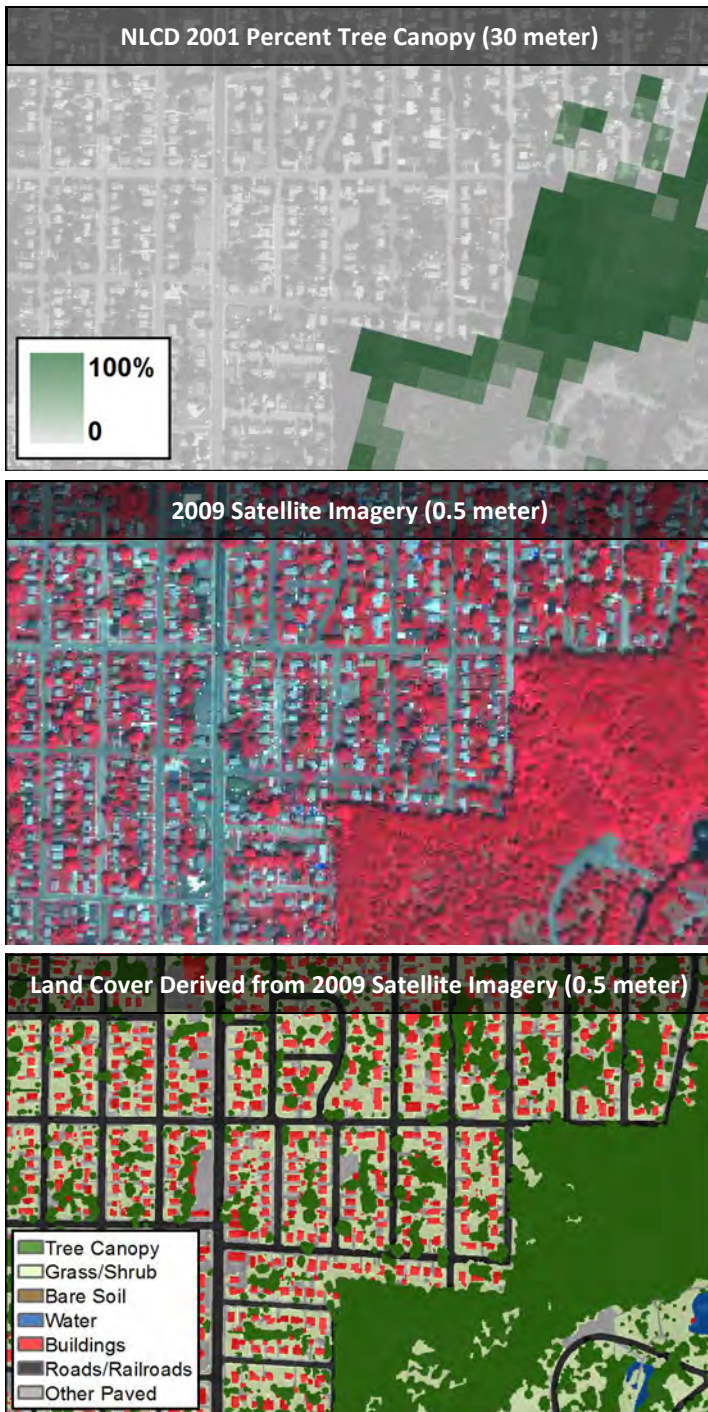


Figure 3a, 3b, 3c: Comparison of NLCD 2001 to high-resolution land cover.

Parcel & Land Use Summary

The detailed land-cover mapping conducted as part of this assessment permitted calculation of the percentage of Existing and Possible TC for each parcel in the city (Figure 4). Additional analyses were performed with zoning designations to examine general ownership and use patterns (Figure 5, Table 1). The highest proportion of Pawtucket's Existing TC occurs in the Residential Single-Family category (26%), followed by Public Open (23%) and other residential classes. The Public Open category includes publicly-owned natural areas (e.g., river corridors, wetlands) and recreational parks. Most of the land suitable for establishing additional tree cover also occurs in the residential classes, which encompass a combined 58% of Possible TC. These zones contain expanses of lawn and paved surfaces that theoretically could be modified to support additional tree growth. However, the Commercial and Industrial classes also contain large volumes of Potential TC, suggesting that these areas of the city offer ample opportunities for expanding tree canopy.

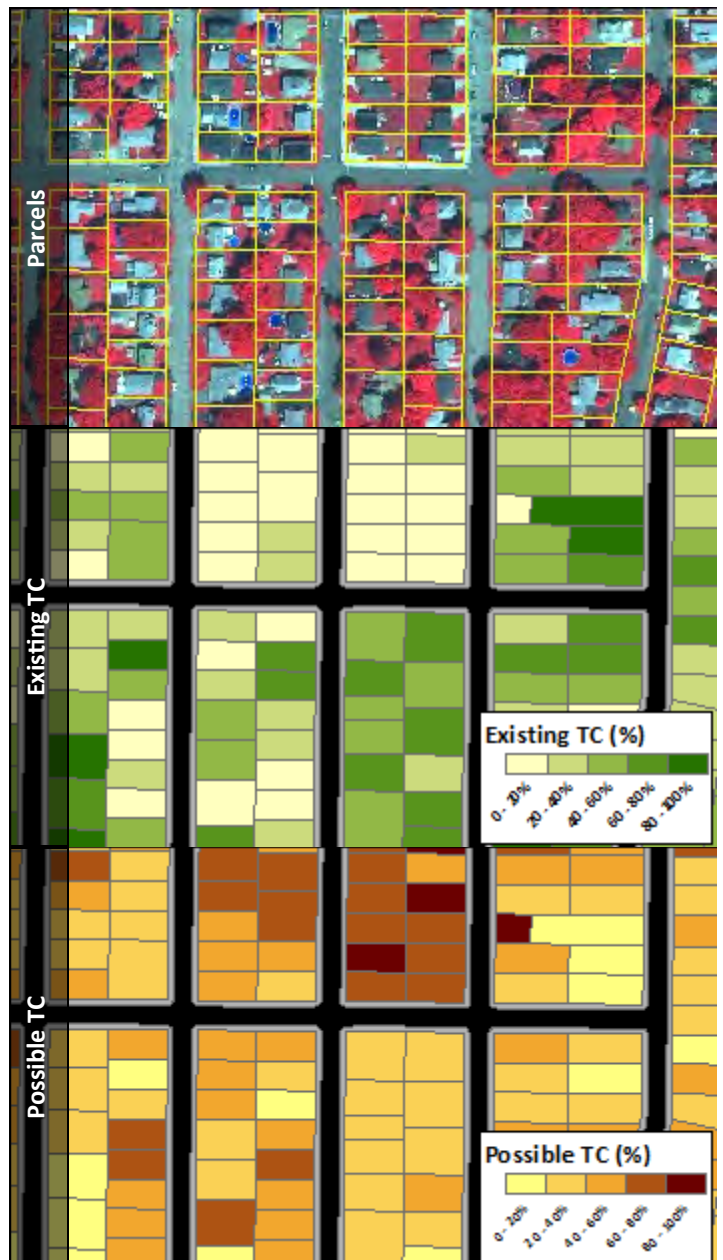


Figure 4a, 4b, 4c: TC metrics summarized at the property parcel level.

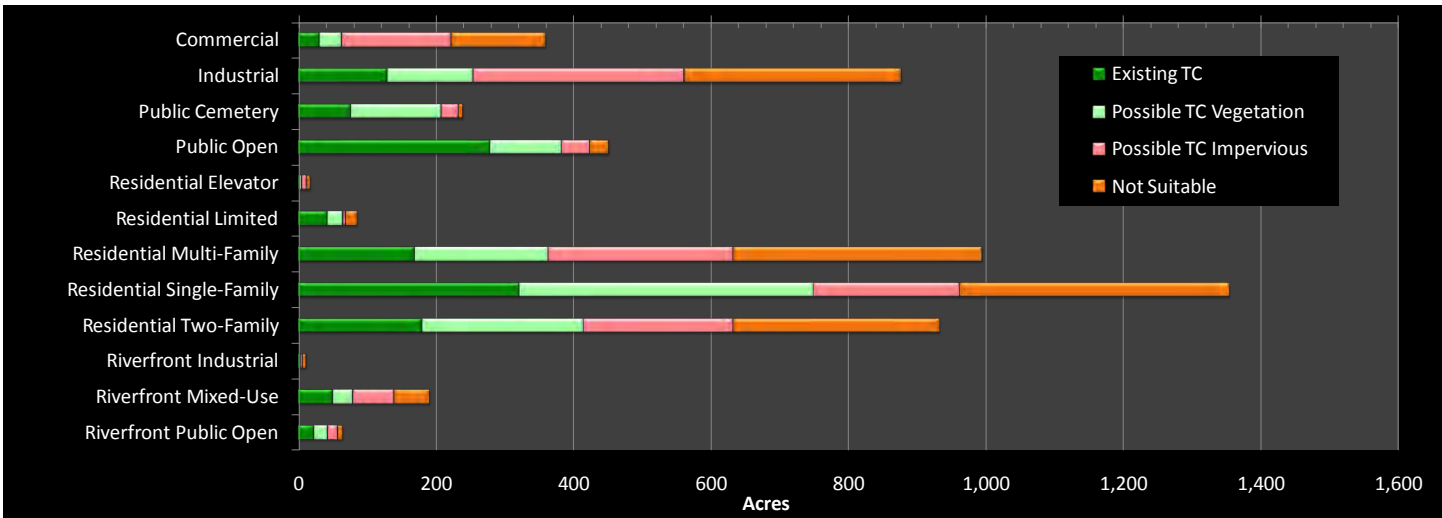


Figure 5: TC metrics summarized by land-use designation.

Land Use	Existing TC			Possible TC Vegetation			Possible TC Impervious		
	% Land	% Category	% TC Type	% Land	% Category	% TC Type	% Land	% Category	% TC Type
Commercial	1%	9%	3%	1%	9%	3%	3%	44%	13%
Industrial	2%	15%	11%	2%	14%	10%	6%	35%	24%
Public Cemetery	1%	32%	6%	2%	55%	10%	0%	10%	2%
Public Open	5%	62%	23%	2%	23%	8%	1%	9%	3%
Residential Elevator	0%	18%	0%	0%	16%	0%	0%	36%	1%
Residential Limited	1%	50%	3%	0%	26%	2%	0%	5%	0%
Residential Multi-Family	3%	17%	14%	3%	20%	15%	5%	27%	21%
Residential Single-Family	6%	24%	26%	8%	32%	34%	4%	16%	17%
Residential Two-Family	3%	19%	15%	4%	25%	18%	4%	23%	17%
Riverfront Industrial	0%	29%	0%	0%	5%	0%	0%	25%	0%
Riverfront Mixed-Use	1%	27%	4%	1%	15%	2%	1%	32%	5%
Riverfront Public Open	0%	37%	2%	0%	29%	2%	0%	22%	1%

$\% \text{ Land} = \frac{\text{Area of TC type for specified land use}}{\text{Area of all land}}$
 $\% \text{ Category} = \frac{\text{Area of TC type for specified land use}}{\text{Area of all land for specified land use}}$
 $\% \text{ TC Type} = \frac{\text{Area of TC type for specified land use}}{\text{Area of all TC type}}$

The % Land Area value of 3% indicates that 3% of Pawtucket's land area is tree canopy in areas where the zoning is "Residential Two-Family."
 The % Land Use value of 19% indicates that 19% of "Residential Two-Family" land is covered by tree canopy.
 The % TC Type value of 15% indicates that 15% of all Existing TC lies in the "Residential Two-Family" land use.

Table 1: TC metrics summarized by land-use category. For each category, TC metrics were computed as a percent of all land in the county (% Land), as a percent of land area by land-use category (% Category), and as a percent of the area for the TC type (% TC Type). Note that multiple Commercial and Industrial categories were aggregated to facilitate display.

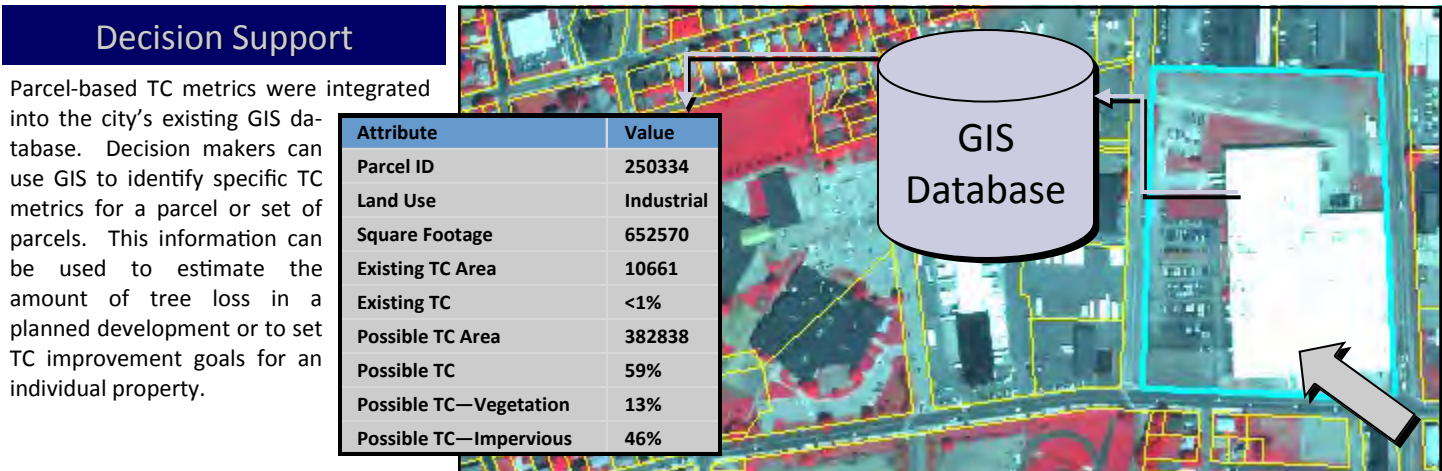


Figure 6: GIS-based analysis of parcel-based TC metrics for decision support. In this example, GIS is used to select an individual parcel; the attributes for that parcel are displayed in tabular form, providing instant access to relevant tree-canopy information.

Environmental Analysis—Watersheds

Many different environmental variables can be factored into TC assessments, including watersheds, storm sewer systems, and other features that influence storm-water runoff. By watershed, for example, the Ten Mile and Moshassuck Watersheds have the highest proportions of Existing TC (Figure 7, 8a). Given its volume of natural areas and recreational spaces, however, the Ten Mile Watershed has the largest total area of tree canopy. The Seekonk-Providence Watershed has the largest area of Possible TC, but proportionately it is similar to the other watersheds (Figure 8b). All four watersheds have large volumes of grass/shrubs and paved surfaces where tree-planting programs might be beneficial. Note that all watersheds encompassing Pawtucket extend into adjacent municipalities.

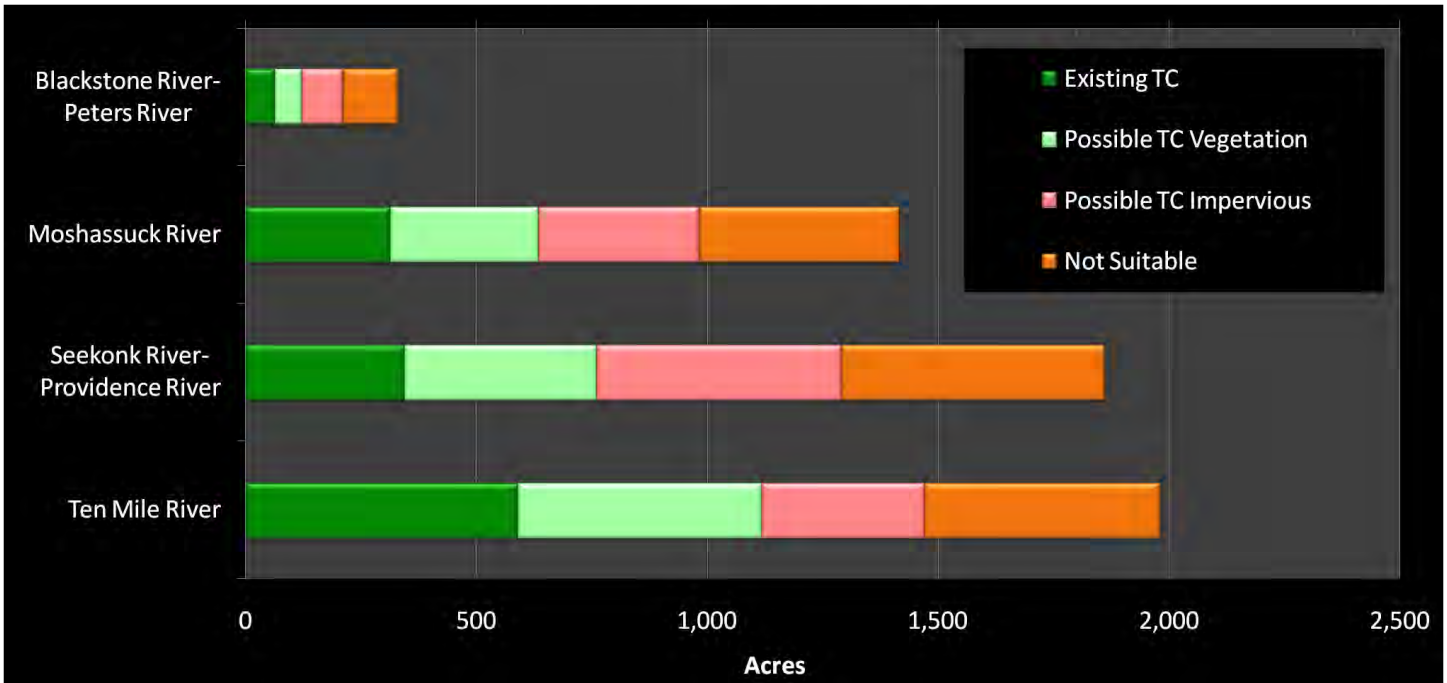


Figure 7: Distribution of existing and possible tree canopy in Pawtucket, RI watersheds.

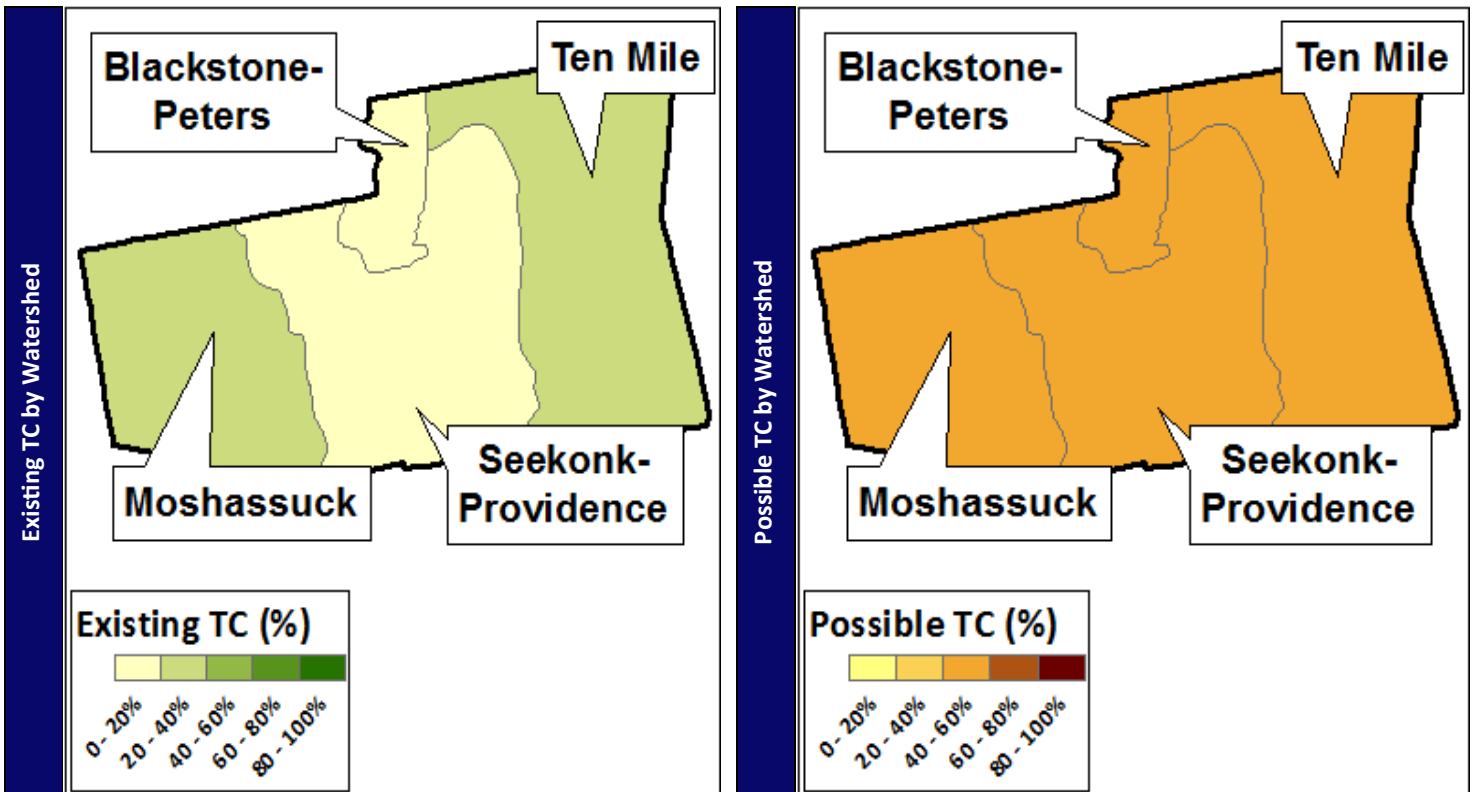


Figure 8a: Existing TC, expressed as the percentage of land area, for watersheds.

Figure 8b: Possible TC, expressed as the percentage of land area, for watersheds.

Socio-Demographic Analysis

A block group is the smallest unit of analysis containing sample data collected by the United States Census Bureau. Block groups contain a wealth of socio-demographic information that, when combined with TC metrics, provide new insights. An inverse relationship between existing tree canopy and renter occupancy rates is evident when comparing block groups in the city (Figure 9a and 9b). Block groups with higher proportions of renters generally have relatively low percentages of tree canopy. Many of the block groups with the largest proportions of renters are also among those with the lowest tree canopy per capita (Figure 9c). The Priority Planting Index (PPI) incorporates census data and TC metrics to score block groups from 0 - 100, with higher values indicating greater need for tree plantings. PPI identifies many of these same block groups on either side of the Blackstone River as having greater need for tree plantings (Figure 9d).

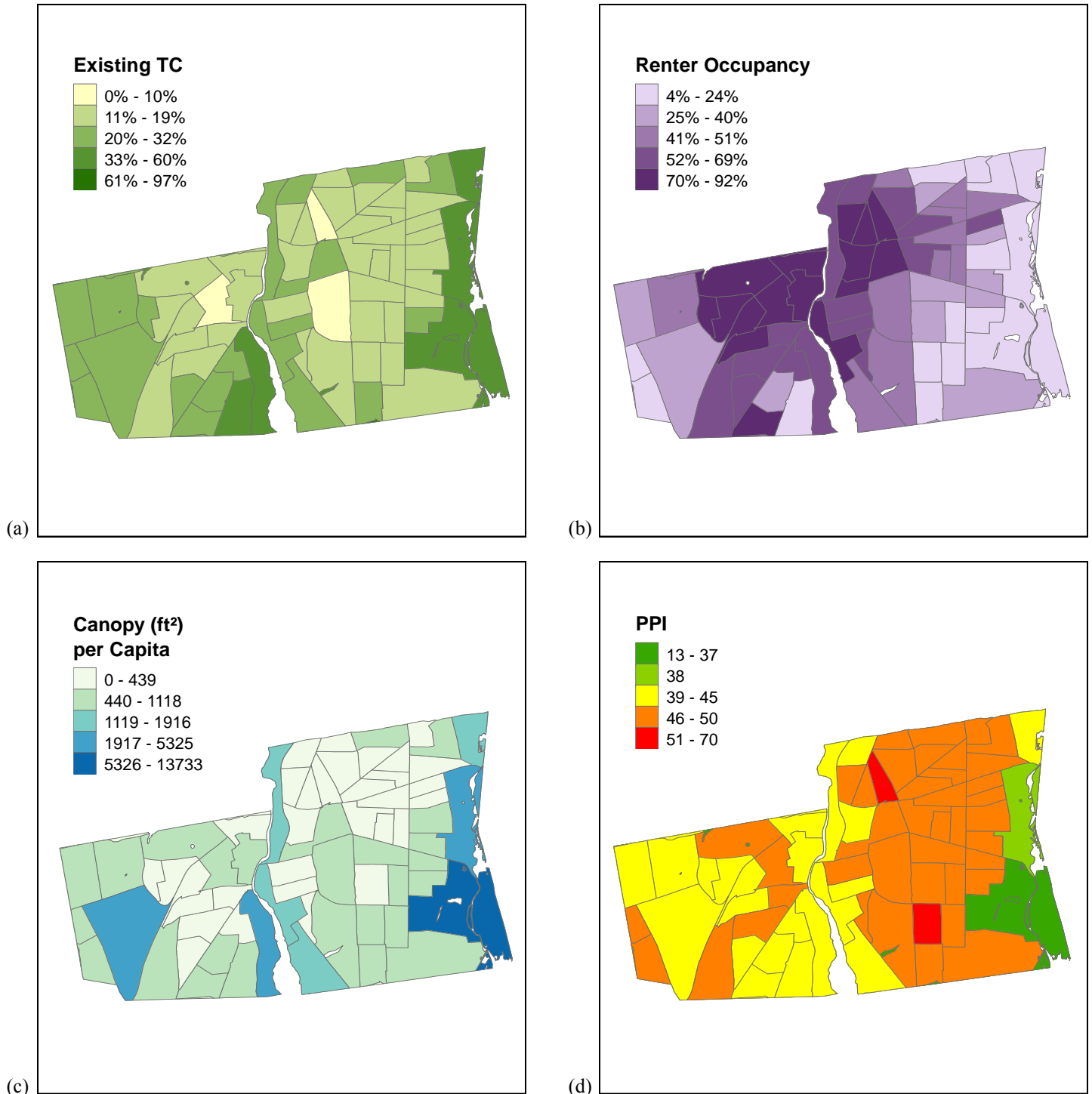


Figure 9: (a) Percent Existing TC; (b) proportion of housing units occupied by renters; (c) tree canopy per capita; and (d) Priority Planting Index.

Tree Canopy Opportunity Index

In addition to simple descriptive statistics, more sophisticated techniques can help identify areas of the city where tree-planting and stewardship programs would be most effective. One approach would be to focus on spatial clusters of Existing and Possible TC. For example, when a 250-foot grid network is superimposed on the city's land-cover map (Figure 10a), it is possible to map regions of the city where high values of Existing TC are tightly clustered (Figure 10b). A similar map can be constructed for Possible TC (Figure 10c). It is even more informative, however, to create a single index by subtracting the percentage of Existing TC per grid cell from Possible TC, which produces a range of values from -1 to 1. When clustered, this tree canopy opportunity (TCO) index highlights areas with high Possible TC and low Existing TC (Figure 10d); these areas theoretically contain the best opportunities for expanding the city's tree canopy and increasing its many attendant benefits.

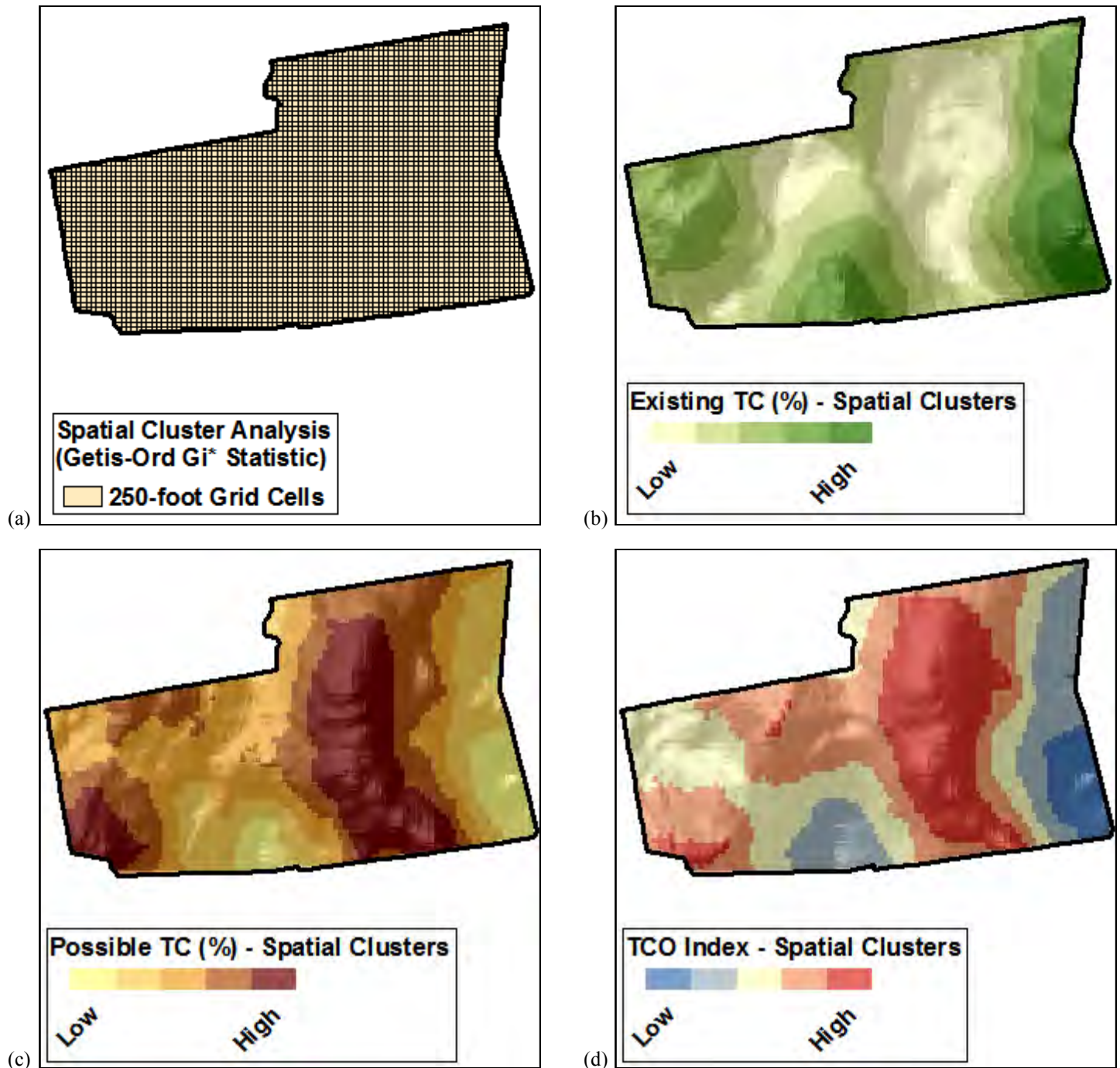


Figure 10: (a) Grid network (250-foot cells) superimposed on land-cover map for Pawtucket and then used in spatial cluster analyses; (b) Spatial clustering of Existing TC in Pawtucket; dark green areas are highly clustered and have high Existing TC values; (c) Spatial clustering of Possible TC in Pawtucket; dark red areas are highly clustered and have high Possible TC values; and (d) Spatial clustering of a combined index of Existing and Possible TC; red areas theoretically provide the best opportunities for expanding tree canopy.

Conclusions & Recommendations

- Pawtucket’s tree canopy is a vital community asset, reducing storm-water runoff, improving air quality, reducing the city’s carbon footprint, enhancing quality of life, contributing to savings on energy bills, and serving as habitat for wildlife.
- With 24% of its land area occupied by tree canopy, Pawtucket has fewer trees than many cities and counties in the northeastern United States (Figure 11). However, it is similar to other New England cities with an historic industrial presence (e.g., Central Falls, Rhode Island; Lawrence, Massachusetts).
- Most of the city’s Existing TC is located in areas designated as Residential, followed by Public Open spaces (e.g., natural areas, parks). Preserving canopy in these areas is crucial to maintaining the city’s overall tree canopy.
- Residential areas provide a rich opportunity for expanding TC, encompassing proportionately large areas of non-canopy vegetation and paved surfaces that theoretically could be modified to accommodate additional tree growth. Industrial and Commercial areas also contain large areas where tree planting is theoretically possible but contingent on social, financial, and logistical constraints.
- TC goals for Pawtucket should not be limited to increasing the city’s overall tree canopy; they should also focus on increasing tree canopy in those parcels or blocks that have the least Existing TC and highest Possible TC. This targeted effort can be performed using the land-cover map that was produced as part of this assessment.
- Private residential landowners control the largest percentage of Possible TC. Programs that educate residents on tree stewardship and provide incentives for tree planting are essential if the city is to sustain its TC in the long term.
- Some land-use categories (e.g., Industrial) offer greater economies of scale for TC improvements. Because these parcels are generally larger in size and are often managed by commercial, institutional, or government entities, the opportunity exists to engage more directly in large-scale greening initiatives.
- Of particular focus for TC improvement should be parcels in the city that have large, contiguous impervious surfaces. These parcels contribute high volumes of runoff, degrading water quality. The establishment of tree canopy on these parcels will help reduce runoff during periods of peak overland flow.

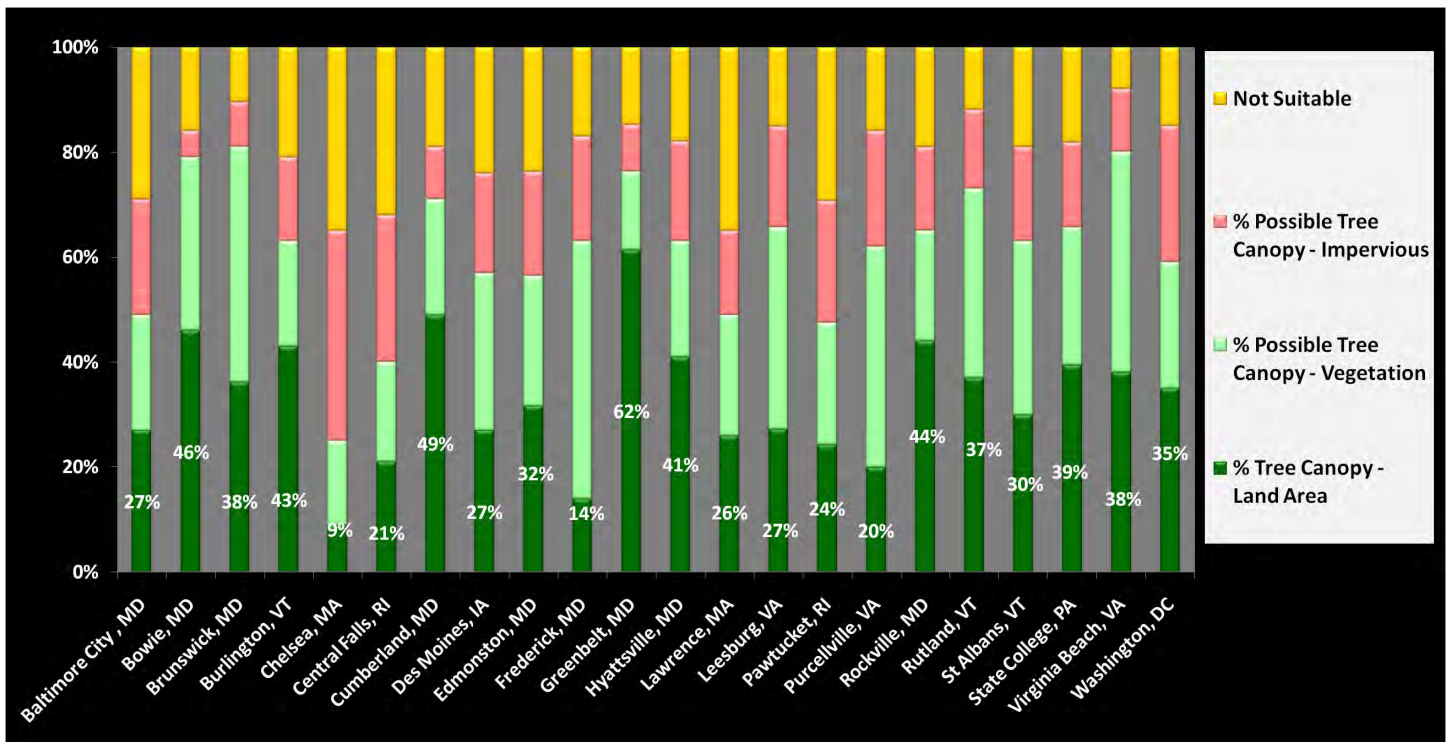


Figure 11: Comparison of Existing and Possible TC in selected cities and counties that have also completed TC assessments.

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Additional Information

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<http://nrs.fs.fed.us/urban/TC/>



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