City of Tampa Tree Canopy and Urban Forest Analysis

2021

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Final Report to the City of Tampa
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Executive Summary

Background

This report summarizes the fourth tree canopy and urban forest analysis conducted for the City of Tampa and represents the year 2021. The City of Tampa tree ordinance (Ord. No. 2006-74, § 9, 3-23-06) requires an assessment of the tree canopy and urban forest every five years (beginning in 2006[1]). In an effort to reduce concerns over bias, this work has been conducted by a collaborative team from the University of South Florida and the University of Florida following established USDA Forest Service protocols.

This report provides detailed information about the current size, composition, health, and distribution of Tampa's urban forest. It also shows how the tree canopy, urban forest and associated benefits have changed over the last five-year monitoring intervals and since 1973, 33 years before regular monitoring began. Specific results are used to evaluate the performance criteria listed in the City of Tampa's Urban Forest Management Plan[2], including tree canopy change and other results associated with the five Planning Districts whose boundaries were adopted in the Tampa Comprehensive Plan[3] (see Figure 1).

As part of this 2021 assessment, the report also includes several additional analyses to assist the City of Tampa with the management of the tree canopy and urban forest, including:

- Results of an online survey and in-person interviews focused on residents' experiences and values of trees, including benefits, drawbacks, and priorities for the urban forest in the City of Tampa.
- Presentation of an urban heat map, showing areas of the City with measurably hotter summertime temperatures and how urban heat is related to the amount of tree canopy, grass/shrub, and other land cover.
- An analysis of environmental equity, showing how specific sociodemographic groups might be disproportionately impacted by urban heat, lack the benefits provided by tree canopy.

The intended audience for this report includes policymakers, agency managers, businesses, neighborhood associations and the City's residents. This project is part of the City of Tampa's Urban Forest Program. This report is intended to help Tampa enact tangible solutions to protect the City's natural environment for future generations.

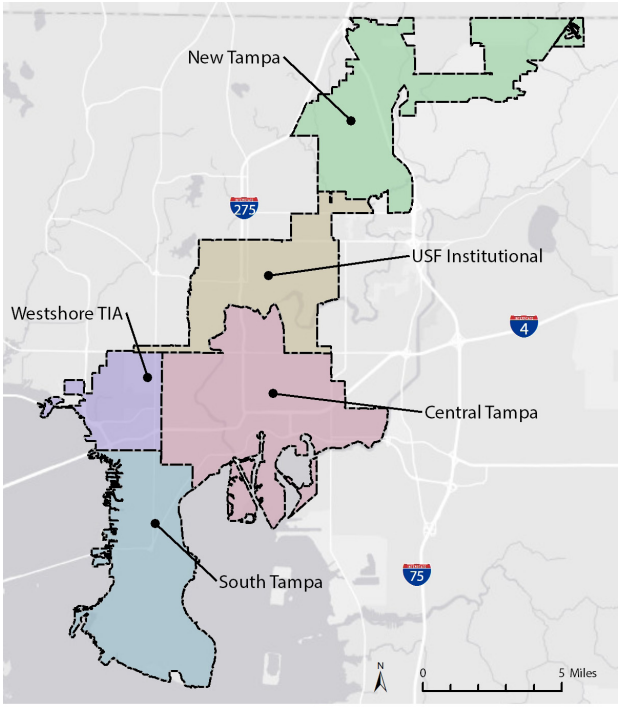


Figure 1. Tampa Planning Districts

[1] Andreu, M., Friedman, M., Landry, S., & Northrop, R. (2008). City of Tampa urban ecological analysis 2006–2007. Final Report to the City of Tampa. Tampa, Florida. 76 pp.

[2] Northrop, R.J., Beck, K. Irving, R., Landry, S., & Andreu, M. (2013). City of Tampa Urban Forest Management Plan. November 2013.

[3] HCCCPC. (2016). *Imagine 2040: Tampa Comprehensive Plan.* Hillsborough County City-County Planning Commission, Tampa, FL, https://planhillsborough.org/.

Key Findings – Urban Forest Composition

- Tampa's municipal forest consists of 10,401,421 trees and contains 114 tree and palm species (hereafter referred to as trees unless otherwise noted) and 145 shrub species, for a total of 259 woody plant species.
- 66% of City trees are species that are listed in the Urban Forest Management Plan's Tree Matrix as desirable species suitable for planting. 25% of the tree species are rated as having a high to medium-high wind resistance; and 30% having a medium-low to low wind resistance. There is no reliable wind resistance information on the remaining 45%.
- Native species account for 86% of all the trees found in Tampa. Brazilian pepper, a species native to South America, now represents 6% of the total population (9% if mangroves are excluded).
- The 10 most common species of trees account for 68% of the City's trees.
- Almost one-third of trees in Tampa is a mangrove species. However, mangrove ecosystems account for only 1.6% of Tampa's land area and 2.6% of the leaf area.
- The high density of these mangrove ecosystems partially explains why tree size is skewed to smaller diameter trees — with 71% between 1" and 6" in diameter.
- While some areas of the City are densely forested, Tampa has an average of 138 trees per acre — slightly higher than a third of what is typical of native forests.
- With regard to tree canopy health, 20% of trees are rated as being in excellent condition; 45% are in good condition, 21% are in fair condition, and 8% are in poor condition or dead.

Key Findings – Urban Forest Canopy Cover

- Estimated citywide tree canopy cover was lower in 1973 (25.6%) than it has been in all subsequent years, with the likely reasons for the increase being (1) the landscape, tree protection and site clearing regulations that were first adopted in 1973, and (2) growth of trees that were planted during neighborhood development activities in New Tampa and elsewhere since 1973.
- Estimated citywide canopy coverage decreased from 34.6% in 1995 to 31.7% in 2006, increased to 34.4% in 2011, but then decreased to 32.3% in 2016, and then decreased again to 30.0% in 2021. Tree canopy in 2021 was at the lowest percentage in 26 years (since 1995).
- The loss of tree canopy since 2011 is over 3,300 acres, an area roughly the size of clear-cutting four Davis Islands, five Downtown areas, 25 Al Lopez Parks, 3.7 USF campuses, or over 1,325 times the area of the Raymond James Stadium field where the Tampa Bay Buccaneers play football.
- Tree canopy within the City's five Planning Districts show increases between 1973 to 1995, decreases between 1995 and 2006, increases from 2006 to 2011 and 2016, but then a decrease in canopy between 2016 and 2021. Tree canopy in 2021 was at its lowest amount since 1995 in all five Planning Districts, and tree canopy in Westshore TIA is even slightly lower than it was in 1973.
- In South Tampa, even considering the uncertainty of the analysis, there has been a statistically significant decline in tree canopy between 2016 and 2021. In fact, 2021 tree canopy in South Tampa is slightly lower than it was in 2006 and 1995; the lowest percentage in the past 26 years.
- In Central Tampa, we cannot say with certainty that the decline in tree canopy between 2016 and 2021 was statistically significant, but there was a statistically significant decrease in canopy between 2011 and 2021. The 2021 tree canopy in Central Tampa was also the lowest amount in 26 years; lower than it was in 1995 and 2006.
- Potential tree planting locations within the City of Tampa cover 15,071 acres of land. Planting in all these areas, albeit not realistic, could increase citywide tree canopy by at least 20%.
- Excluding properties with an athletic field, golf course, cemetery, or event venue (e.g., Julian B. Lane Riverfront Park), there are approximately 263,769 potential planting sites located on properties owned by the City of Tampa.
- Planting trees in potential planting locations could increase tree canopy by 23% in the Central Tampa Planning District, 24% in New Tampa, 14% in South Tampa, 22% in USF Institutional and 11% in Westshore TIA.
- Similar to the citywide tree canopy change results, the 2021 tree canopy was lower than it was in 1995 for all City Council Districts. There was a large increase in canopy between 1973 and 1995, then a decline between 1995 and 2006 in all Districts.

- In City Council Districts 5 and 6, tree canopy increased from 2006 to 2011, but then decreased between 2011 and 2016, and declined further by 2021. In District 7, the tree canopy cover increased slightly each year between 2006 to 2016 and decreased slightly in 2021.
- In District 4, tree canopy decreased from 1995 to 2006, increased from 2006 to 2011, remained nearly the same in 2016, but then had a statistically significant decrease between 2016 and 2021. District 4 tree canopy was slightly lower in 2021 than it was in 1995 and 2006. .
- Most of the City's tree canopy is located on properties that are currently residential (42% of citywide canopy acreage) and Public Lands (47% of citywide canopy acreage).
- Properties designated as Residential 10 units/acre in the Land Use Element of the Tampa Comprehensive Plan (i.e., Future Land Use) contain the largest amount of tree canopy (7,646 acres) followed by properties designated as Major Environmentally Sensitive Areas (6,630 acres). Together, these two areas represent approximately 54% of all tree canopy within the City.
- Approximately 74% of all canopy is located within the Planned Development Alternative (PD-A), Residential Single-Family (RS-60), Residential Single-Family (RS-50) Residential Multi-family (RM) or Community Unit (CU) categories.
- Dedicated residential zoning categories, excluding the mixed-use, Planned Development and Community Unit, comprise 14,757 acres of tree canopy, or 54% of tree canopy within all zoned areas. These results illustrate the importance of households and families for the management of tree canopy within the City of Tampa.
- With regard to the Neighborhood Associations, tree canopy ranged from a low of 7% in the Channel District and 9% in the Tampa Downtown Partnership to a high of 73% in Tampa Palms, 60% Hunter's Green - Pinnacle and 57% in New Suburb Beautiful. However, the total acreage of tree canopy is largest in the Tampa Palms, Old Seminole Heights, Gandy Civic Association and Hunters Green neighborhood associations.

Key Findings – Urban Heat and Equity Analysis

- A map of urban heat, based on summertime land surface temperatures, found that areas with tree canopy are nearly 6°F cooler than areas with more impervious surfaces.
- Neighborhoods with a higher median household income have more tree canopy and cooler summertime land surface temperatures than lower income neighborhoods.
- Tree canopy is higher in neighborhoods with more children (<18 yrs.) and more elderly residents (>65 yrs.).
- Neighborhoods with a higher percentage of renters have less tree canopy and hotter summertime land surface temperatures than neighborhoods with more home-owning residents.
- Areas with a higher percentage of Hispanic residents have less tree canopy and hotter summertime land surface temperatures than other neighborhoods.
- There are sufficient potential planting areas in most neighborhoods to allow tree planting as a strategy to address any potential equity concerns within the City of Tampa.

Key Findings – Urban Forest Economic Benefits and Ecosystem Services

- Each year, Tampa's urban forest:
    - Reduces 1004 tons of air pollutants that cause respiratory problems — eliminating an estimated $9.9 million in health care costs
    - Reduces residential building air conditioning (shading) and heating (wind break) costs by $6.3 million
    - Reduces 74.8 million cubic feet of stormwater runoff (valued at $4.9 million, provided by both trees and shrubs)
    - Stores 1.4 million tons of carbon in trees and woody shrubs (valued at $238 million)
    - Sequesters 70,501 tons/year (net) of atmospheric carbon by trees and shrubs (valued at $12.9 million), which is equivalent to the carbon emitted from all Tampa government operations in 121 days, according to the City of Tampa Greenhouse Gas Inventory.
- Total estimated structural (or replacement) value of the urban forest is $2.03 billion.

Key Findings - Social Science Study of Equity and Values of the Urban Forest

Values and Benefits of Trees

- Survey results show that having “a lot of trees in the city” is either “extremely important” (70.4%) or “very important” (21.6%), suggesting that 92% of survey participants highly value the trees in the City.
- Interviews with residents, business owners, and others illustrate the ways trees and the ecosystems they support are connected to the historical sense of place that long-term residents of Tampa have experienced and still value for the future.
- In neighborhoods where housing development has resulted in measurable tree canopy loss, residents are voicing concern for the associated change in biodiversity, local character, and sense of place.
- Survey results show that the top benefits of trees for Tampa residents are shade and heat reduction, habitat for native species, beauty and aesthetics, noise reduction, improved air quality, water retention, and carbon sequestration.
- Overwhelmingly, the most often mentioned benefit in both survey and interview results was the shade that trees provide for homes, businesses, even parking lots.
- Trees also provide the intangible benefits of spirituality and sacredness to individuals and communities across the City.

Risks and Drawbacks of Trees

- Pollen from trees can trigger allergic reactions, and the level of severity varies by individual. Residents disagree about balancing the allergenic risk with the documented benefits of the trees. However, the majority agree that the benefits outweigh the risks due to allergies.
- Survey results show that the top risks and drawbacks of trees are the costs of maintenance, pruning, removal, and permits and the risks of damage to property from falling limbs and trees (due to storms, diseased and dying trees, or lack of maintenance), and infrastructure damage (sidewalks, pipes).
- Survey results showed high levels of disagreement across respondents on many topics related to the drawbacks of trees. Some residents expressed the trade-offs being worth it, given the overall benefits of trees.
- TECO has been connected in participant’s responses with loss of trees and poor maintenance practices throughout the City, and pruning practices by utilities have been cited as a top concern for tree health in interviews and surveys.

Tree Planting and Removal

- There is wide demand for expansion of the capacity of City-sponsored Tree-mendous tree planting program and for tree-planting in general, particularly in public spaces and with neighborhood street trees.
- Residents would like to see more shade trees planted and replaced, more biodiversity promoted through tree species selection, and more fruiting trees to support the local food system of a growing city.
- “Developers” were most frequently cited as the source of tree canopy loss over time across neighborhoods, while poor tree pruning practices were cited as causing “sick” trees that would be lost sooner than their lifespan or could make trees less resilient in storms.
- Many residents expressed special concern about the recent pace of tree canopy loss over the last two to four years and expect that the measures for tree replacement are disproportionate to the effects of removal.
- Residents widely support increased tree planting throughout the City (82.57%), yet almost a third of survey respondents (28.7%) also report having a tree they would like removed from their property. Expense or concern for the tree are common reasons for not yet having removed a tree.
- Residents cite maintenance concerns, safety and damage concerns, aesthetic preferences, room for additions to homes, tree aging, and tree death as primary motivations for tree removal.

Social Equity in the Urban Forest

- The costs of tree maintenance and tree removal are of viewed as “very expensive” and “expensive” (78% of survey participants), causing significant concern across all neighborhoods and income levels. Study findings indicate the high cost burden is inequitably distributed for lower income residents, preventing desired maintenance of existing canopy.
- Participants agree that there is inequitable distribution of tree canopy density and maintenance across the City.

- The East Tampa tree-pruning grant is viewed as a very effective program for supporting equitable access to tree maintenance. Residents recommend that it should be expanded, with greater funds within and beyond the East Tampa neighborhood.
- Higher cost burdens, lack of maintenance by property owners/landlords and the City, and concerns about crime are some reasons for lower support for tree planting in low-income neighborhoods.
- Reduced access to appropriate tree maintenance over time can lead to higher risk perception levels within neighborhoods.
- Higher risks associated with trees can lead to support for tree removal, exacerbating inequitable distributions of heat vulnerability across the City.

Perceptions of Management of Trees in the City

- Residents have reported dissatisfaction with the timely removal of unhealthy or dead trees (42%), the equitable planting of trees across the City (49%), engagement with the community on decisions related to public trees (51%), appropriate management of living trees (43%), and appropriate management of trees to provide habitat for wildlife (43%).
- Residents are often aware of the City's tree ordinance (60% of survey respondents), but express conflicting understandings of size and other criteria for permitted removal.
- Many residents independently cited concern for state regulations that undermine local ordinances, but there is variability in perceptions/understanding of current regulations as well as how and whether they are enforced.
- Many residents shared first-hand experiences with observed abuses of tree ordinance regulations and covert tree removals. The majority of interviewees who contacted the research team about an interview cited this topic as a major concern.
- Not all trees are viewed in the same way by residents. 79% of participants in the survey think "grand oaks" should have greater protection than other trees. Many of the personal stories shared in interviews focused on removal of grand oaks or other grand trees. Damage to water/sewer lines (26%) and diseased trees likely to fall (40%) were cited as justifying removal of large trees.
- Residents describe the tree fund and its uses as needing more accountability and transparency. Some participants describe it as a way for developers to pay low penalties for tree removals at minimal cost to them, and say that they do not know where the funds are spent or how trees are replaced.
- The City website serves as a primary source of information on arborists and tree management processes, but many participants are still unclear about these processes.

Urban Forest Management Plan

- The majority of public survey participants appear to lack awareness of the urban forest management plan (UFMP). 72% of residents are "not familiar" or "have not heard of" the UFMP and express confusion about its implementation. However, the majority of participants have a strong preference for more trees in the City and for greater attention and resources for management of tree planting, pruning, and removal.
- Study participants are interested in receiving more information on trees from the City. Only 31% of participants have had any interaction with the City regarding trees on or in front of their place of residence, and 63% of residents have not received any information about trees from the City.
- Of the participants who were more aware of the City policies and plans for managing the urban forest, they often mention the recent (since 2019) changes in State statutes that have significantly altered the enforceability of the City's Tree Ordinances and prior to 2019 processes for regulating tree pruning and/or removal.
- When asked if there was anything else survey participants wanted to share with the City, the comment, "Tampa has been known and lauded for our tree canopy. Too many trees are being taken down," is representative of the majority of comments. Other final comments from residents focused on "planting new trees in a responsible way," and the need for permit enforcement with local regulations. Finally, several participants mentioned the urgency of protecting the canopy to address climate change impacts: "[the] City needs to institute new models for tree preservation to offset climate change and set up programs for low income to get help with tree related issues on their properties by certified arborists so trees can be conserved."

Purpose of the Urban Forest Analysis

The City of Tampa's Urban Forest Management Plan was adopted by the Tampa City Council in 2013 and enacted by an executive order in 2014. Defined objectives and measurable performance criteria within the UFMP guide its implementation and ongoing evaluation. The 2021 Tampa Tree Canopy and Urban Forest Analysis describes the state of the urban forest and estimates some of its economic, social, and environmental values as a part of the evaluation process. The data collected and summarized here allow the City to measure its progress, identify confounding issues, and make operational and policy adjustments as it strives to meet the plan's intended outcomes.

The 5-year cycle of inventory and analysis also coincides with the cycle for review and possible revisions to the Urban Forest Management Plan. This report will be reviewed by the City and its Natural Resources Advisory Committee. This committee will make recommendations (as needed) to Tampa's planning department and executive branch on ways to improve the efficiency and effectiveness of urban forestry operations and policy.

Urban Forest Management Plan

The City of Tampa's Urban Forest Management Plan (Northrop et al. 2013) outlines numerous management and urban forest resource objectives, establishes a timeframe for the implementation of management efforts, and identifies the agency or partnership responsible for completing the work. Performance criteria are used to judge the effectiveness of these efforts and their impact on the environmental, economic, social, and cultural function of Tampa's urban forest. These criteria are intended to reflect public values, as well as the vision and goals initially set by the Steering Committee on Urban Forest Sustainability.

Each criterion provides a range of performance indicators that are used to gauge the current state of Tampa's urban forest management and facilitate decision-making in the City's urban forest policy processes (Tables 1 and 2). This allows the City to assess and improve urban forest management practices over time through an adaptive management process.

Specific criteria and performance indicators associated with the City's urban forest vegetation resource are monitored every five years though the Urban Forest Analysis (i.e., this report). In addition to the Vegetation Resource, the results from the survey and interviews conducted as part of this 2021 study allowed the research team to recommend ratings for two of the four Community Resource criteria (Table 2).

Monitoring these specific criteria and performance indicators allows the City of Tampa to use an adaptive management approach to urban forestry and promote flexible decision-making. Careful monitoring of the indicators will help the administration adjust policies or operations as part of an iterative learning process leading to more effective decisions and enhanced benefits while reducing tensions among stakeholders.

Performance indicators for the Vegetation Resources and the Community Framework are shown in Tables 1 and 2. Cells outlined in black indicate the condition of the urban forest given the results of this 2021 study. Numbers at the bottom of cells (i.e., 11, 16) indicate the ratings assigned in 2011 and 2016. Note that the Community Framework criteria were last rated in 2011.

Table 1. Performance criteria related to Tampa's urban forest vegetation resource

Cells outlined in black indicate the condition of the urban forest given the results of the 2021 Urban Forest Analysis and the performance indicators provided. (11) and (16) indicate criteria ratings in 2011 and 2016, respectively, as listed in the City of Tampa Urban Forest Management Plan, November 2013.

Criteria	Vegetation Resource – Performance Indicators				Key Objective
	Low	Moderate	Good	Optimal	
1 Species suitability for Tampa's climate zones	Less than 50% of trees are of species considered suitable for Tampa. (11, 16)	**50%–75% of trees are of species considered suitable for Tampa.**	More than 75% of trees are of species considered suitable for Tampa.	At least 90% of the trees are of species suitable for Tampa.	Establish a tree population suitable for Tampa's urban environment and adapted to the regional environment.
2 Canopy cover relative to goals by municipal planning district	The existing canopy cover equals 0%–25% of the goal.	The existing canopy cover equals 25%–50% of the goal.	**The existing canopy cover equals 50%–75% of the goal.**	The existing canopy cover equals 75%–100% of the goal. (16)	Relative canopy cover to goal for each municipal planning district category. The goal is defined as no net loss in a Planning District.

Table 1 (continued). Performance criteria related to Tampa's urban forest vegetation resource

Criteria	Vegetation Resource – Performance Indicators				Key Objective
	Low	Moderate	Good	Optimal	
3 Tree species diversity	Fewer than five species dominate the entire tree population citywide.	No species represents more than 20% of the entire tree population citywide.	**No species represents more than 15% of the entire tree population citywide. (16)**	No species represent more than 10% of the entire tree population citywide. (11)	Establish a diverse tree population citywide.
4 Diameter (DBH) distribution of trees in the City	Any relative DBH (RDBH) class (0%-25% RDBH, 26%-50% RDBH, etc.) represents more than 75% of the tree population. (16)	**Any RDBH class represents between 50% and 75% of the tree population.**	No RDBH class represents more than 50% of the tree population.	25% of the tree population is in each of four RDBH classes.	Provide for uneven aged distribution citywide.
5 Tree health condition by municipal planning district.	**Less than 30% of trees rated as excellent health condition.**	31–60% of trees rated as excellent health condition. (11-16)	61–85% of trees rated as excellent health condition.	Greater than 85% of trees rated as excellent health condition in all municipal planning districts.	Healthy trees live longer, produce greater no. of benefits and reduce costs associated with maintenance.
6 Wind resistance of tree species citywide	Majority of trees are rated in lowest category of wind resistance.	**Majority of trees are rated in medium and high categories of wind resistance. (11, 16)**	Majority of trees are rated in high category of wind resistance.	Greater than 80% of trees are rated in highest category of wind resistance.	Reduce disruption of social and economic services; reduce cost of cleanup and protect private property and human well-being.
7 Tree species longevity	Less than 25% of trees are of species considered long-lived for Tampa.	**25% to 49% of trees are of species considered long-lived for Tampa. (16)**	50%–75% of trees are of species considered long-lived for Tampa. (11)	More than 75% of trees are of species considered long-lived for Tampa.	Establish a long-lived tree population that maximizes benefits vs. costs.
Current State - Summary	**1**	**4**	**2**	**0**	

Clarification of criteria:

1. Based on the proportion of trees that were species listed on the Tampa Tree Matrix (https://www.tampa.gov/document/city-tampa-tree-matrix-17196).
2. This report will interpret the criteria "Canopy cover relative to goals by municipal Planning District" as the percentage of planning districts that did not have loss of canopy cover. Three out of five (60%) of Planning Districts had no statistically significant net loss in tree canopy.
3. By stem count in managed areas of the City (i.e. not including mangrove or natural/conservation lands land use areas)
4. RDBH – Relative Diameter at Breast Height: the ratio between the measured diameter at breast height and the maximum diameter for the species. By stem count in managed areas of the City (i.e. not including mangrove or natural/conservation lands land use areas). Uneven Aged Distribution: The population of all trees is comprised of a diversity of ages. Uneven-aged forest stands (urban forests) usually possess a reverse J-shaped diameter distribution, with large numbers of small trees and relatively few large-diameter trees. In reality, each species of tree within the forest stand (urban forest) will have its own diameter distribution, and the overall age distribution is a composite of these (after Nyland, 1996).
5. Tree health averaged across Planning Districts. For the purposes of this report, tree health was assessed using the i-Tree crown assessment protocol.
6. Wind Resistance of Trees: Duryea et al. (2007). Hurricanes and the urban forest: effects on southeastern coastal plain trees. Arboriculture and Urban Forestry, 33(2): 83-97. And Duryea et al. (2007). Hurricanes and the urban forest: Effects on tropical and sub-tropical trees. Arboriculture and Urban Forestry, 33(2): 98-112. Excludes species with unknown resistances.
7. Long-lived: refers to species of trees that exhibit the ability to tolerate harsh urban conditions for time frames that approximate their natural lifespan.

Table 2. Performance Criteria related to Community Framework

Criteria	Community Framework – Performance Indicators				Key Objective
	Low	Moderate	Good	Optimal	
General awareness of the urban forest as a community resource	Urban forest seen as a community problem.	Urban forest seen as important to the community. (11)	**Urban forest acknowledged as providing environmental, social, and economical services.**	Urban forest recognized as vital to the community's environmental, social, and economic well-being.	The general public understands the importance of the urban forest to the community.
Neighborhood cooperation	Majority of neighborhoods are unfamiliar with Urban Forest Management Plan (11)	**Isolated or limited number of active neighborhood groups.**	Majority of neighborhood associations form partnerships with city government.	All neighborhood associations form partnerships with city government.	At the neighborhood level, citizens understand and cooperate in urban forest management.
Current State - Summary		**1**	**1**		

Clarification of criteria:

1. The survey and interview findings revealed that the community viewed trees as very important, preferred more trees, and expressed strong agreement with many of the scientifically supported environmental, social and economic services provided by trees.
2. A long list of neighborhood associations was reported by survey respondents and several neighborhood associations reached out to project researchers to find out more about the study and tree ordinances and enforcement. Results did not provide evidence that a "majority" of neighborhood associations formed partnerships (i.e., the rating of "Good"), but there was strong evidence for a limited number of active neighborhood groups.

Project Methods

Study Area

The City of Tampa, Florida (28°N, 82°W) is located on the west coast of Florida and sits close to the mid-point of the peninsula. The City's political jurisdiction as of 2021, including the shoreline of Tampa Bay, was used to define the project study area (Figure 2). The total study area is 118 square miles (75,288 acres). According to the United States Census Bureau (www.census.gov), total population within the City of Tampa was 335,709 in 2010, 384,959 in 2020 and was estimated at 387,050 in July 2021.

Tampa is located in a transitional zone between subtropical south Florida and temperate north Florida. The City is also split into two different USDA Plant Hardiness Zones with the northern inland parts of the City in zone 9b and the southern coastal parts in zone 10a. Tree species found in this unique transitional climate are generally specific to either subtropical or temperate climates. Therefore, this coexistence of tree species at their northern and southern limits provides for a unique and diverse urban forest composition.

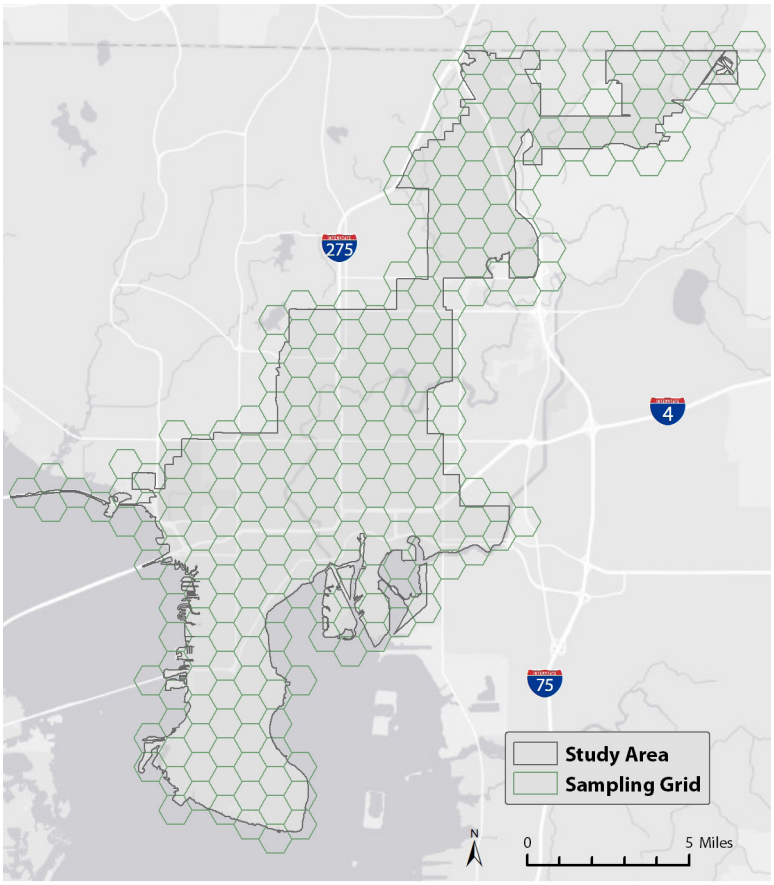


Figure 2. Project study area and field sampling grid.

Field Methods

The City of Tampa's initial urban forest assessment took place in 2006-2007. In creating the sampling design, a hexagonal grid (Figure 2) was transposed onto the City, with each hexagon unit representing 437 acres and containing one randomly generated sample point. Two hundred and one permanent inventory plots were created within Tampa's political boundary. The latitude and longitude coordinates for each sample point were used to define plot centers. In the field, plot centers were located by GPS and confirmed by measuring proximity to fixed reference objects (e.g., buildings, intersections, etc.). A fixed radius 1/10 acre (r=37.2 ft) sample area from plot center was used to establish the plot boundaries.

In compliance with the City of Tampa tree ordinance Ord. No. 2006-74, § 9, 3-23-06, follow-up assessments were conducted every five years after the initial inventory was completed. Re-inventories were conducted in 2011-2012, 2016-2017, and 2021-2022. The 2016 follow-up assessment collected data at 193 of the original 201 plots. Eight new locations (not sampled in 2011) were added to the project to replace plots that researchers were unable to access in 2016. The 2021 inventory collected data at 189 previously sampled plots and added 12 replacement plots, for a total of 201 plots.

For this study, data were collected on trees, shrubs (i.e., understory), and ground cover. Only trees 1 inch in diameter at breast height (DBH, measured 4.5 feet from the ground) were recorded. Woody plants taller than 1 foot but with stems less than 1 inch at DBH were considered shrubs. Woody or herbaceous vegetation less than 1 foot tall were considered ground cover.

Figure 3. Measuring a tree's diameter at breast height (DBH).

Data were collected following the plot sampling protocol referenced in the 2017 i-Tree User's Manual (v6), Phase III found at www.itreetools.org. Though not required by the protocol, palm tree and palm shrub cover were defined separately from woody tree and woody shrub cover to account for differences in their growth habit and biology. These data were aggregated prior to ecosystem service modeling.

Researchers collected the following data: percent cover of tree and shrub stratum (with and without palm species); percent ground cover; identification of tree and shrub species; tree DBH; tree height; tree crown measurements; crown condition assessments; proximity of trees to buildings; and tree crown light exposure index.

Data were analyzed by the i-Tree Eco software tool (v6), formerly known as UFORE (Urban Forest Effects Model) (Nowak et al. 2002), which was created by the U.S. Forest Service. Models within i-Tree Eco quantify the structure and following values of the urban forest: structural value; residential heating and cooling savings; avoided air pollution abatement value; public health savings; carbon sequestration value; carbon storage value; and avoided stormwater costs.

Field Plot Stratification and Reporting

Field data collected at the 201 field sampling plots were extrapolated to estimate urban forest composition, structure (e.g., tree size, density) and benefits for the entire City of Tampa. This extrapolation was conducted for each land use (e.g., residential, commercial, etc.), and projected over the total area for each land use within the City. These total areas were determined using a parcel-based land use map combined with maps of open-water and mangrove habitats. The land use designations assigned represent how land was actually being used at the time of the 2021 field sampling and tree canopy mapping. They do not necessarily correspond to regulatory designations such as zoning or future land use.

The land use designations are shown in Table 3, and a selected portion of the map is shown in Figure 4. The total acreage and percent of the City's area are based on Tampa's jurisdictional boundaries excluding the open water of Tampa Bay. Also included in the table is the number of field plots that represent each land use. All field plot land use assignments were based on location within a geographic information system, and field verified to ensure the designation made was appropriate.

Table 3. Land use categories, associated acreage, and number of field plots.

Current Use of Land	Area (acres)	City Area	# Field Plots
Agriculture	1,143	2%	1
Commercial	6,992	9%	12
Industrial	2,877	4%	10
Mangrove	1,180	2%	4
Natural / Conservation Lands	5,315	7%	11
Parks / Recreation	2,518	3%	10
Private Institutional	2,082	3%	10
Public Communications / Utility	342	1%	3
Public Institutional	12,692	17%	34
Residential Multi-Family	3,549	5%	8
Residential Single Family	20,516	27%	52
Right-of-Way / Transportation	13,053	17%	36
Water	3,040	4%	8

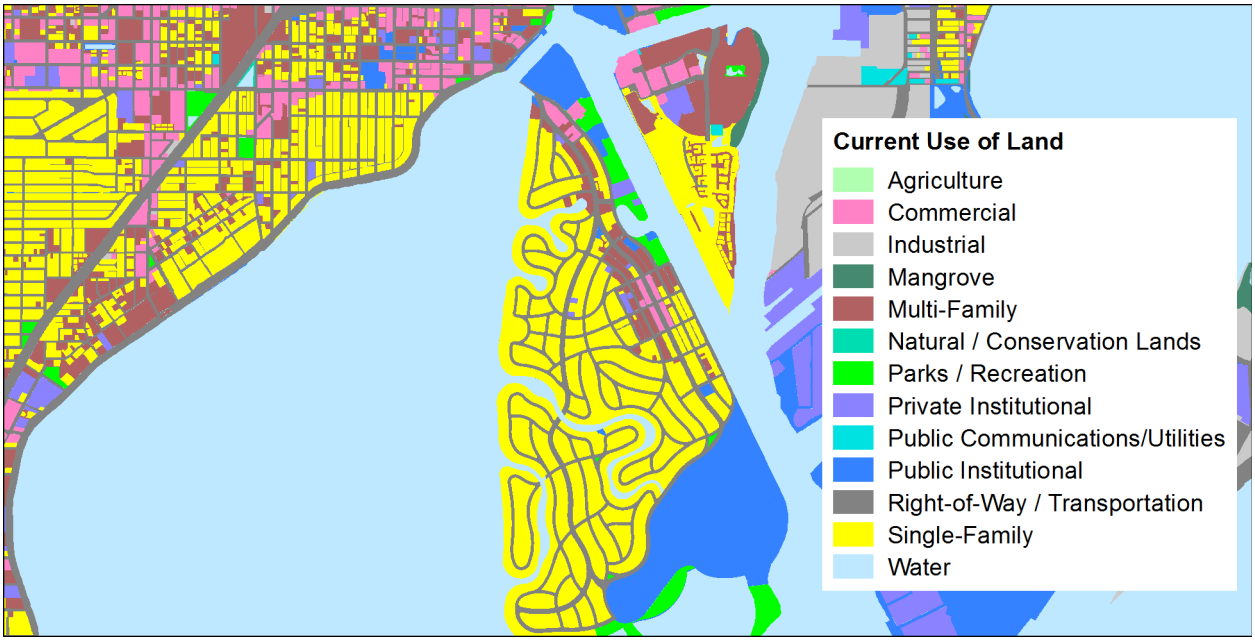


Figure 4. Map snippet showing mosaic of Current Use of Land in the City of Tampa.

Tree Canopy Methods

Tree Canopy is the mass of leaves, branches and stems of trees that cover the ground when viewed from above. The sample-based field inventory was used to estimate urban forest composition, structure, health and associated benefits. We additionally used remote sensing techniques to measure 2021 tree canopy cover, as well as change in canopy coverage within the City of Tampa since 1973.

Tree Canopy Mapping

Tree canopy mapping provides information about the distribution of tree cover, as well as grass/shrub and other land coverage within the City of Tampa. Tree canopy mapping for 2021 was conducted using advanced object-based image analysis techniques in collaboration with Jarlath O'Neil-Dunne from the University of Vermont (O'Neil-Dunne et al. 2014). Object-based methods have been shown to be more accurate for mapping tree cover in the Tampa area than other land cover classification methods.

The tree canopy map was based on six-inch resolution (i.e. imagery capturing objects as small as 6 inches), multi-spectral (blue, green, red, near-infrared) aerial imagery from early spring 2021 obtained from the Hillsborough County Property Appraiser. Aerial LiDAR (Light Detection and Ranging) data from the Southwest Florida Water Management District was converted to relative height above ground level and used to differentiate between trees and grass or buildings and other impervious surfaces. These data sources, as well as ancillary data like road centerlines and water/wetland boundaries were used as part of a set of land cover classification rules. Extensive manual corrections were then made to the initial maps by visual examination of all sections of the study area.

The final map included seven land cover classes: tree canopy (>8 ft tall); grass/shrub (<8 ft tall); buildings; roads, other impervious surfaces (e.g., sidewalks, driveways, parking lots); bare earth; and water. Accuracy of the tree canopy cover dataset was assessed by visually comparing the classified land cover at 8,813 randomly distributed points. Overall accuracy of the final tree canopy cover was 93%.

Tree canopy and other land cover classes were summarized for different geographic areas of the City using geographic information systems data acquired with the assistance of staff from City of Tampa Planning & Development. Boundary layers for tree cover summaries included: Zoning categories, Future Land Use categories, Neighborhood Associations, and the i-Tree land use classifications described above.

Figure 5. Aerial images, LiDAR and ancillary map data are used to create the detailed land cover maps.

Tree Canopy Change

A long-term assessment of tree canopy cover change since 1973 was conducted using the dot-based method of tree canopy change detection. The dot-based method, developed by researchers from the U.S. Forest Service, uses geographic information systems software to create randomly distributed point locations throughout the City (Nowak et al. 1996). At each point, a trained technician examines an aerial image and determines whether or not the point falls on a tree canopy. While labor intensive, an advantage of the dot-based method is that the accuracy of the tree cover estimates is not sensitive to differences in the resolution of the aerial images used for the analysis. Figure 6 illustrates why tree canopy maps generated from aerial images are typically not appropriate for measuring change over time. Notice how the lines on the football field are difficult to see on the images on the left. Computer algorithms that generate tree canopy maps are very sensitive to image resolution. Small trees that were mapped in 2016 using the image on the right (0.5 ft pixel) may not have been mapped in 2006 using the image on the left (3.28 ft pixel). Thus, a change analysis based on tree canopy maps would show an increase in trees solely due to the higher resolution. The dot-based method overcomes this problem and therefore it is a more accurate change analysis technique.

Tree canopy change was quantified using aerial images to estimate tree canopy in 2006, 2011, 2016, and 2021. Tree canopy was additionally estimated for the year 1995 using 1-meter resolution color-infrared Digital Orthographic aerial imagery, and for the year 1973 using black and white imagery from the USDA National Agriculture Imagery Program (NAIP). Citywide tree canopy coverage for each year was determined by two trained technicians independently evaluating over 4,000 points. Tree canopy change results within Tampa's Planning Districts and City Council Districts were determined based on the assessment of over 9,000 points by a single trained technician. The results produce estimates of overall tree canopy as well as the uncertainty associated with the estimate. The statistical significance of changes from one year to the next were based on overlap of 95% confidence levels.

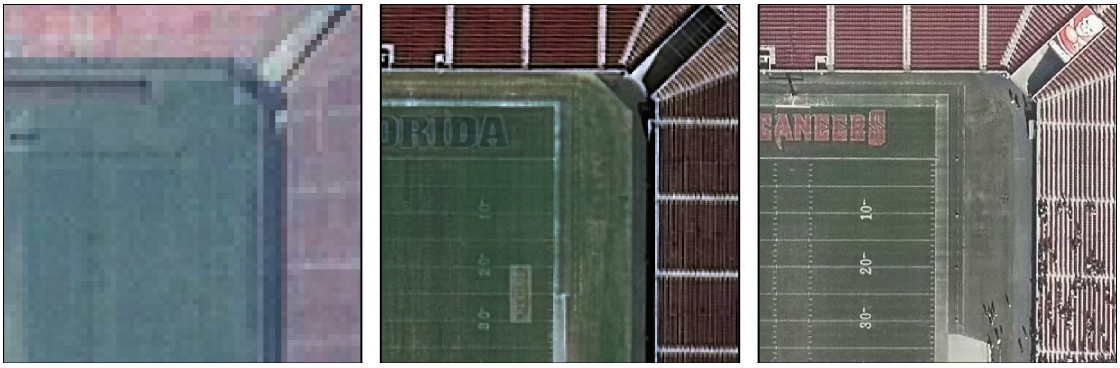


Figure 6. Image resolution for tree canopy analysis. Left to right: 2006 (3.28 ft./pixel), 2011 (1 ft./pixel), 2016 and 2021 (0.5 ft./pixel).

Urban Heat Mapping

Urban heat is a problem for many cities, especially in the face of climate change related temperature increases. Research has shown that the air temperature can vary substantially in a city, with some areas being subjected to summertime air temperature that is much higher than other areas of a city. Higher air temperatures can pose the risk of heat stroke for people working or playing outside, and for vulnerable communities who may lack adequate air conditioning. Higher air temperatures also result in higher costs for air conditioning, and increased pollution typically associated with power generation.

This project utilized an urban heat map produced for the City of Tampa by ARTi Analytics BV as part of EXTREMA Global, with support from Bloomberg Associates. Landsat-8 Thermal Satellite data was used as the basis for mapping the spatial distribution of summertime urban surface temperatures (land surface temperature) for the City of Tampa. The urban heat map used a five-year (2017-2021) time series of satellite-derived daytime land surface temperate that correspond only to summer months (i.e., June, July and August).

The urban heat map was used to examine the relationship of tree canopy, grass/shrub, and other land covers with summertime temperatures in Tampa, since research has clearly shown cooler temperatures in areas with more tree canopy (i.e., shade). In addition, as part of an equity analysis for Tampa, summertime temperatures within different areas of the City were compared to the sociodemographic of the people living in those areas.

Equity Analysis

The concept of equity is quite simple in the context of City planning, and by extension, urban forest management. Equity is the idea that people from all backgrounds should benefit from city services and public amenities, and that no community should be disproportionately impacted by negative aspects of living in the city.

Equity is a theme that is embraced by the City of Tampa planning document, *Resilient Tampa* (https://www.tampa.gov/resilience), released in 2021. According to the introduction, Resilient Tampa "…set forth an ambitious but achievable plan for building resilience by addressing our city's most urgent shocks and stresses in an integrated way. This tactical roadmap is organized around aspirational visions and goals for our city's future that span every scale, from individual Tampanians, to neighborhoods, to infrastructure systems, to the city as a whole." According to *Resilient Tampa* Action 3.3.3, Preserve and Increase Tampa's Tree Canopy: "The City will continue to advance tree protection policies aimed at ensuring no net loss in the tree canopy within any of its Planning Districts will result in tree mitigation and planting that ensures that the benefits provided by trees are available to all residents, including low-income communities."

This report used 2016-2020 US Census data (https://www.census.gov/programs-surveys/acs) to compare the amount of tree canopy within different areas of Tampa to sociodemographic characteristics that are typically used to examine issues of equity.

Survey and Interview Methods

An important component of the 2021 study was to conduct a social survey to understand opinions about trees and urban forest management. In addition, to supplement the survey and ensure participation by residents from across the City's neighborhoods, in-depth interviews (typically 30 minutes to an hour) were also conducted. The survey was developed based on a systematic review of existing survey study findings from the urban forestry literature, as well as four focus groups between April-May 2021 with City staff from the Natural Resources Planning Department, Forestry, Parks and Recreation, and Office of Sustainability, and informal interviews with members of the Natural Resources Advisory Committee as well as residents and business owners. The online survey was available (using Qualtrics) and promoted by the City of Tampa between April 22, 2022 and August 7, 2022. During late 2021 and 2022, 35 half-hour to an hour-long semi-structured interviews were conducted with residents, business owners, local environmental organizations, and developers. Results were analyzed with the assistance of Dedoose Qualitative Data Analysis software. Additional detail about the methods for the survey and interview component of the study are available within the Social Science Study section.

Urban Forest Composition

Tree Population

As of 2021, there are an estimated 10,401,421 trees in the City of Tampa, representing 114 species. The ten most common tree species, representing 68% of the total population, are white mangrove (*Laguncularia racemose*), cypress (*Taxodium* spp.), black mangrove (*Avicennia germinans*), Brazilian peppertree (*Schinus terebinthifolia*), laurel oak (*Quercus laurifolia*), cabbage palmetto (*Sabal palmetto*), southern bayberry or wax myrtle (*Morella cerifera*), swamp tupelo (*Nyssa sylvatica* v. *biflora*), live oak (*Quercus virginiana*), and buttonbush (*Cephalanthus occidentalis*) (Figure 7). Brazilian pepper, an exotic invasive tree, is the only species represented in the top ten that is not native to Florida.

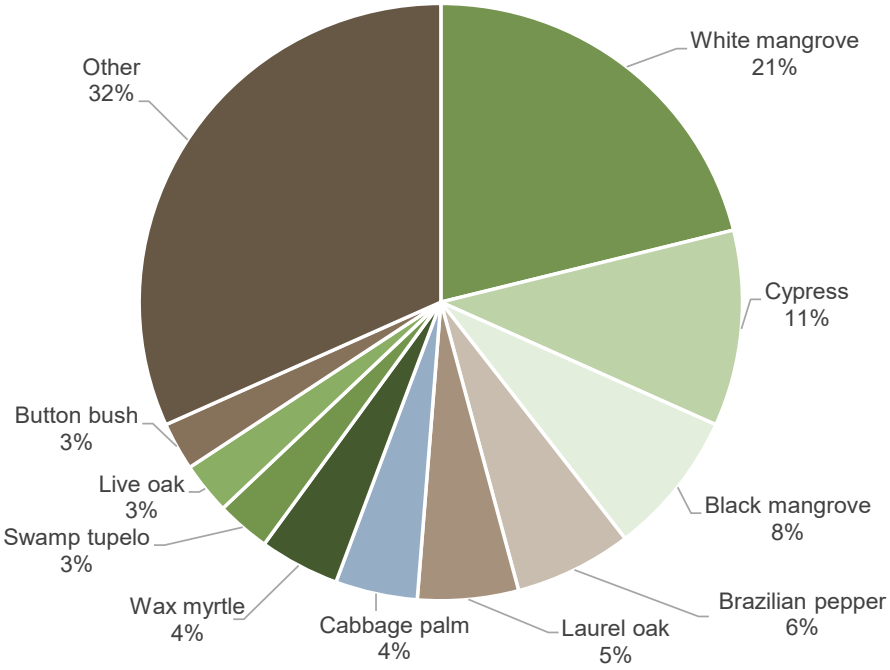


Figure 7. Top ten tree species and their associated percentages by estimated tree numbers in 2021.

White mangrove
Laguncularia racemosa

Cypress
Taxodium spp.

Black mangrove
Avicennia germinans

Brazilian pepper
Schinus terebinthifolius

Laurel oak
Quercus laurifolia

Diversity

Diversity, or species richness, is the number of species present in a given area. Species diversity can be an important indicator of an urban forest's vulnerability or resilience to natural disturbances such as insect and disease outbreaks (Alvey 2006, Duryea et al. 2007, Escobedo et al. 2009, Raupp et al. 2006). Areas with low species diversity can be highly vulnerable if and when these disturbances occur. 259 plant species were identified in the City. Of these, 114 species (Appendix A) were trees (woody stems ≥1" DBH), and 145 species were shrubs (woody plants ≥ 1ft height, <1" DBH).

When looking at the total number of tree species per land use category, Residential Single-Family areas had the greatest diversity (72 species), containing over 63% of the total tree species identified in this study. This comes as little surprise as homeowners typically plant a broader range of tree species in their home landscapes or as part of their gardening activities. By comparison, Natural/Conservation Lands had less than half the number of species seen in Residential Single-Family areas, 29 species) (Figure 8).

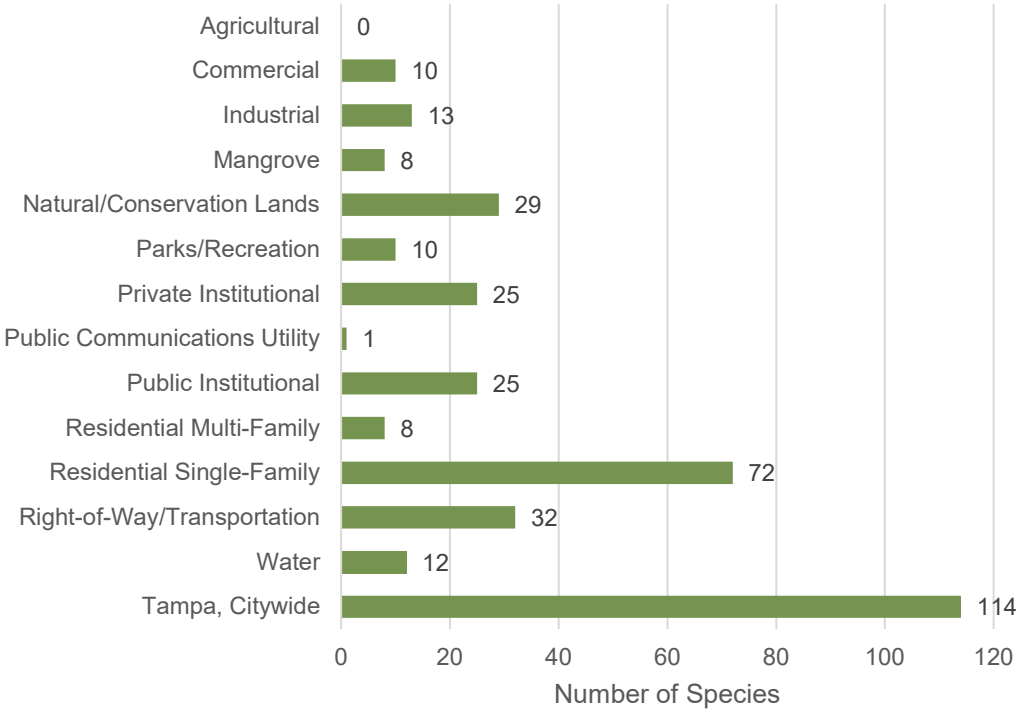


Figure 8. Comparison of the number of tree species by land use in 2021. Note that the Agricultural land use category is represented by only a single field plot.

Cabbage palm
Sabal palmetto

Wax Myrtle
Morella cerifera

Swamp tupelo
Nyssa sylvatica var. *biflora*

Live oak
Quercus virginiana

Buttonbush
Cephalanthus occidentalis

Native and Non-Native Tree Species

Species that were found in Florida prior to European colonization in the 16th century are considered native to the state. Non-native species are those that were introduced beyond their native range by humans. Of the 114 tree species identified in the City of Tampa, approximately 86% are native to Florida. Invasive species are non-native species that spread into and dominate a new area due to a lack of natural diseases and/or predators. The presence of invasive species can negatively impact the abundance and distribution of native plants and animals.

Seventeen of the species found in the 2021 Urban Forest Analysis are listed by the Florida Invasive Species Council (formerly the Florida Exotic Pest Plant Council; FISC 2019) as known invasives. Eight of the 17 species are listed as Category I invasive species by FISC, indicating these species are known to cause severe ecological damage in Florida. Brazilian pepper is one of the 8 FISC Category I listed species and one of the top-ten dominant species in the City, representing around 6% of the total tree population. This species is one of great concern for the City as it readily spreads into disturbed areas, creating dense thickets that are costly and time-consuming to eradicate.

Figure 9. The flamegold or goldenrain tree, *Koelreuteria elegans* subsp. *formosana*, is a Category I invasive species in central and south Florida.

Palms

Palms represent a unique structural element of the City's landscape and are often distinct features in the City's skyline. Palm species are commonly planted on residential sites and public rights-of-way to accent the City's sub-tropical climate. Palms (monocots) technically have more in common biologically with grasses than hardwood trees. Their physical structure and metabolic systems differ widely from flowering and coniferous trees. However, palms do represent a substantial portion of Tampa's urban forest (7%) and provide important ecological and economic values that should be considered when evaluating the urban forest.

Twelve different palm species were identified in Tampa's urban forest in 2021, with an estimated total number of 724,419 trees. The single-family land use category had the greatest abundance and number of palm species in 2021 with 9 palm species (Figure 10). The right-of-way land use category had the second highest number of palm species with 7 species. Palm species were infrequent in industrial, mangrove, park, public communication/utility, and water land uses. Florida's state tree, the cabbage palm, is one of the top ten dominant species in the urban forest canopy (4% of all trees) and the most common of the palms (Figure 11). Four of the 12 palm species documented in 2021 are listed as FISC Category II invasive, indicating these species have increased in abundance or frequency but have not yet altered plant communities to extent of FISC Category I species (FLEPPC 2017). The four Category II invasive palms identified in the City's urban forest are Senegal date palm (*Phoenix reclinata*), Chinese fan palm (*Livistona chinensis*), Mexican fan palm (*Washingtonia robusta*), and queen palm (*Syagrus romanzoffiana*).

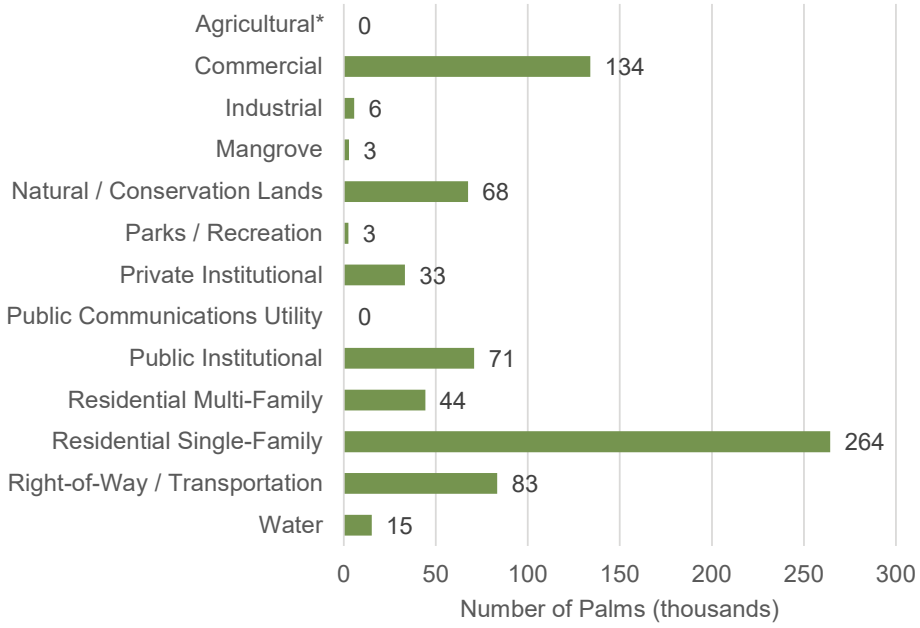


Figure 10. Number of palms by land use in 2021.
Note: Agricultural category is represented by only one sample plot.

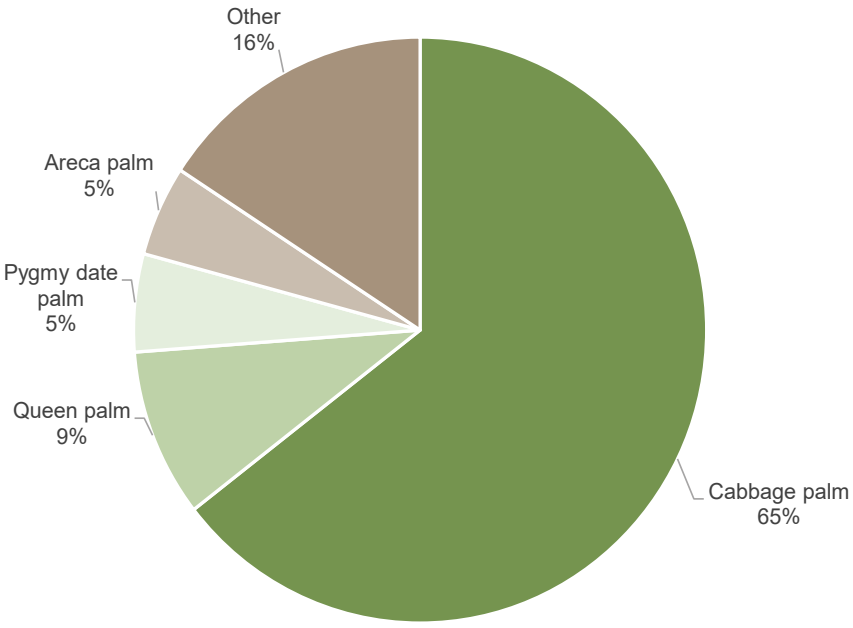


Figure 11. Relative number of the top five palm species based on the estimated number of trees in 2021.

Mangroves

The natural range of mangrove forests in the United States is mainly limited to Southeastern coastal areas due to their sensitivity to sub-freezing temperatures. They are found on the coasts of North and South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, and Texas (Odum and McIvorm 1990). The mangrove forest is valued for its ability to stabilize sediments, protect shorelines from erosion, and filter out pollution from the water (Rey and Connelly 2015). In addition, mangrove forests are an integral part of the Tampa Bay estuary since they serve as important nursery, feeding, and nesting areas for a variety of fish, shellfish, birds, and other wildlife. Many of Florida's threatened and endangered plant and animal species live in these forests. There are three species of mangroves found in Florida: the red mangrove (*Rhizophora mangle*), the black mangrove (*Avicennia germinans*), and the white mangrove (*Laguncularia racemosa*).

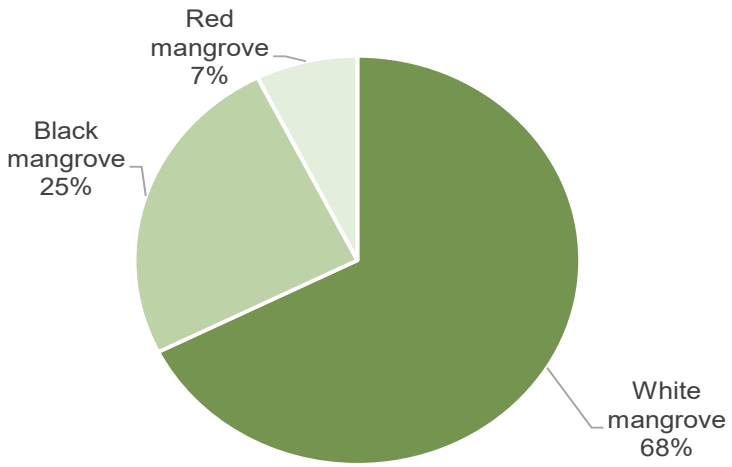


Figure 12.Proportion of mangrove species in 2021.

These three species represent 31% of the total number of trees in Tampa's urban forest (estimated 3,251,814 mangrove trees). Mangroves are typically small diameter trees that grow in dense thickets and are confined to overlapping ecological zones along the coastline. While these species represent a sizable portion of the urban forest by stem count, they occupy only a small area compared to other species with similar tree numbers. Within the mangrove population itself, white mangroves represent 68% of trees, black mangrove 25%, and red mangroves 7% (Figure 12).

Figure 13. Mangrove forest is found on the undeveloped portions of the Tampa Bay coastline.

Managed Forest

The managed forest is defined as the portion of Tampa's urban forest that excludes mangrove and natural/conservation land use areas. Although these areas play a critical role in the City's urban forest, they are often managed separately from the City's main urban forestry efforts. An estimated 4,617,860 trees represented by 101 tree species occupy the managed areas of Tampa's urban forest. The top ten tree species represent 64% of total number of trees within the in-land forest (Figure 14). Brazilian pepper (13% of managed forest trees) is the only non-native invasive tree represented in the top ten list.

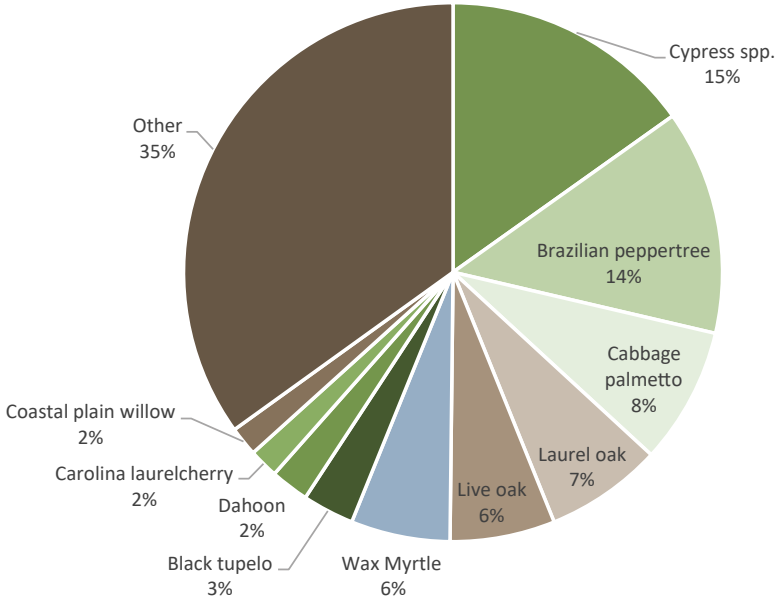


Figure 14. Top ten species of the managed urban forest (without mangroves or natural/conservation areas) in 2021.

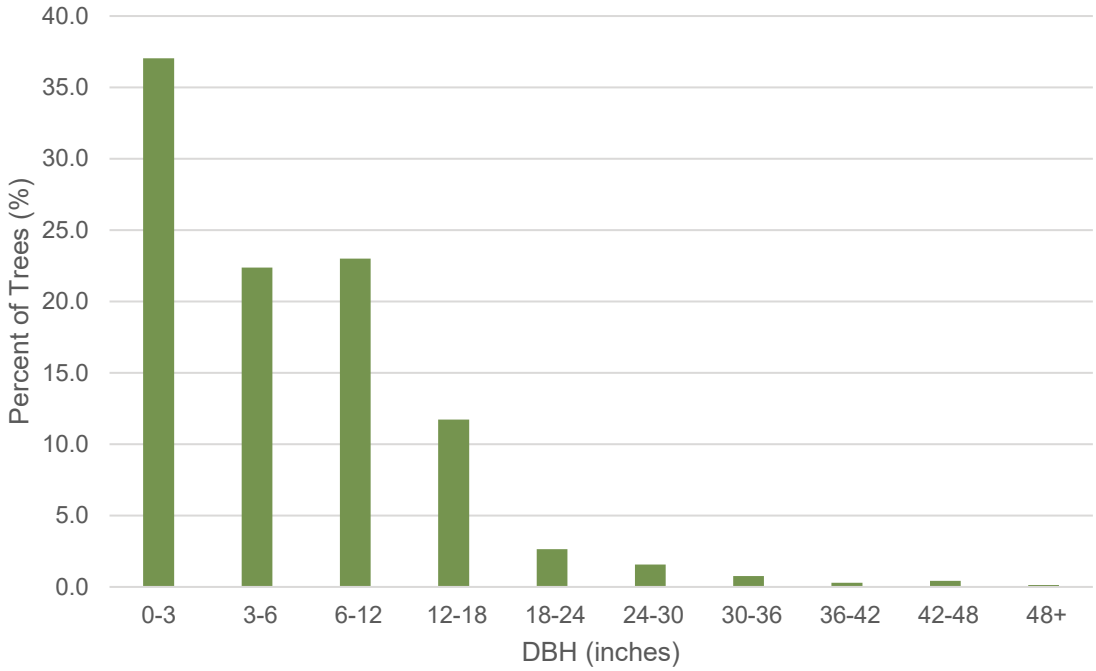


Figure 15. Diameter (DBH) distribution) of managed urban forest trees (without mangroves or natural/conservation areas).

Urban Forest Management Plan Performance Criteria

Species suitability for Tampa's climate zones

The species suitability for Tampa's climate zones criterion was designed to measure the suitability of Tampa's trees to the present urban and regional environment. Health, growth, and longevity of trees are dependent upon species-specific needs for water, sunlight, and appropriate temperature range. Tree suitability is calculated using research from University of Florida and U.S. Department of Agriculture – Forest Service. Results indicate that 66% of the tree species, comprising 71% of the leaf area, are well suited to Tampa's environment. Therefore, a "Moderate" rating is assigned to this vegetation resource performance criterion, unchanged since 2016 and 2011.

Table 4. Performance criteria related to species suitability.

Criteria	Vegetation Resource – Performance Indicators				Key Objective
	Low	Moderate	Good	Optimal	
Species suitability for Tampa's climate zones	Less than 50% of trees are of species considered suitable for Tampa.	**50%-75% of trees are of species considered suitable for Tampa. (11, 16)**	More than 75% of trees are of species considered suitable for Tampa.	At least 90% of the trees are of species suitable for Tampa.	Establish a tree population suitable for Tampa's urban environment and adapted to the regional environment.

Tree species diversity

Performance indicators for the tree species diversity criterion measure the variation in tree species found within Tampa's urban forest. A diverse urban forest, including genetic diversity, helps to protect against potentially catastrophic impacts associated with insect and disease infestation. Tree species diversity is calculated from collected field data and compared to general recommendations from the urban forestry profession. Results indicate that only white mangrove represents 21% of the total tree population in the City and the next most common species, cypress, represents 11% of the total population. Therefore, a "Good" rating is assigned to this vegetation resource performance criterion, unchanged since the rating in 2016.

Table 5. Performance criteria related to tree species diversity.

Criteria	Vegetation Resource – Performance Indicators				Key Objective
	Low	Moderate	Good	Optimal	
Tree species diversity	Fewer than five species dominate the entire tree population citywide.	No species represents more than 20% of the entire tree population citywide.	**No species represents more than 15% of the entire tree population citywide. (16)**	No species represent more than 10% of the entire tree population citywide. (11)	Establish a diverse tree population citywide.

Wind resistance of tree species citywide

The wind resistance for tree species citywide criterion was developed to measure the ability of the urban forest to withstand the strong winds associated with hurricanes and thunderstorms that frequent the region. Damage or loss during these storms increases costs and reduces the benefits to citizens. Wind resistance is calculated using research results from the University of Florida suggesting tree species resistance to wind damage (Duryea et al. 2007). Results indicate that 67% of trees are species with a high to medium-high wind resistance rating; and 32% of trees are species with a medium-low to low wind resistance. About half of Tampa's trees lack a wind resistance assignment for their species. Therefore, a "Moderate" rating is assigned to this vegetation resource performance criterion, unchanged since 2011.

Table 6. Performance criteria related to wind resistance.

Criteria	Vegetation Resource – Performance Indicators				Key Objective
	Low	Moderate	Good	Optimal	
Wind resistance of tree species citywide.	Majority of trees are rated in lowest category of wind resistance.	**Majority of trees are rated in medium and high categories of wind resistance. (11,16)**	Majority of trees are rated in high category of wind resistance.	Greater than 80% of trees are rated in highest category of wind resistance.	Reduce disruption of social and economic services; reduce cost of cleanup and protect private property and human well being.

Tree species longevity

Performance indicators for the tree species longevity criterion measure the percentage of tree species found within Tampa's urban forest considered to be long-lived. Trees that are long-lived help to reduce the high initial costs associated with planting and establishment, while often living out the latter part of their lives as relatively larger trees producing high levels of benefits for the community. For the purpose of this evaluation, trees considered long-lived have average life spans of greater than 125 years (Loehle 1987). They are expected to outlive the generation that plants them.

Results indicate that 26% of the total population of trees, comprising 51% of the leaf area, are considered long-lived. Therefore, a "Moderate" rating is assigned to this vegetation resource performance criterion, the same rating as 2016.

Table 7. Performance criteria related to tree species longevity.

Criteria	Vegetation Resource – Performance Indicators				Key Objective
	Low	Moderate	Good	Optimal	
Tree species longevity	Less than 25% of trees are of species considered long-lived for Tampa.	**25% to 49% of trees are of species considered long-lived for Tampa. (16)**	50%-75% of trees are of species considered long-lived for Tampa. (11)	More than 75% of trees are of species considered long-lived for Tampa.	Establish a long-lived tree population that maximizes benefits vs. costs.

Urban Forest Structure

Forest structure is the horizontal and vertical distribution of vegetation layers (trees, shrubs, and ground cover) in the forest. The City of Tampa's urban forest structure was determined by measuring and calculating various physical forest attributes such as: tree density, diameter distribution, vegetation cover, leaf area, and tree canopy health. Assessing the structure of a forest is critical for evaluating its ability to provide ecosystem services and perform ecological functions. In addition, these forest structure metrics provide important data that can be used to help drive urban forest management policies and laws.

Tree Density

Tree density is measured in number of trees per acre, which is a useful metric for characterizing tree abundance throughout the different land uses in this study. The citywide tree density average for Tampa was 138 trees/acre, which is comparable to the 112 trees/acre found in the similarly sized city of Atlanta, GA (estimated 9.4 million trees, 134 sq. miles). The mangrove land use area had the highest tree density in the City's urban forest with approximately 1,560 trees/acre (Figure 16). However, this is not surprising since mangroves form dense thickets of numerous small-diameter stems and are mainly limited to tidally influenced areas that occupy a small percentage (1.6%) of total City area. The natural/conservation lands had the second highest tree density value of 435 trees/acre and represent the naturally forested areas of the City that have not been greatly impacted from urbanization. In comparison, the Residential Single-Family land, which covers the most acreage 27%) and has the most tree species (72), has only 96 trees/acre. The lowest tree density values are found in the multi-family and public communications/utility land uses with 25 and 7 trees/acre respectively.

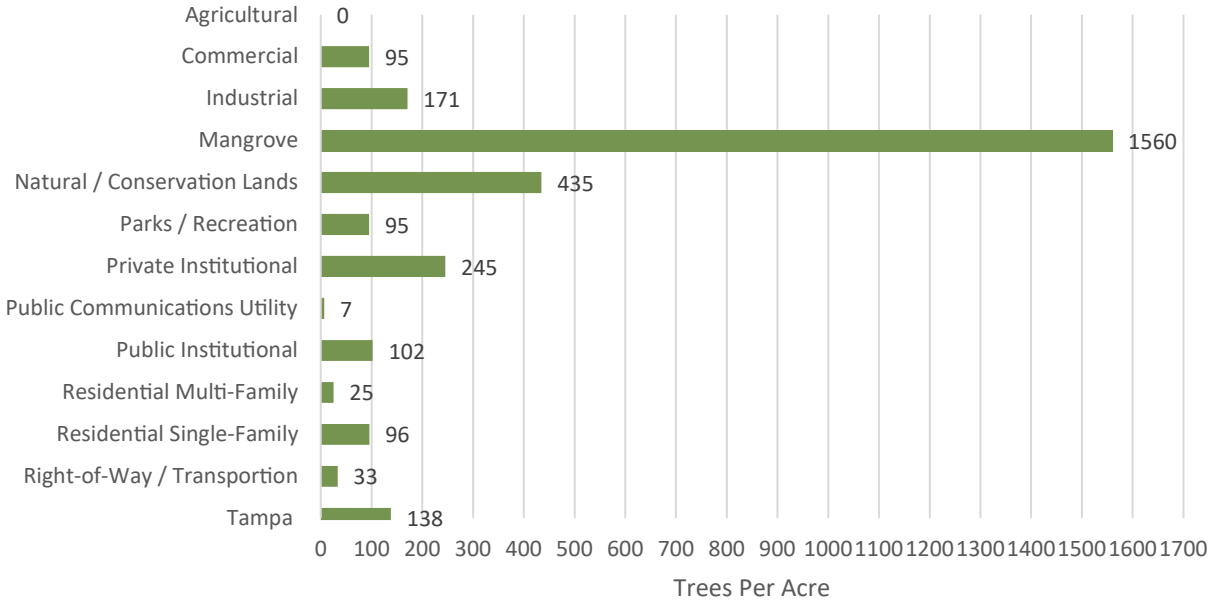


Figure 16. Average trees per acre for each land use in the City of Tampa. Note: Agricultural category is represented by only one sample plot.

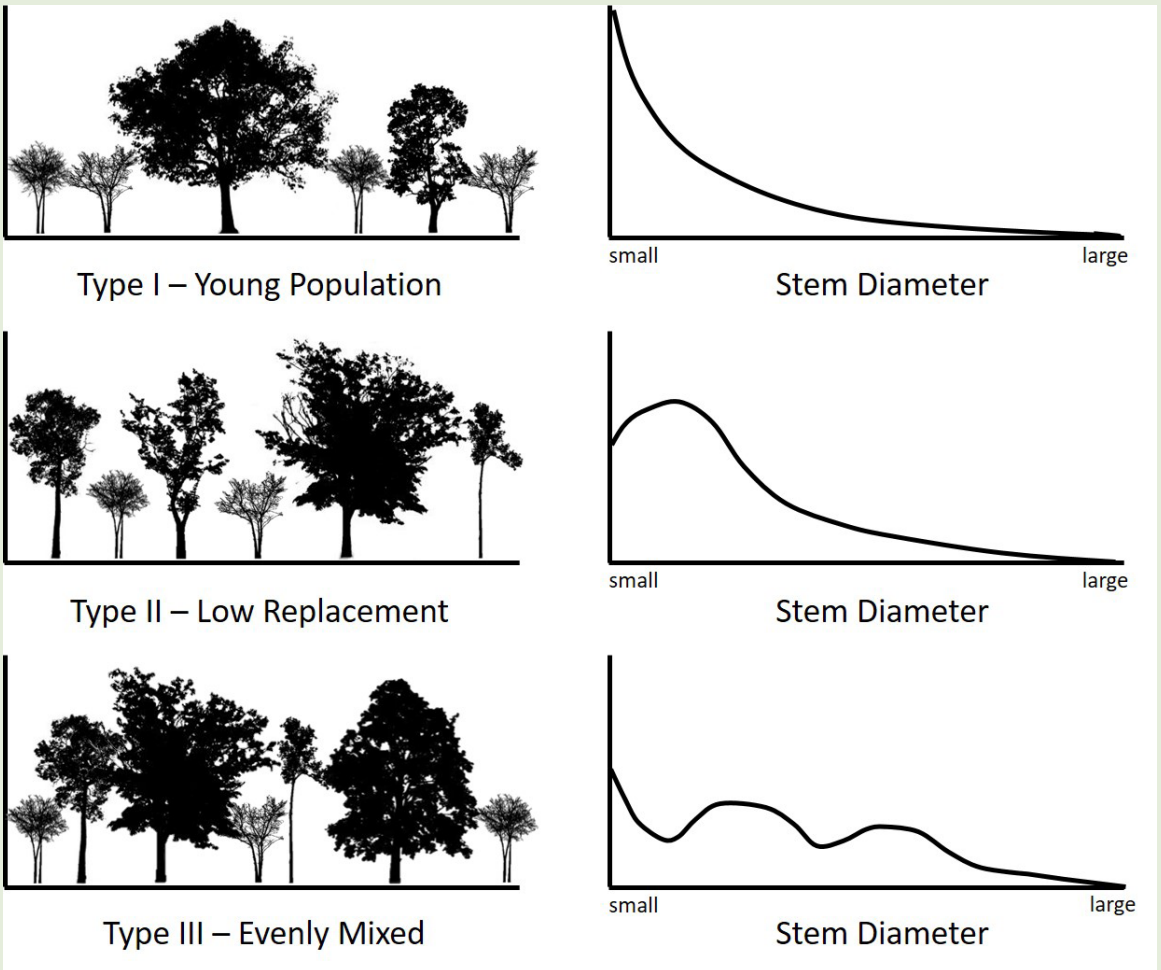
Tree Diameter Distribution

Tree diameter distribution is an important metric used by foresters to help estimate the relative age distribution of trees in the forest. As urban trees grow and increase in diameter, so do the ecosystem services they provide. Moreover, most of the net benefits (ecosystem services) received from an individual tree are not fully accounted until it reaches a mature size. However, this does not imply that forest managers want a tree population dominated by large diameter trees as this would have implications on the sustainability of the forest over time as these larger trees decline and die. Instead, a common goal most cities and foresters aim for is an uneven-aged distribution (i.e., a mix of young, mature, and older trees) in the tree population.

Explanation for Tree Diameter Distribution

Coniferous and broadleaf trees need to grow continuously to survive. As such, their stem diameters can be used to approximate tree age. Urban forest managers often look at the distribution of these diameters to make inferences regarding the age of their vegetative resource and the management implications associated with this information. In looking at Figures 17 and 18, we can see Tampa has a forest that most closely resembles Type - Young Population. This is an indication that there are many small trees present in the City (even when mangroves are excluded), with noticeably lower numbers of medium-to-large trees. Heightened planting efforts, the presence of dense thickets of invasive, small-diameter trees (e.g. Brazilian pepper), the relative newness of many developments, and removals related to tree safety and development likely all contribute to this pattern of stem diameters.

Figure 17. Forest Types.



The diameter distribution of Tampa's urban forest is skewed towards the smaller diameter classes (1 to 6 inches), accounting for 71% of the total tree population (Figure 18). Small diameter trees represent both understory or shrublike species and the future of Tampa's urban forest (i.e., young trees). White and black mangroves account for 35% and 12%, respectively of the 1 to 3-inch diameter class, which reflects the tendency for mangroves to form dense thickets of small-diameter stems. 63% of Brazilian peppertree, the most abundant exotic and invasive species, are found in the 1 to 3-inch diameter class. The 12 to 18-inch diameter class is dominated by cypress and cabbage palmetto, 27% and 23% of the size class, respectively. The largest size class, trees greater than 48 inches in diameter, only contains three species: cypress (*Taxodium* spp.), earpod tree (*Enterolobium cyclocarpum*), and live oak (*Quercus virginiana*).

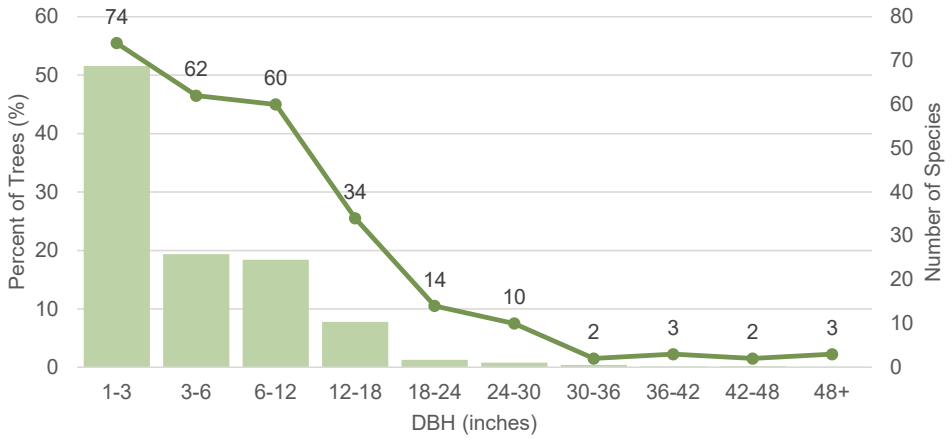


Figure 18. Tree diameter (DBH) distribution by diameter class (columns) with the number of species present in each class (line). Data include mangroves.

Leaf Area and Importance Values

Leaf area is the measure of the total green leaf surface area on a tree. This tree measurement is used in the i-Tree Eco model to estimate some of the ecosystems services (e.g., air pollution removal and avoided runoff) that the urban forest provides. The i-Tree Eco model calculates leaf area of individual tree species using regression equations for urban tree species and accounts for certain tree conditions (e.g., tree health and crown light exposure) that may impact this calculated metric (Nowak 1996).

When determining the relative importance of a species, context is important. Live oak (19%), laurel oak (16%), and cypress (16%) represent the top three species for leaf area, accounting for 48% of total leaf area in the City, despite being only 19% of the total estimated tree population (Figure 19). In contrast, white mangrove and Brazilian pepper represent 27% of the total estimated tree population (21% and 6% respectively) yet only contribute 6% to the total leaf area. For ecosystem services like avoided runoff, species with a higher relative proportion of leaf area are the species contributing the most.

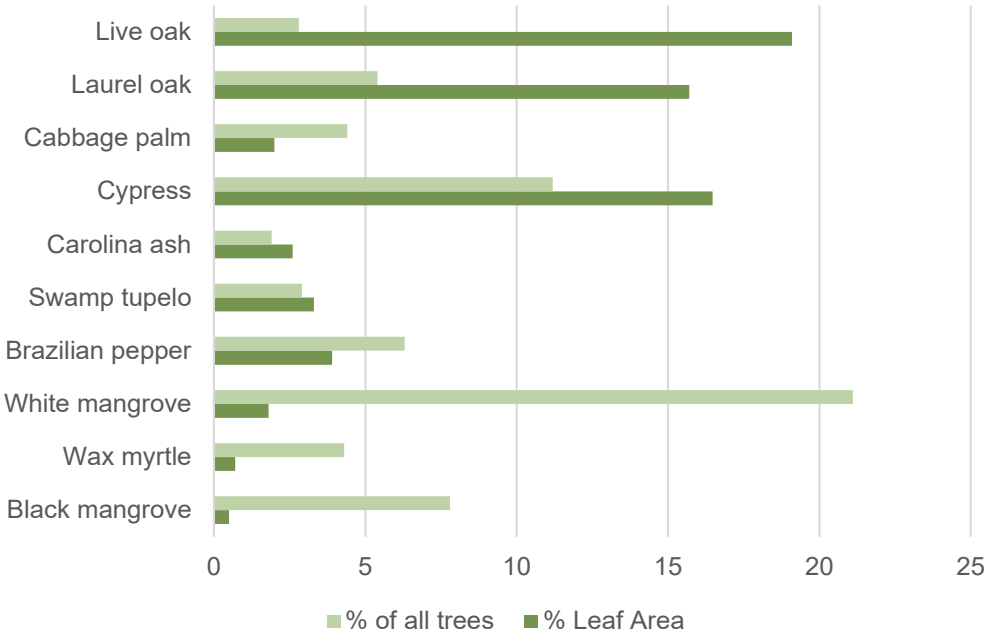


Figure 19. Percent leaf area and percent of total population of each species.

Canopy Health

The overall health of a forest is critical to understanding its functionality and ability to produce various ecosystem services. In this study, forest health was estimated by individual tree canopy condition ratings. In particular, tree canopy conditions were evaluated by rating the percentage of leaf dieback. These ratings are used to adjust estimates of carbon storage/sequestration and energy conservation (Nowak et al. 2008). Forest health was evaluated by land use category and for each of the City of Tampa's planning districts.

Citywide, 20% of the trees are considered to be in excellent health, 45% are in good health, 21% are in fair health, and the remaining 14% are considered to be in poor health condition or standing dead (Figure 20). The commercial, multi-family residential, mangrove, and public communications/utility land uses, had the greatest number of trees classified as having excellent crown condition. For the industrial, natural/conservation lands, public institutional, private institutional, parks and recreation, single-family, and right-of-way/transportation land uses, the majority of trees were classified with good crown conditions.

Forest Health was also evaluated by the City of Tampa's five planning districts (Figure 21). The South Tampa planning district has the highest percentage of healthy trees (excellent category) – 50%. In comparison, the New Tampa district represented the district with the lowest percentage of healthy trees with 5%. The Westshore TIA planning district had the highest percentage of poor to dead trees at 51%. Between 13 and 20% of the trees in the remaining three districts (Central Tampa, USF Institutional, and Westshore TIA) were considered to be healthy.

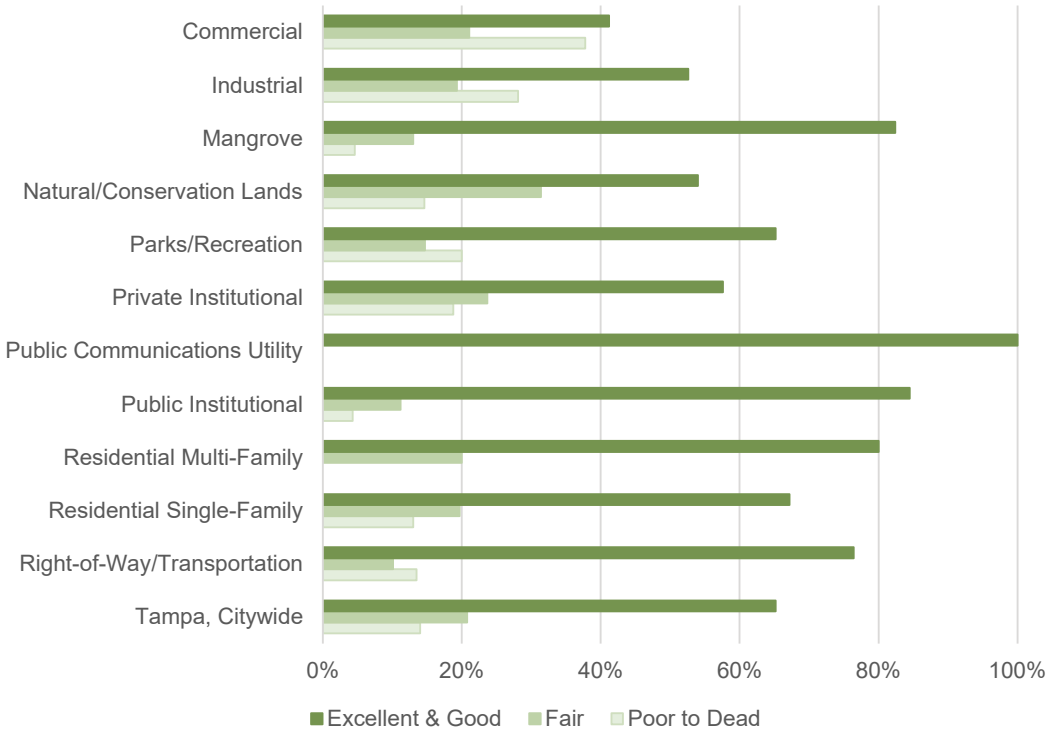


Figure 20. Tree health condition by land use.

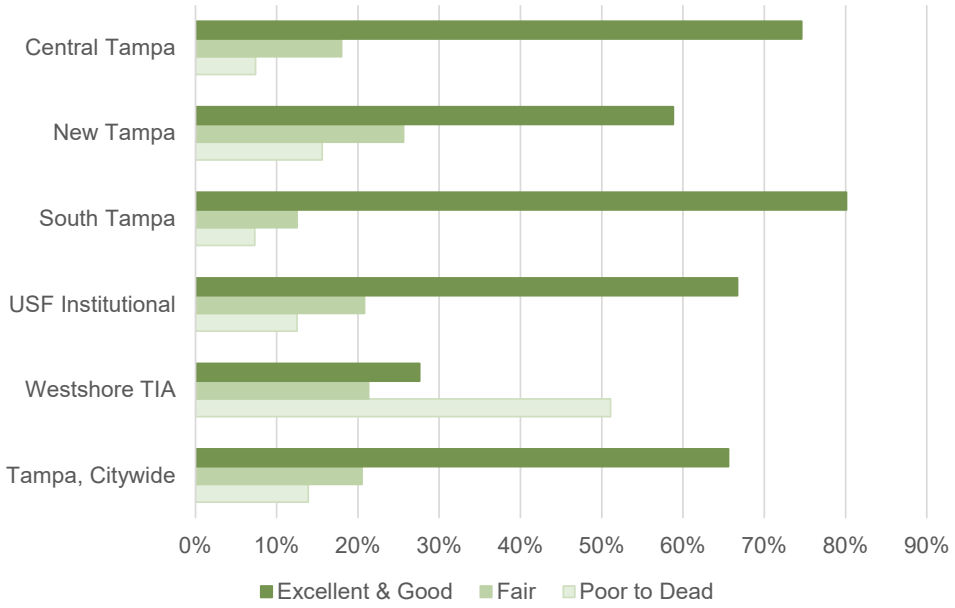


Figure 21. Tree health condition by City Planning District.

Shrub Cover

Percent shrub cover is an estimate of area that is covered by woody plants at least one foot in height and with less than one inch stem diameter. This is often an overlooked component of the urban forest, but shrubs do add to the overall species diversity and ecosystem services provided by the urban forest. For example, the additional leaf area provided by shrubs in areas where trees do not already exist can help increase pollution removal rates and decrease storm-water runoff amounts by intercepting more rainfall. That said, areas where trees are present over shrubs are simply designated as tree cover (their impacts are not additive).

In Tampa, the estimated shrub coverage throughout the City is approximately 12% (Figure 22) and is comprised of 145 different species (Figure 23). The highest shrub cover is found in the mangroves with 57% coverage distributed over 9 different species. By comparison, the Residential Single-Family areas (which are among the most treed) had only 13% shrub coverage. However, this area had over 85 different shrub species. The Natural/ Conservation Land areas, which represent more of the natural forested areas of the City, have 38% shrub coverage, comprised of 22 shrub species.

Ixora (*Ixora coccinea*) is an exotic shrub frequently used in landscapes.

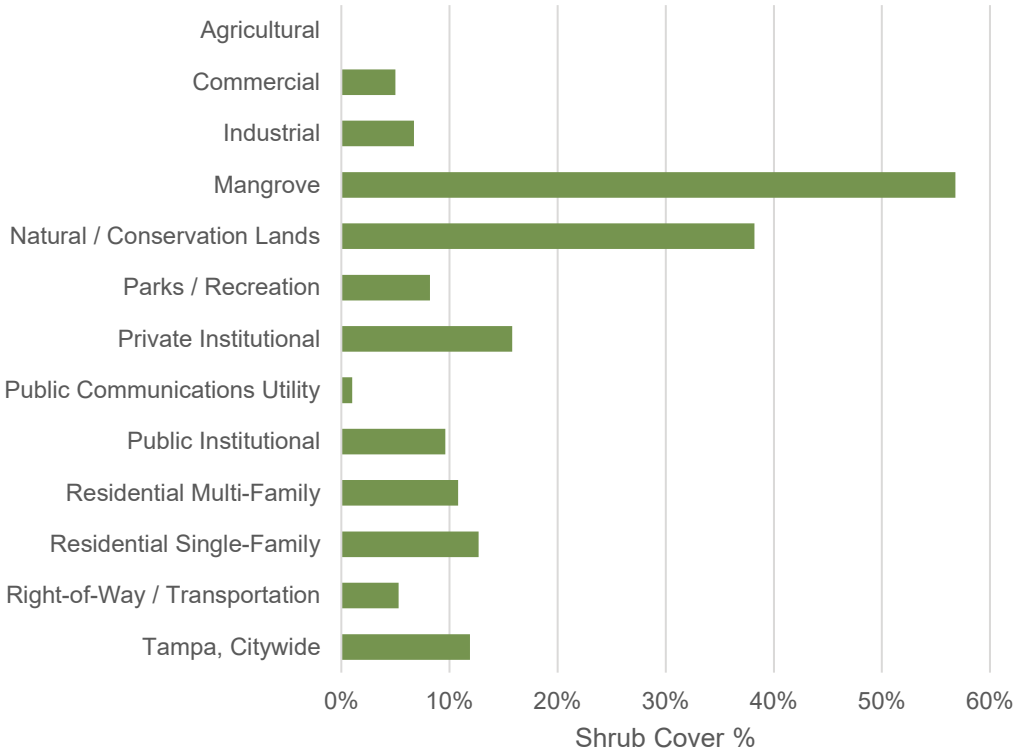


Figure 22. Percent shrub cover by land use. Note: Agricultural category is represented by only one sample plot.

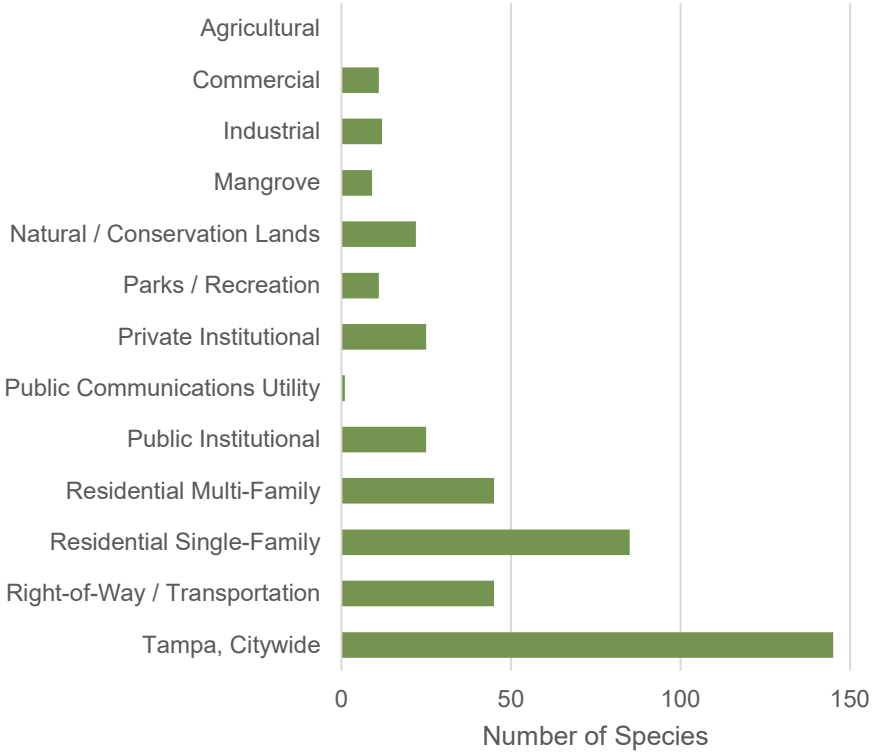


Figure 23. Number of shrub species present in each land use category. Note: Agricultural category is represented by only one sample plot.

Ground Cover

The ground cover stratum consists of a variety of surface types covering the ground including woody and herbaceous vegetation less than one foot tall. For this study, ground cover is divided into two broad categories: impervious (asphalt, cement, and buildings) and pervious (bare soil, leaf litter, herbaceous vegetation, maintained grass, rock, wild grass, and water) surfaces. In general, impervious surfaces result in rainwater being diverted as storm water runoff while pervious areas allow for rainwater infiltration into the soil. Urbanization of lands typically results in a greater percentage of impervious surface areas which have been documented to have numerous effects on natural hydrological processes (Shuster et al. 2005).

Based on the field sampling, which differs slightly from the land cover mapping, 36% percent of the ground cover in the City of Tampa is classified as impervious surfaces (Figure 24). However, three land use types had more than 50% impervious area each (Figure 25): Right-of-Way/Transportation (57%), Multi-Family Residential (56%), and Commercial (50%). In comparison, the Agricultural, Water, Mangrove, and Natural/Conservation Lands land use areas all contained 0% impervious surfaces.

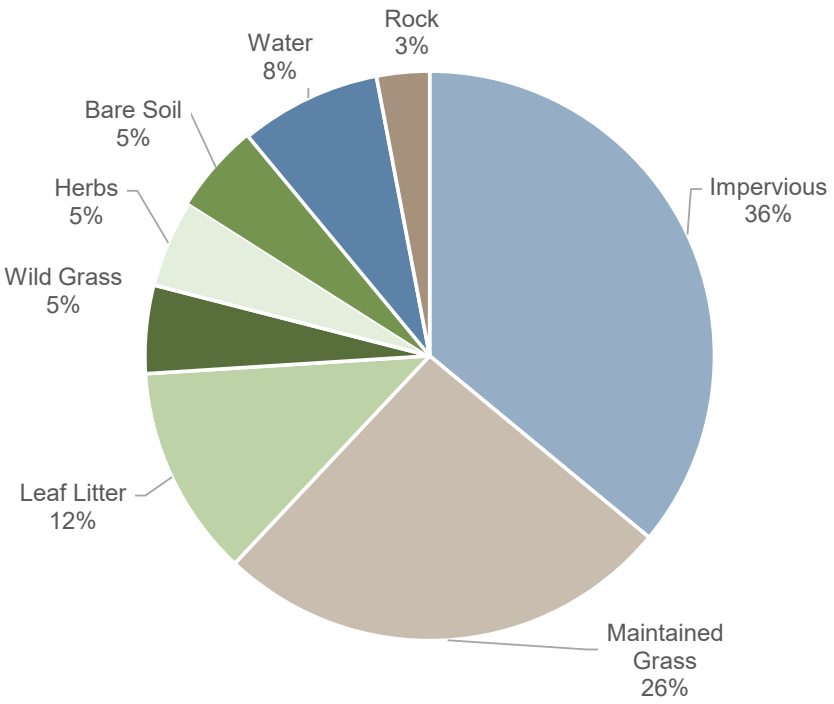


Figure 24. Distribution of ground cover types by percent in the City of Tampa.

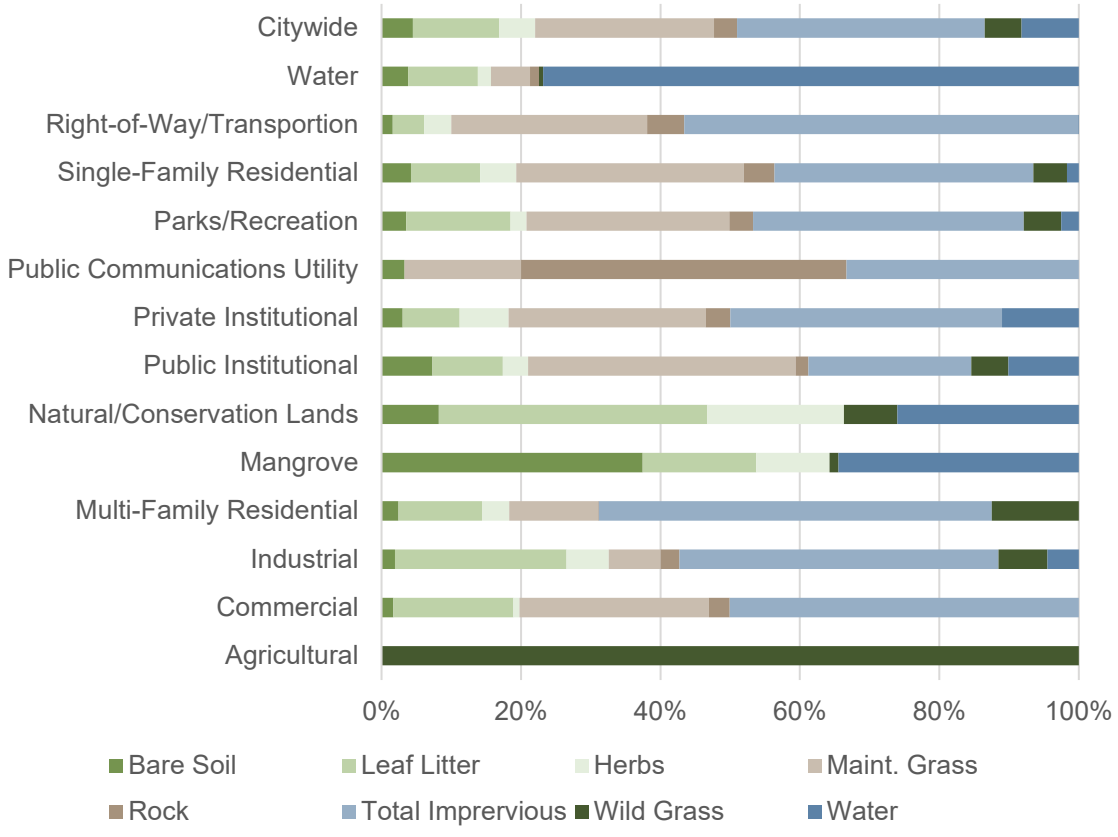


Figure 25. Proportional distribution of ground cover types by land use in the City of Tampa. Note: Agricultural category is represented by only one sample plot.

Urban Forest Management Plan Performance Criteria

Diameter (DBH) distribution of trees in the City

While it is not always possible to determine the exact age of trees, tree diameter often serves as proxy for guiding management decisions. With regard to sustainability, a mix of tree sizes/ages is desired to stagger losses associated with old age and decline. When assessing the diameter distribution in Tampa, relative diameter (RDBH) classes were calculated to account for differences in growth potential for small- and large-stature trees. The smallest RDBH class, trees with a DBH that is 0-25% of the maximum DBH, represented approximately 25% of the total tree population. The 25-50% RDBH class had the highest proportion of trees (53% of the population) while the 75-100% RDBH class had the lowest proportion of trees (9% of the population). Therefore, a “Moderate” rating is assigned to the diameter distribution of all trees in the city indicator.

Canopy health by municipal planning district

The tree health condition criteria were developed on the premise that healthy trees live longer, produce greater number of benefits, and reduce cost associated with maintenance. Healthy trees were defined as trees receiving an excellent canopy condition rating. Results indicate that all planning districts have at least 5.3% of trees have an excellent condition rating in them with a citywide average of 21.4% of trees in excellent condition. Therefore, a “Low” rating is assigned to this vegetation resource performance criteria in 2021, a decrease from 2016 and 2011. Hurricane Irma in 2017 may have contributed to this decline in canopy health from 2016 to 2017.

Table 8. Performance criteria related to urban forest structure.

Criteria	Vegetation Resource – Performance Indicators				Key Objective
	Low	Moderate	Good	Optimal	
Diameter (DBH) distribution of trees in the City	Any relative DBH (RDBH)i class (0%–25% RDBH, 26%–50% RDBH, etc.) represents more than 75% of the tree population.	**Any RDBH class represents between 50% and 75% of the tree population. (16)**	No RDBH class represents more than 50% of the tree population.	25% of the tree population is in each of four RDBH classes.	Provide for uneven aged distribution citywide.
Tree health condition by municipal planning district.	**Less than 30% of trees rated as excellent health condition.**	31%–60% of trees rated as excellent health condition. (11, 16)	61%–85% of trees rated as excellent health condition.	Greater than 85% of trees rated as excellent health condition in all municipal planning districts.	Healthy trees live longer, produce greater no. of benefits and reduce costs associated with maintenance.

Tree Canopy Change Analysis

Tree Canopy Change 1973–2021

One indicator of whether the City of Tampa Urban Forest Management Plan and land development policies are having the desired effect is to accurately measure how tree canopy cover has changed over recent years. Tree canopy change was estimated using the dot-based method described in the project methods section. Aerial images from 1973, 1995, 2006, 2011, 2016 and 2021 were used to estimate tree canopy cover for each of those years. The current (i.e., 2021) City boundary was used for all years, even though most of the New Tampa area was not annexed into Tampa until the 1980s. Statistical uncertainty with each estimate was calculated as the 95% confidence interval and tells us if the amount of canopy between two years is statistically different. It should be noted that the 20+ year jump from the 1973 to the 1995 analysis was due to an inability to find usable aerial images from the 1980s.

Citywide

To estimate citywide tree canopy cover change, two separate technicians independently reviewed aerial images from 1973, 1995, 2006, 2011, 2016 and 2021 using the dot-based method. To eliminate potential error introduced by a single technician, the only points included in these results were the ones where both technicians agreed on the interpretation. Tree Canopy was calculated using 8,813 points for 2021, 4,199 points for 2016, 1,890 points for 2011, 1,864 points for 2006, 8,107 points in 1995, and 8637 points from 1973. More points were used for the 2021 and 2016 estimates to reduce measurement uncertainty (i.e., 95% confidence interval) from the change estimates, while more points were used in 1973 and 1995 due to the lower resolution of the imagery.

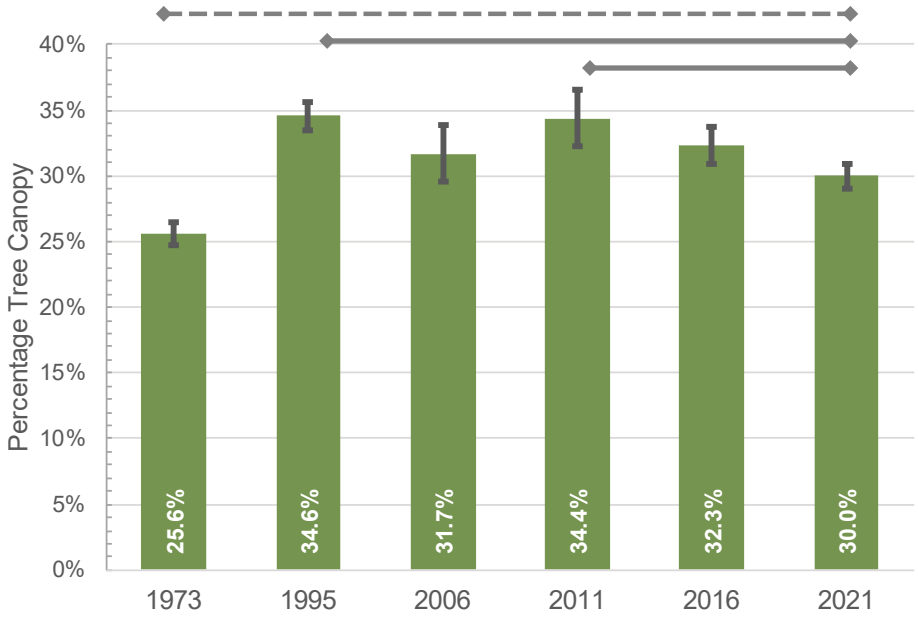


Figure 26. Citywide Tree Canopy Change 1973-2021. Error bars show 95% confidence interval. Horizontal grey lines indicate a statistically significant change between two years (i.e., between 1995-2021, and between 2011-2021. Dashed line shows that 1973 tree canopy was significantly lower than all subsequent years.

Results indicate that the average citywide tree cover was lower in 1973 (25.6%) than in all subsequent years. Within the twenty-two years between 1973 and 1995, there was a substantial increase in tree canopy. Several important factors could explain that large increase. First, in 1973, Tampa adopted its first comprehensive landscape, tree protection and site clearing regulations (Ords. 5670-A, 5677-A, 5712-A). The new regulations likely limited the amount of tree/canopy loss after 1973. A second, fairly obvious explanation for the increase between 1973 and 1995 was the development of the New Tampa area (i.e., neighborhoods north of Fletcher Ave.). As shown in Figure 27, most of the pre-development New Tampa land area was a mix of wetlands and upland pine flatwoods or rangeland with very sparse tree cover. Since the neighborhoods were developed on the uplands, the trees planted as part of typical landscaping during housing development would have matured into an extensive tree canopy cover that had not historically been part of that ecosystem. Similarly, newly developed neighborhoods near MacDill Air Force Base (Figure28#) and large areas of the A.F.B. property itself has very sparse tree cover in 1973 compared to recent years.

Figure 27. Illustration of pre-development to post-development tree canopy in the New Tampa area. Aerial image from 1973 shows pine flatwoods or rangeland with sparse tree canopy compared to the same area post-development where neighborhoods have abundant trees (2021).

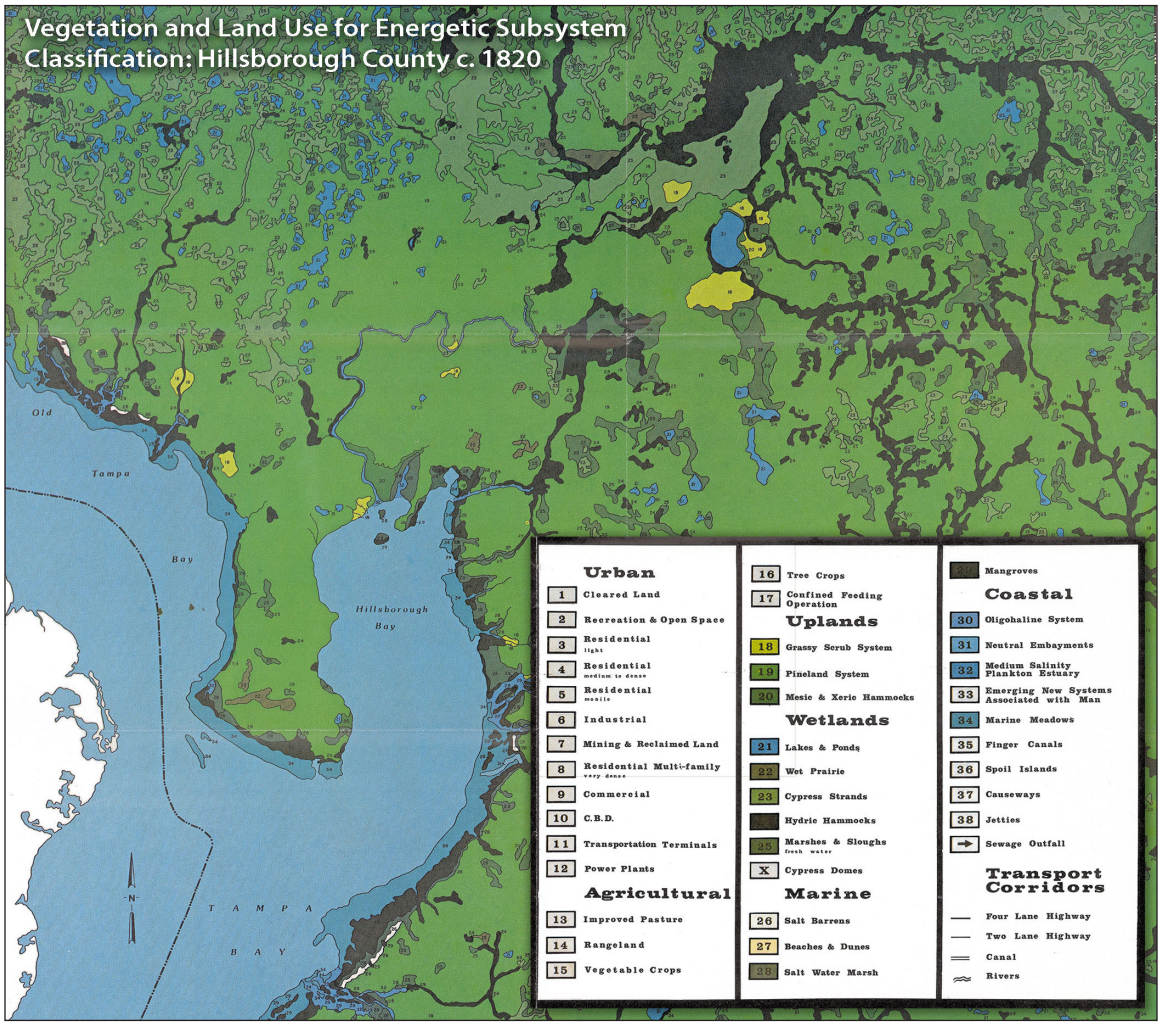
Figure 28. Illustration of tree canopy increase since 1973 in the MacDill A.F.B. area of South Tampa. The aerial image from 1973 shows newly developed neighborhoods with sparse tree canopy as well as large areas of the MacDill A.F.B property (e.g., left of the runway) where trees have grown since 1973.

Tree canopy decreased from 34.6% in 1995 to 31.7% in 2006, then increased to a 26-year high of 34.4% in 2011. Tree canopy then decreased to 32.3% in 2016 and decreased further to 30.0% in 2021. In 2021, the percentage of Citywide tree canopy was the lowest amount within the past 26 years (since 1995).

There is a level of uncertainty associated with all scientific measurements. In statistical terms, the error associated with the estimates (i.e., confidence intervals) show that the 30.0% tree canopy for 2021 has a 95% probability of being as low as 29.0% or as high as 31.0%, while the 2016 estimate has a 95% probability of being as low as 30.9% (a slightly overlap of 0.1%). Statistical comparison using 94% confidence intervals result in no overlap between 2021 and 2016 estimates. After considering statistical estimates of possible measurement error, results show a 94% certainty of tree canopy decline from 2016 to 2021, and a 99% certainty of tree canopy decline from 2011 to 2021, and from 1995 to 2021.

The decline in tree canopy between 2016 and 2021 is equal to a loss of approximately 1,729 acres of trees. To add perspective to this number, the tree canopy loss between 2016 and 2021 is roughly the equivalent to clearing of land in an area twice the size of Davis Islands, twice the area of the USF campus, more than 13 Al Lopez Parks, or 2.5 times the area of Downtown including Channelside.

The loss of tree canopy since 2011 is over 3,300 acres, an area roughly the size of clearing land in four Davis Islands, five Downtown areas, 25 Al Lopez Parks, 3.7 USF campus', or over 1,325 time the area of the Raymond James Stadium field where the Tampa Bay Buccaneers play football.



A map developed to estimate circa 1820 vegetation and land use in Hillsborough County shows that Tampa was likely covered by extensive pine forests (Lee 1979)

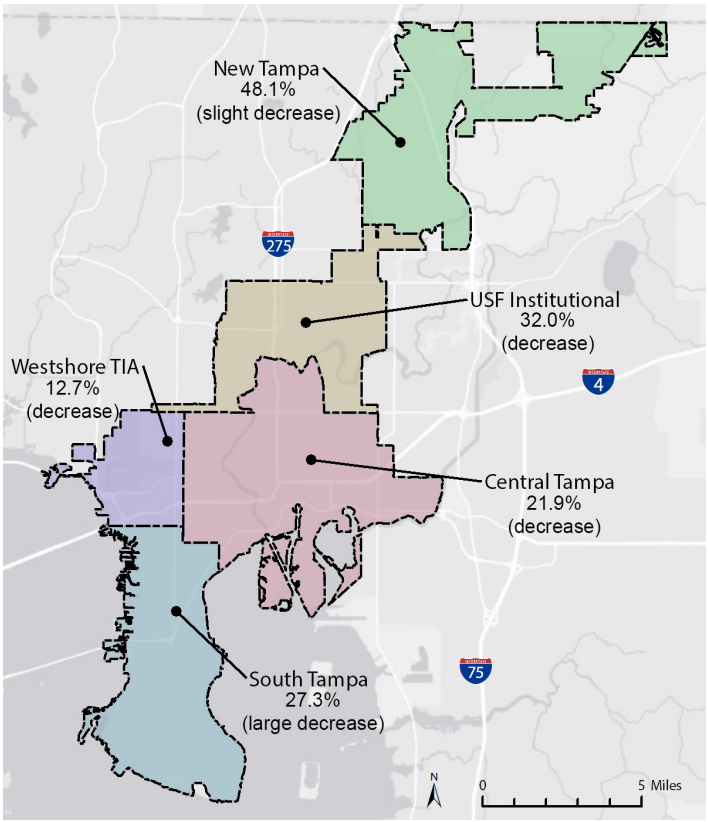


Figure 29. City of Tampa Planning Districts.

Planning District

The dot-based method was also used to estimate change in tree canopy for the five Planning Districts within the City of Tampa. A total of 8,813 random points, distributed within the Districts, were evaluated for 1973, 1995, 2006, 2011, 2016 and 2021.

The graph shows the average tree canopy cover for 1973, 1995, 2006, 2011, 2016 and 2021 for each of the five Planning Districts. The error bars on the graph and the numbers in the table show the 95% confidence interval of the estimates. The confidence estimates are a scientific way of showing the uncertainty in the change analysis.

Results for all Planning Districts show decreases in tree canopy from 1995 to 2006, increases in tree canopy from 2006 to 2011 and 2016, but then a decrease in canopy between 2016 and 2021. When we consider the 95% confidence interval of the estimates, the decrease in tree canopy between 2016 and 2021 in New Tampa, USF Institutional and Westshore TIA Planning Districts were alarming, but not statistically significant. The decrease in tree canopy between 1995 and 2021 is statistically significant in USF Institutional, and there was a statistically significant decline in New Tampa between 1995 and 2006 that has since somewhat recovered. Tree canopy in the USF Institutional and Westshore TIA Planning Districts has essentially returned to the amount that existed in 2006, while New Tampa tree canopy remains closer to the slightly higher levels in 2011 and 2016.

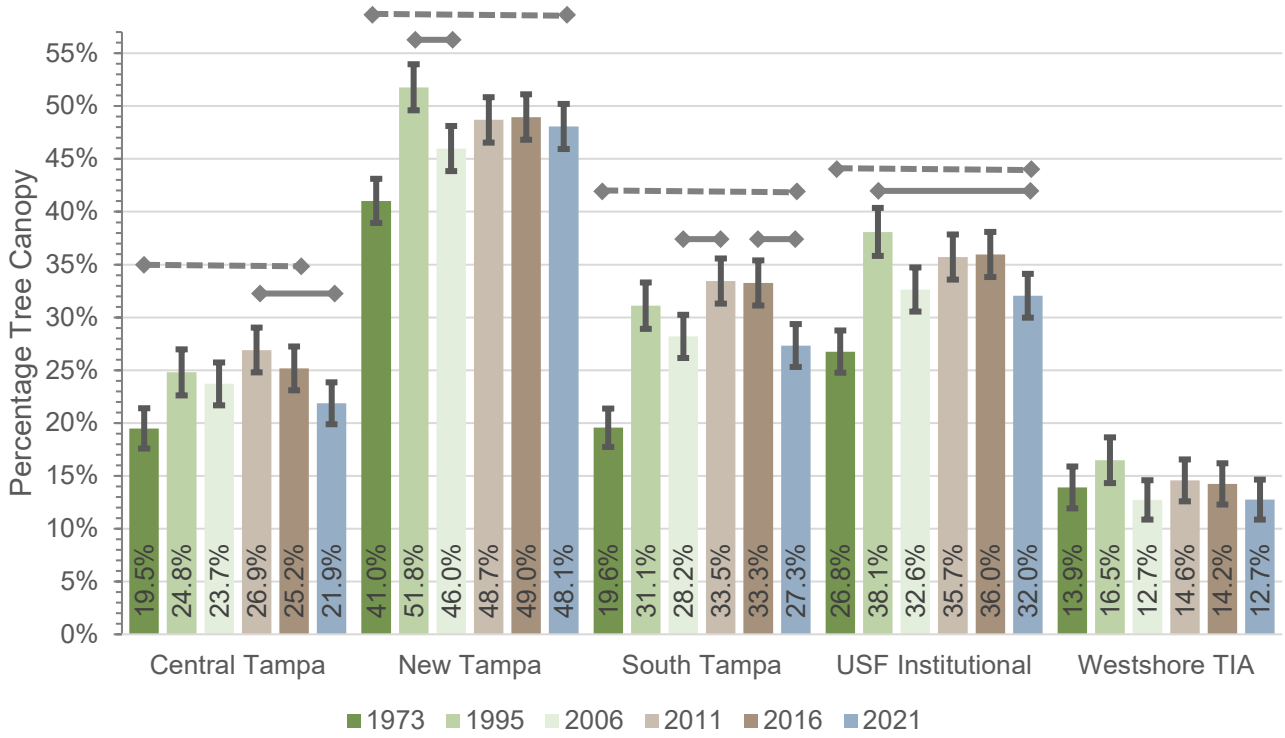


Figure 30. Planning District Tree Canopy Change 1973-2021. Horizontal grey lines indicate a statistically significant change between two years. Dashed line shows that 1973 tree canopy was significantly lower most subsequent years in several of the Planning Districts.

In South Tampa, even considering the uncertainty of the analysis, there has been a statistically significant decline in tree canopy between 2016 and 2021. In fact, 2021 tree canopy in South Tampa is slightly lower than it was in 2006 and 1995; the lowest percentage of tree canopy in the past 26 years.

In Central Tampa, we cannot say with absolute certainty that the decline in tree canopy between 2016 and 2021 was statistically significant, but there was a statistically significant decrease in canopy between 2011 and 2021. Similar to the results from South Tampa, the 2021 tree canopy in Central Tampa was lower than it was in 2006 and 1995.

Table 9. Canopy cover estimates by Planning District using dot-based method. Values represent the 95% confidence interval of each estimate.

Planning District	1973	1995	2006	2011	2016	2021
Central Tampa	17.6 - 21.4%	22.6 - 27.0%	21.7 - 25.7%	24.8 - 29.0%	23.2 - 27.2%	19.9 - 23.8%
New Tampa	38.9 - 43.1%	49.5 - 54.0%	43.9 - 48.1%	46.6 - 50.8%	46.9 - 51.0%	45.9 - 50.2%
South Tampa	17.7 - 21.4%	28.9 - 33.3%	26.2 - 30.2%	31.4 - 35.5%	31.2 - 35.3%	25.3 - 29.4%
USF Institutional	24.8 - 28.5%	35.8 - 40.4%	30.6 - 34.7%	33.6 - 37.7%	33.9 - 38.0%	30.0 - 34.1%
Westshore TIA	11.9 - 15.9%	14.3 - 18.7%	10.9 - 14.6%	12.6 - 16.5%	12.3 - 16.2%	10.9 - 14.5%

Urban Forest Management Plan Performance Criteria

Canopy cover relative to goals by municipal planning district

The City of Tampa Urban Forest Management Plan recommends “No net loss of canopy cover by municipal Planning District” as a performance criterion for the vegetation resource. This report will interpret the criteria “Canopy cover relative to goals by municipal Planning District” as the percentage of planning districts that did not have loss of canopy cover.

Results indicate that there was a statistically significant loss of tree canopy within the South Tampa Planning District between 2016 and 2021, and a statistically significant decrease in Central Tampa between 2011 and 2021. Based on these results, only three out of the five Planning Districts achieved the goals of no net loss (i.e., 60% of Districts). Therefore, a rating of only “Good” is assigned to the Canopy cover performance criterion, representing in a decline from the Optimal rating assigned in 2016.

Table 10. Performance criteria related to canopy cover goals.

Criteria	Vegetation Resource – Performance Indicators				Key Objective
	Low	Moderate	Good	Optimal	
Canopy cover relative to goals by municipal planning district	The existing canopy cover equals 0%–25% of the goal.	The existing canopy cover equals 25%–50% of the goal.	**The existing canopy cover equals 50%–75% of the goal.**	The existing canopy cover equals 75%–100% of the goal. (16)	Relative canopy cover to goal for each municipal planning district category. The goal is defined as no net loss in a Planning District.

City Council District

The dot-based method was also used to estimate change in tree canopy for each of the City Council Districts within the City of Tampa. The same random points evaluated for the Planning Districts were assigned to the appropriate City Council District based on geographic location. Since the boundaries were identical, the results from the citywide canopy change were used for the three At-Large Districts (i.e., Districts 1-3).

Results showed that tree canopy in 1973 was statistically significantly lower than all subsequent years for City Council Districts 4, 7 and At-Large. 1973 tree canopy was also lower than all years for Districts 5 and 6, but the differences was not statistically significant for all years. Similar to the Citywide tree canopy change results, the 2021 tree canopy was lower than it was in 1995 for all City Council Districts (Figure 32). However, the difference between 1995 and 2021 was not statistically significant for District 4.

In District 4, tree canopy decreased from 1995 to 2006, increased from 2006 to 2011, remained nearly the same in 2016, but then had a statistically significant decrease between 2016 and 2021. District 4 tree canopy was slightly lower in 2021 than it was in 1995 and 2006.

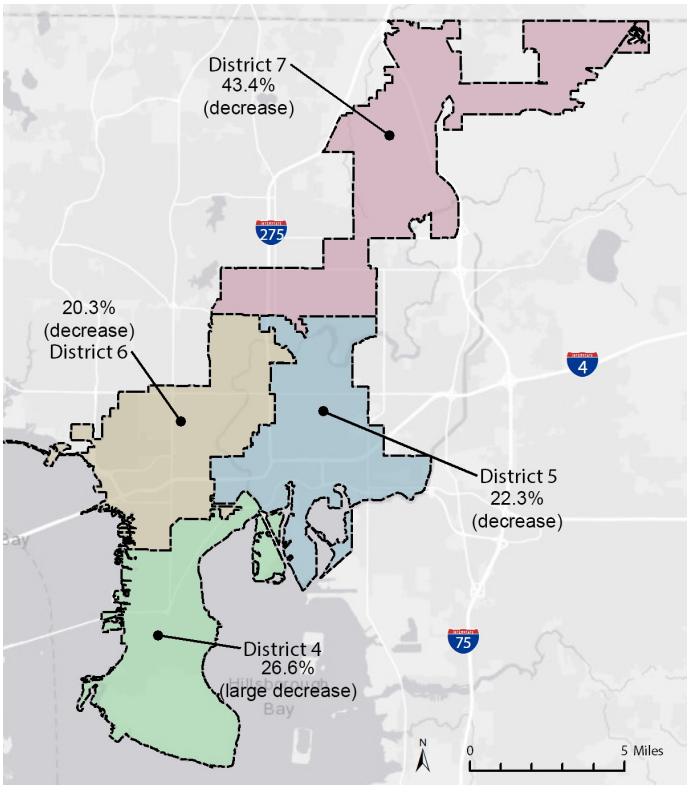


Figure 31. Tampa City Council Districts.

In Districts 5 and 6, tree canopy increased from 1973 to 1995, decreased from 1995 to 2006, increased from 2006 to 2011, but then decreased between 2011 and 2016, and declined further by 2021. In District 7, the tree canopy cover decreased from 1995 to 2006, increased slightly each year between 2006 to 2016, and decreased slightly in 2021. Finally, the tree canopy change in the At-Large Districts was the same as citywide change: a decline from 1995 to 2006, slight increase from 2006 to 2011, followed by slight decrease in 2016 and another decline in 2021.

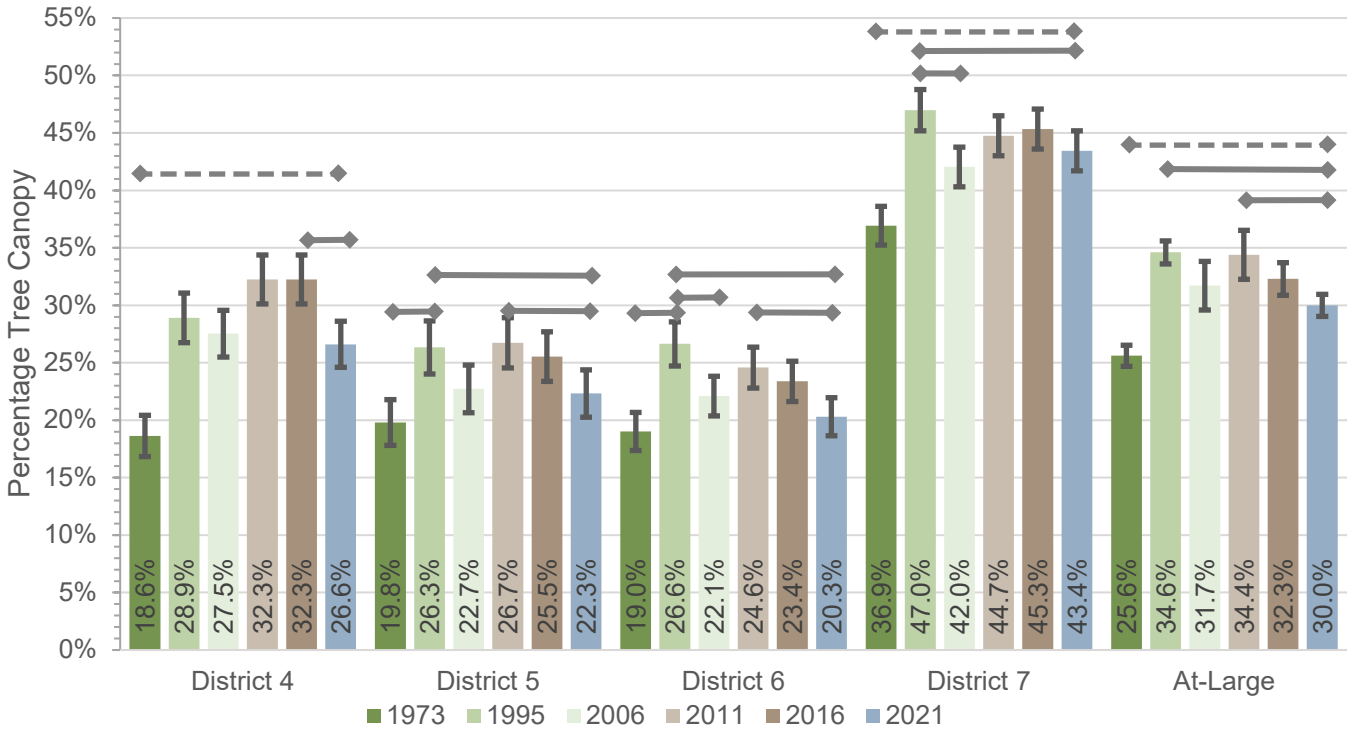


Figure 32. City Council District Tree Canopy Change 1973-2021. Horizontal grey lines indicate a statistically significant change between two years. Dashed line shows that 1973 tree canopy was significantly lower most subsequent years in several of the City Council Districts.

Table 11. Canopy cover estimates by City Council District using dot-based method. Values represent the 95% confidence interval of each estimate

City Council District	1973	1995	2006	2011	2016	2021
District 4	16.8 - 20.4%	26.7 - 31.1%	25.6 - 29.5%	30.2 - 34.3%	30.2 - 34.3%	24.6 - 28.6%
District 5	17.8 - 21.8%	24.9 - 28.6%	20.7 - 24.7%	24.6 - 28.9%	23.4 - 27.6%	20.3 - 24.4%
District 6	17.4 - 20.7%	24.7 - 28.6%	20.4 - 23.8%	22.8 - 26.3%	21.7 - 25.1%	18.6 - 22.0%
District 7	35.2 - 38.6%	45.2 - 48.8%	40.4 - 43.7%	43.1 - 46.4%	43.7 - 47.0%	41.7 - 45.2%
At-Large (Districts 1,2,3)	24.7 - 26.5%	33.5 - 35.6%	29.6 - 33.8%	32.2 - 36.5%	30.9 - 33.7%	29.7 - 31.5%

Tree Canopy Mapping

Tree canopy mapping was conducted using advanced remote sensing techniques and six-inch resolution aerial imagery from 2021. Seven categories of land cover were mapped, including: tree canopy, grass/shrub (i.e., other vegetation), bare earth, building, roads, other impervious surfaces (e.g., sidewalks, driveways, parking lots), and water. All results are based on the jurisdictional area within the City of Tampa that excludes the open water of Tampa Bay, a total of 75,288 acres. The final canopy maps were determined to be 93% accurate based on a detailed assessment. In contrast to the tree canopy change analysis, urban tree canopy mapping shows us how existing tree canopy is distributed for each property parcel, categories of future land use and zoning, and within each neighborhood association. Given the methods used, canopy coverage can be broken down in nearly any imaginable way, allowing Tampa to conduct additional assessments not detailed in this report should the need arise.

The following pages show maps of tree canopy and the other land cover categories for each Planning District. Maps of the tree canopy and grass/shrub land covers show the distribution of vegetation throughout the City. It is important to understand that even in areas with a low amount of existing tree canopy, there is usually a potential for planting more trees. Areas of grass/shrub and bare earth represent a substantial area of land outside of buildings and other impervious surfaces that could be used to increase tree canopy. In the section of this report called Potential Planting Area, these areas of possible tree canopy are further analyzed to consider the minimum size of locations suitable for planting a tree.

Comparisons between 2016 and 2021 land cover are included in subsequent sections to show the change in tree canopy, grass/shrub, and impervious surfaces within existing and future land use categories, zoning districts and special districts, and neighborhoods.

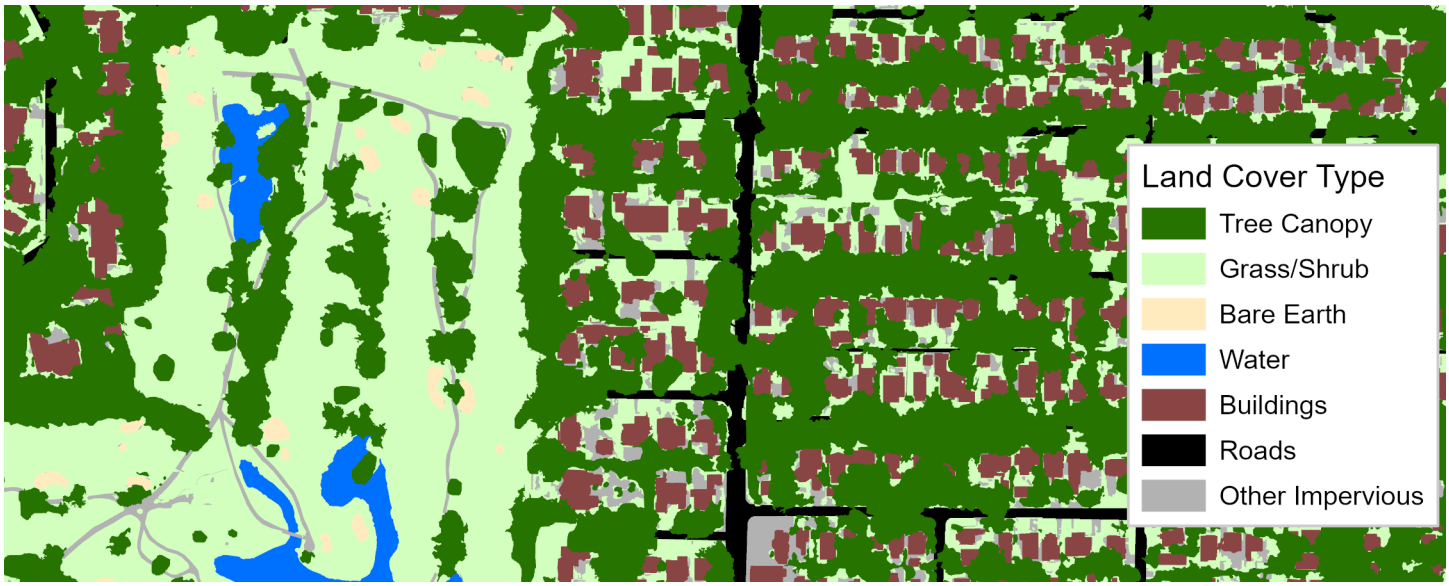


Figure 33. Example land cover map.

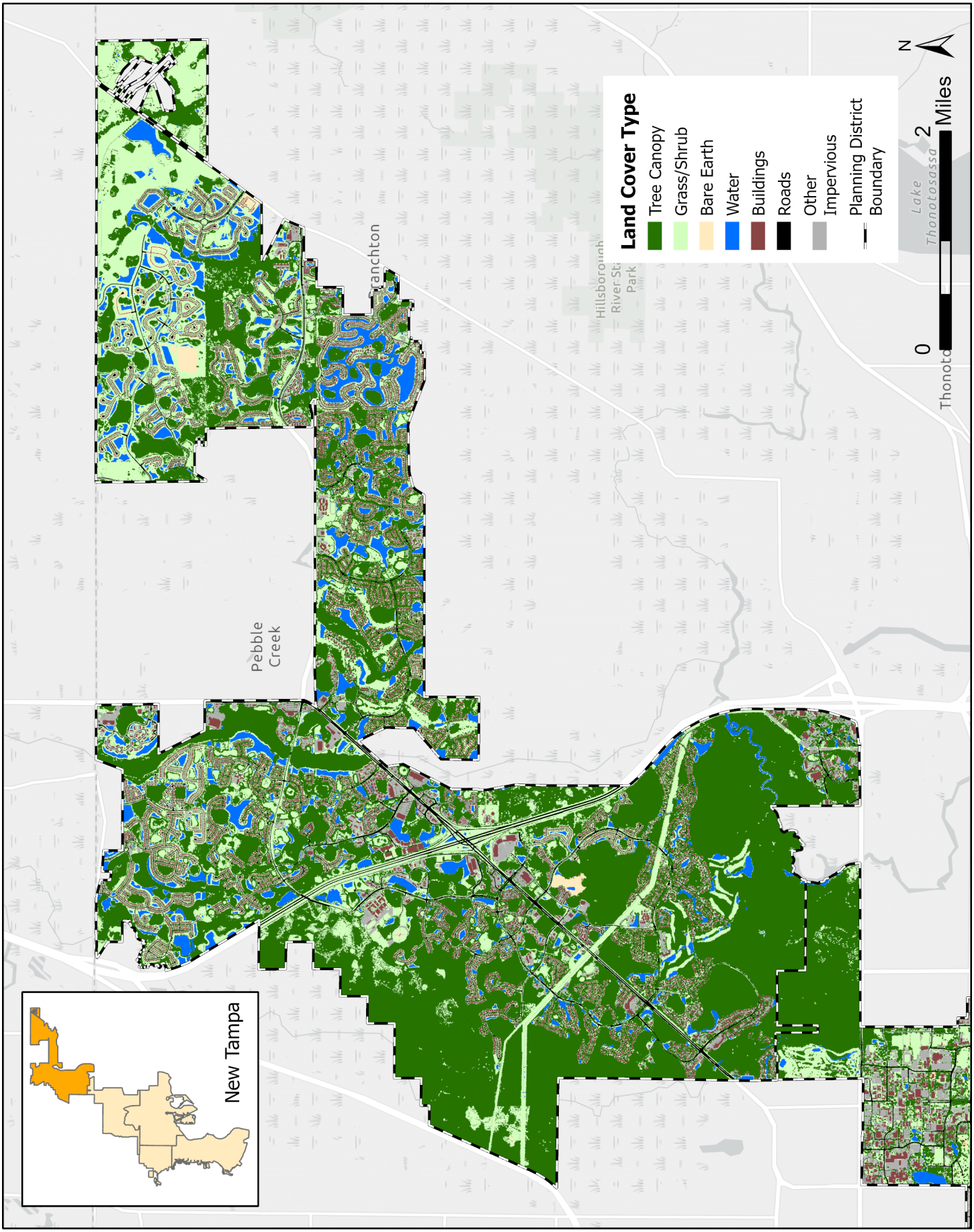


Figure 34. New Tampa land cover in 2021. Tree canopy was 49.0% based on the Change Analysis.

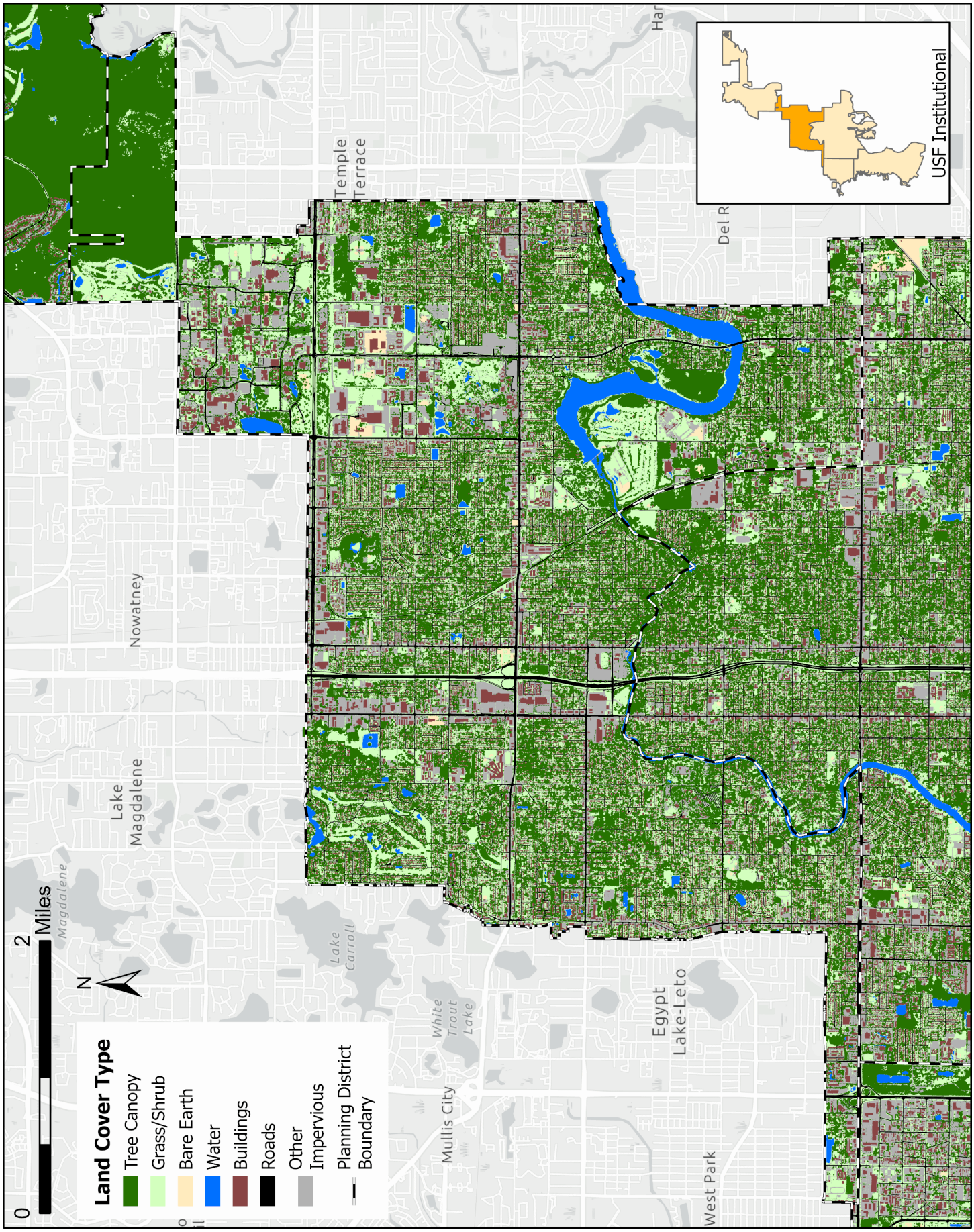


Figure 35. USF Institutional land cover in 2021. Tree canopy was 32.0% based on the Change Analysis.

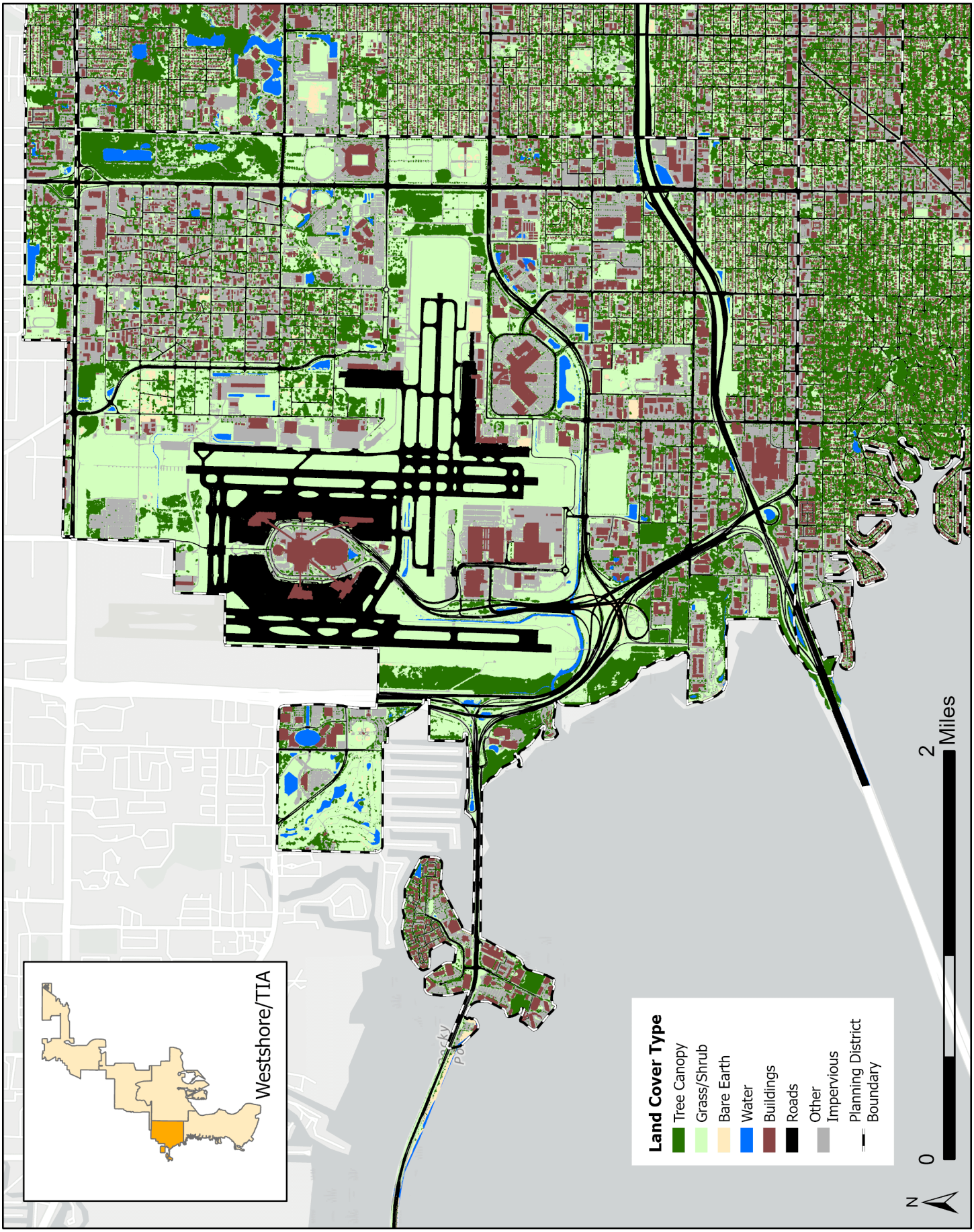


Figure 36. Westshore TIA land cover in 2021. Tree canopy was 12.7% based on the Change Analysis.

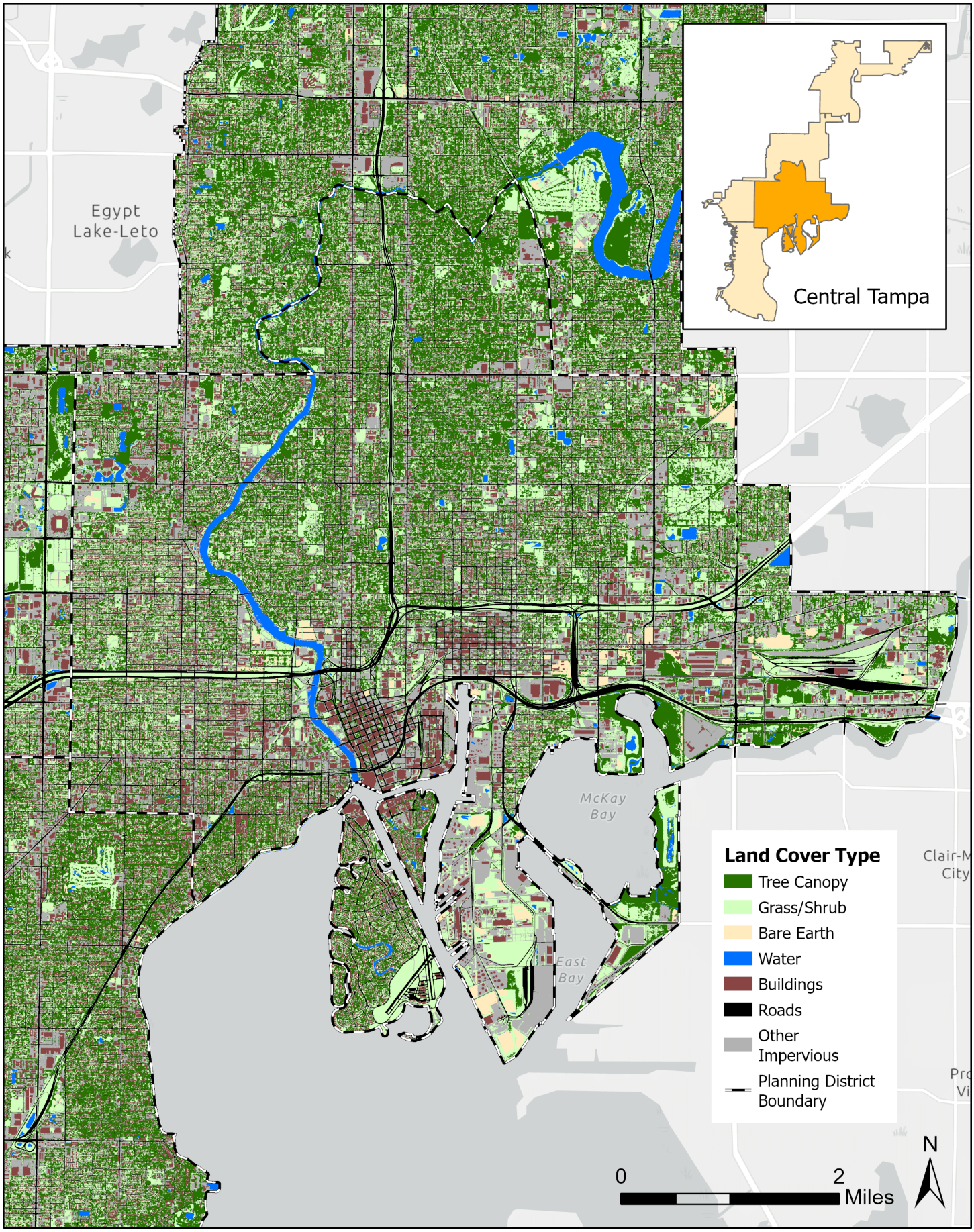


Figure 37. Central Tampa land cover in 2021. Tree canopy was 21.9% based on the Change Analysis.

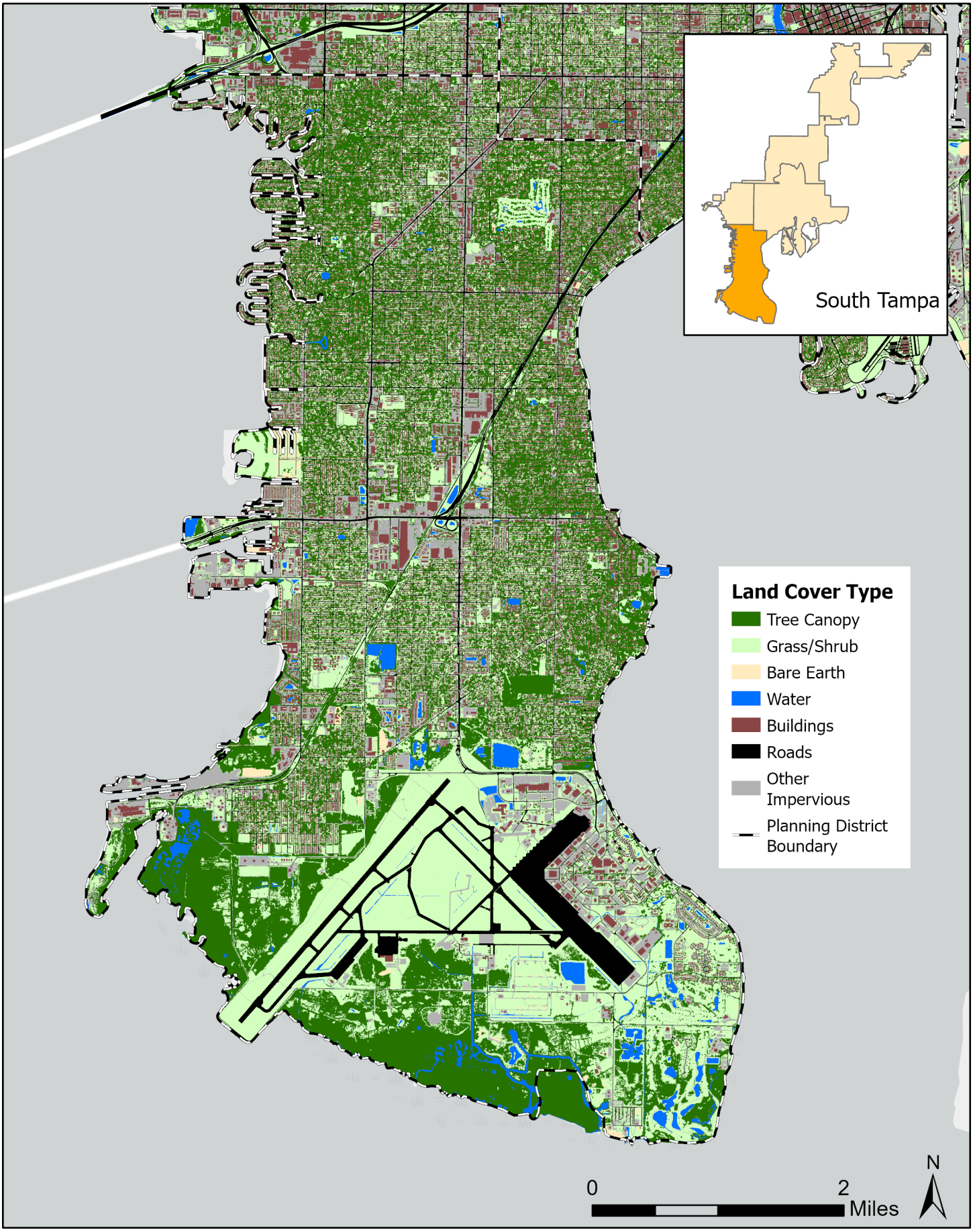


Figure 38. South Tampa land cover in 2021. Tree canopy was 27.3% based on the Change Analysis.

Land Cover by Current Use of Land

As described in the project methods, a customized stratification system was used to maximize the accuracy of extrapolated results from the field sampling of urban forest plots. Land use, for this section, represents how land was actually being used as of 2021 based on field sampling and tree mapping. The terms used should not be confused with regulatory designations such as zoning or future land use.

The table below summarizes 2016 and 2021 tree canopy, grass/shrub and impervious land cover classes within each current use of land category (buildings, roads and other impervious are combined in a single impervious category). In order to provide a meaningful comparison based on current categories of land use, the amount of 2016 canopy, grass/shrub or impervious within a category is based on the acreage and locations of the categories as defined in 2021, not 2016. For example, the 1.7% decrease in tree canopy on Single-family residential land was based on the areas defined as Single-family using the 2021 map of land use. Tree canopy percentages shown in the 2016 City of Tampa Tree Canopy and Urban Forest Analysis may differ slightly as a result of how the data in this section were calculated.

The percentage of land area covered by tree canopy in 2021 was greatest within the Natural/Conservation Lands (91%) and Mangrove (95%) land areas, followed by Residential Single-Family (48%), Parks/Recreation (43%), and Multi-Family Residential (36%). In terms of total acreage within the City, there is more tree canopy within the Single-family and Multi-family Residential properties (11,165 acres) than in all other categories. Lands that are under public ownership or predominantly publicly managed or protected include Public Institutional, Public Communications/Utilities, Parks/Recreation, Mangroves, Natural/Conservation Lands and Right-Of-Way/Transportation. These “public” lands include 13,307 acres of tree canopy and another 10,216 acres of grass/shrub.

Tree canopy increased slightly on Natural/Conservation Lands (0.3%), Parks/Recreation (0.8%), Public Institutional (0.6%) and Right-of-Way (1.1%). The large increase in tree canopy on areas classified as mangroves (11.1%) was largely in the protected areas on MacDill Air Force Base where mangroves continued to expand. Canopy decreased slightly between 2016 and 2021 on Single-family (-1.7%) and Multi-family (-1.4%) properties, as well as Agriculture (-0.4%), Commercial (-0.6%), Industrial (-1.4%), and Public Communications/Utilities (-1.1%) properties. Impervious surfaces increased in all land use categories, by approximately 1,324 acres. Grass/shrub decreased in all categories except Single-Family, by a total decrease of approximately 1,489 acres.

Table 12. Breakdown of 2016 and 2021 land cover within the Current Use of Land categories.

Current Use of Land	Total Acres	2016 Tree Canopy	2016 Grass/ Shrub	2016 Impervious	2021 Tree Canopy	2021 Grass/ Shrub	2021 Impervious	Canopy Change
Agriculture	1,143	21.5%	76.9%	0.7%	21.1%	70.5%	2.7%	-0.4%
Commercial	6,992	22.5%	18.1%	58.6%	21.9%	15.6%	60.6%	-0.6%
Industrial	2,877	17.8%	22.4%	58.4%	16.4%	19.2%	59.3%	-1.4%
Mangrove	1,180	84.2%1	4.9%	0.1%	95.3%	3.4%	0.9%	11.1%
Multi-Family	3,549	37.0%	19.4%	43.2%	35.6%	16.8%	47.3%	-1.4%
Natural / Conservation Lands	5,315	91.1%	8.5%	0.2%	91.4%	7.7%	0.3%	0.3%
Parks / Recreation	2,518	42.5%	48.2%	7.5%	43.3%	45.7%	8.9%	0.8%
Private Institutional	2,082	25.3%	32.6%	41.0%	25.3%	29.7%	42.8%	0.0%
Public Communications / Utilities	342	18.2%	50.1%	30.6%	17.1%	45.0%	35.1%	-1.1%
Public Institutional	12,692	23.5%	44.2%	30.3%	24.1%	42.5%	31.8%	0.6%
Right-of-Way / Transportation	13,053	22.8%	28.3%	48.6%	23.9%	23.5%	52.3%	1.1%
Single-Family	20,516	49.9%	24.2%	25.5%	48.3%	24.9%	26.3%	-1.7%
Water	3,040	10.3%	13.6%	1.1%	10.6%	11.6%	2.2%	0.3%

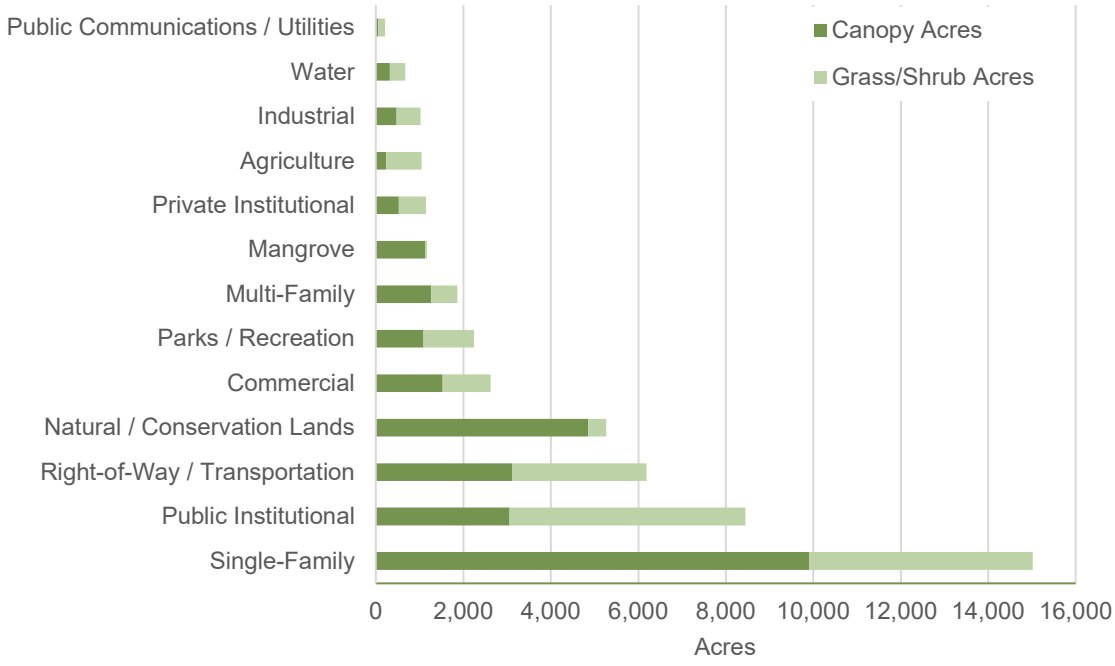


Figure 39. Acres of tree canopy and grass/shrub cover within the Current Use of Land categories.

Future Land Use

Trees and shrubs are found in many of Tampa's undeveloped areas. Whether or not these trees will remain in the years to come depends, in part, on the Future Land Use (FLU) that is approved for different areas of the City. FLU is regulated through the Tampa Comprehensive Plan. The goals, objectives, and policies established through this process are summarized and visualized as the FLU map. Future Land Use along with the Zoning Districts and Special Districts determine applicable land use and development regulations.

The table below summarizes 2016 and 2021 tree canopy, grass/shrub and impervious land cover classes within each Future Land Use category (FLU). Once again, in order to provide a meaningful comparison based on current definitions of FLU, the amount of 2016 canopy, grass/shrub or impervious within a category is based on the acreage and locations of the categories as defined in 2021, not 2016. For example, the 2% increase in tree canopy on properties defined as Central Business District was based on the properties defined as that FLU category using the 2021 FLU map. Between 2016 and 2021, the Central Business District nearly doubled in acreage and therefore some of the canopy increase may have occurred on properties previously defined by a different FLU category. Tree canopy percentages shown in the 2016 City of Tampa Tree Canopy and Urban Forest Analysis may differ slightly as a result of how the data in this section were calculated.

As a simple proportion of the FLU category, 2021 tree canopy cover was highest in Environmentally Sensitive Areas (84% tree cover), followed by residential 6 units/acre (50%) and residential 10 units/acre (45%). The percentage of tree canopy was lowest in the Central Business District, General Mixed Use, Regional Mixed Use, and Heavy Industrial categories. However, even in these categories it might be possible to more than double canopy cover with tree planting in grass/shrub areas.

Percentage tree canopy increased by the largest amount in the FLU categories Central Business District (2%), MacDill AFB (3%), Municipal Airport Compatibility Plan (3%) and Recreation and Open Space (2%). The largest decreases occurred in the Suburban Mixed Use – 6 (-3%), Residential – 3 (-3%), Rural Estate – 10 (-2%) and Urban Mixed Use – 60 (-2%).

Table 13. Breakdown of 2016 and 2021 land cover within each Future Land Use category

Current Use of Land	Total Acres	2016 Tree Canopy	2016 Grass/ Shrub	2016 Impervious	2021 Tree Canopy	2021 Grass/ Shrub	2021 Impervious	Canopy Change
Agriculture	1,143	21.5%	76.9%	0.7%	21.1%	70.5%	2.7%	-0.4%
Commercial	6,992	22.5%	18.1%	58.6%	21.9%	15.6%	60.6%	-0.6%
Industrial	2,877	17.8%	22.4%	58.4%	16.4%	19.2%	59.3%	-1.4%
Mangrove	1,180	84.2%1	4.9%	0.1%	95.3%	3.4%	0.9%	11.1%
Multi-Family	3,549	37.0%	19.4%	43.2%	35.6%	16.8%	47.3%	-1.4%
Natural / Conservation Lands	5,315	91.1%	8.5%	0.2%	91.4%	7.7%	0.3%	0.3%
Parks / Recreation	2,518	42.5%	48.2%	7.5%	43.3%	45.7%	8.9%	0.8%
Private Institutional	2,082	25.3%	32.6%	41.0%	25.3%	29.7%	42.8%	0.0%
Public Communications / Utilities	342	18.2%	50.1%	30.6%	17.1%	45.0%	35.1%	-1.1%
Public Institutional	12,692	23.5%	44.2%	30.3%	24.1%	42.5%	31.8%	0.6%
Right-of-Way / Transportation	13,053	22.8%	28.3%	48.6%	23.9%	23.5%	52.3%	1.1%
Single-Family	20,516	49.9%	24.2%	25.5%	48.3%	24.9%	26.3%	-1.7%
Water	3,040	10.3%	13.6%	1.1%	10.6%	11.6%	2.2%	0.3%

In order to consider the citywide implications of FLU for the tree canopy, it is necessary to examine the total land area within each category. The graph below shows the FLU categories with more than 1,000 acres of all vegetation, tree canopy plus grass/shrub. Residential 10 units/acre (7,646 acres) and Environmentally Sensitive Areas (6,630 acres) remain the categories with the most tree canopy and total vegetation. In fact, these two categories include 14,276 acres of tree canopy which is more than the total of all other FLU categories combined (11,813 acres). Areas with a FLU designation of residential currently have 11,398 acres of tree canopy, compared to 14,690 acres for all other categories combined. However, tree canopy decreased by approximately 264 acres on rural estate and residential FLU categories between 2016 and 2021. This result illustrates the importance of residential properties to the future management of tree canopy within the City of Tampa.

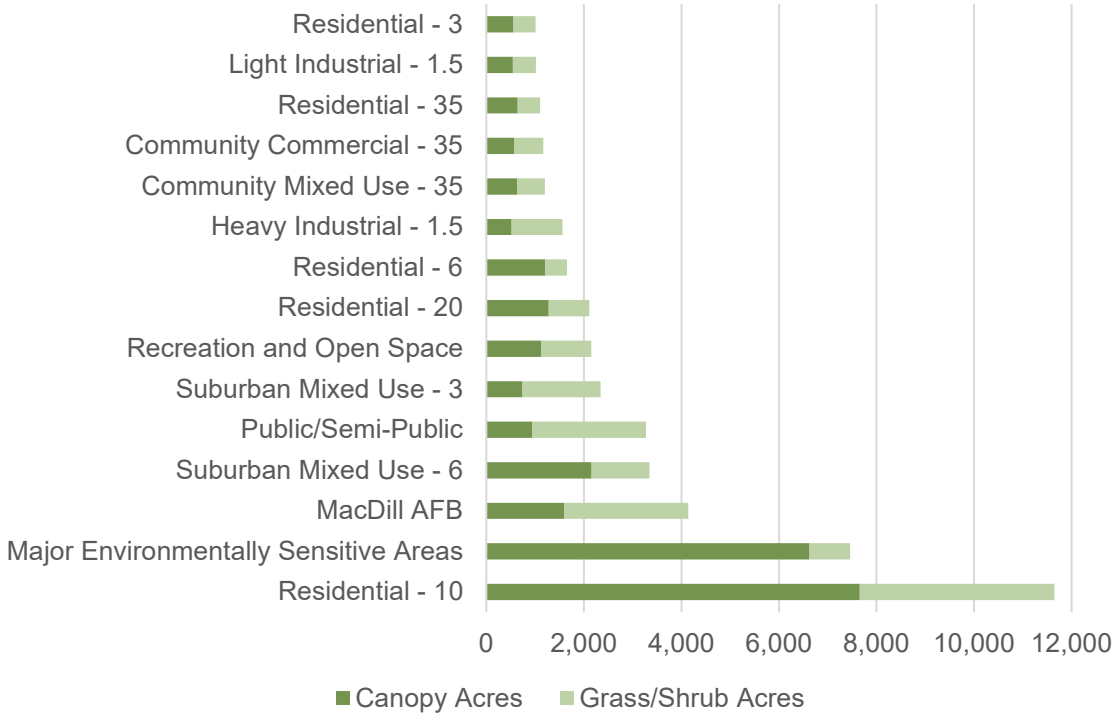


Figure 40. Acres of tree canopy and grass/shrub cover within the Future Land Use categories

Zoning Districts and Special Districts

The City of Tampa designation of Zoning Districts and Special Districts has three primary purposes: 1) to implement the public purpose and objectives of the Tampa Comprehensive Plan; 2) promote the public health, safety, morals, convenience, comfort, amenities, prosperity and general welfare of the City; and 3) divide the City into districts of such number, shape, characteristics, area, common unity of purpose, adaptability or use as will accomplish the objectives of the Tampa Comprehensive Plan. Development standards are set in the Zoning Districts and Special Districts Code. MacDill AFB is excluded from all zoning results, and the area of Bruce B. Downs Boulevard and interstate highways 75 and 275 are also excluded.

The table below summarizes 2016 and 2021 tree canopy, grass/shrub and impervious land cover classes within each Zoning District and Special District Category. Once again, in order to provide a meaningful comparison based on current zoning definitions, the amount of 2016 canopy, grass/shrub or impervious within a category is based on the acreage and locations of the categories as defined in 2021, not 2016. For example, the total area of RS-60 properties increased from 7,996 acres in 2016 to 13,976 acres in 2021 even though the percentage of tree canopy remained unchanged. As a result, the total acres of tree canopy within RS-60 is nearly double the amount it was in the same category in 2016 (6,004 acres in 2021 compared to 3,438 acres in 2016). Tree canopy percentages shown in the 2016 City of Tampa Tree Canopy and Urban Forest Analysis may differ slightly as a result of how the data in this section were calculated.

The table below summarizes tree canopy and other land cover classes within each Zoning District and Special District Category. Tree canopy cover as a percentage of the area within a zoning category is highest in the Community Unit (79%), a zoning category unique to the Tampa Palms area that includes large tracts of forested wetlands. Similarly, Planned Development Alternative includes large areas of forested wetlands in New Tampa and has a high tree canopy cover (48%). All of the single-family residential zoning categories, except Ybor City, have greater than 40% tree canopy cover. Zoning categories in Ybor City, Channel District and Central Business District, and most commercial zoning have some of the lowest percentage of tree cover.

The largest percentage canopy increase occurred within Residential Single-Family RS-150 (6%), and the largest decreases occurred within Seminole Heights Planned Development SH-PD (-11%), Seminole Heights Residential Single-Family Attached SH-RS-A (-9%) and Seminole Heights Residential Office SH-RO (-5%). However, there is only 18 acres within these categories in the City of Tampa.

The proportion of tree canopy in a Zoning District and Special District category may be less important when the total land area is small. The majority of categories comprise less than 1,000 acres of land (28 out of 39 categories) and less than 500 acres of total vegetation cover (25 out of 39 categories). The graph below shows the acreage of tree canopy and grass/shrub within the zoning categories with at least 500 acres of total vegetation. Approximately 74% of all canopy is located within the Planned Development Alternative (PD-A), Residential Single-Family (RS-60), Residential Single-Family (RS-50) Residential Multi-family (RM) or Community Unit (CU) categories. Dedicated residential zoning categories, excluding the mixed-use, Planned Development and Community Unit, comprise 14,757 acres of tree canopy, or 54% of tree canopy within all zoned areas. These results illustrate the importance of households and families for the management of tree canopy within the City of Tampa.

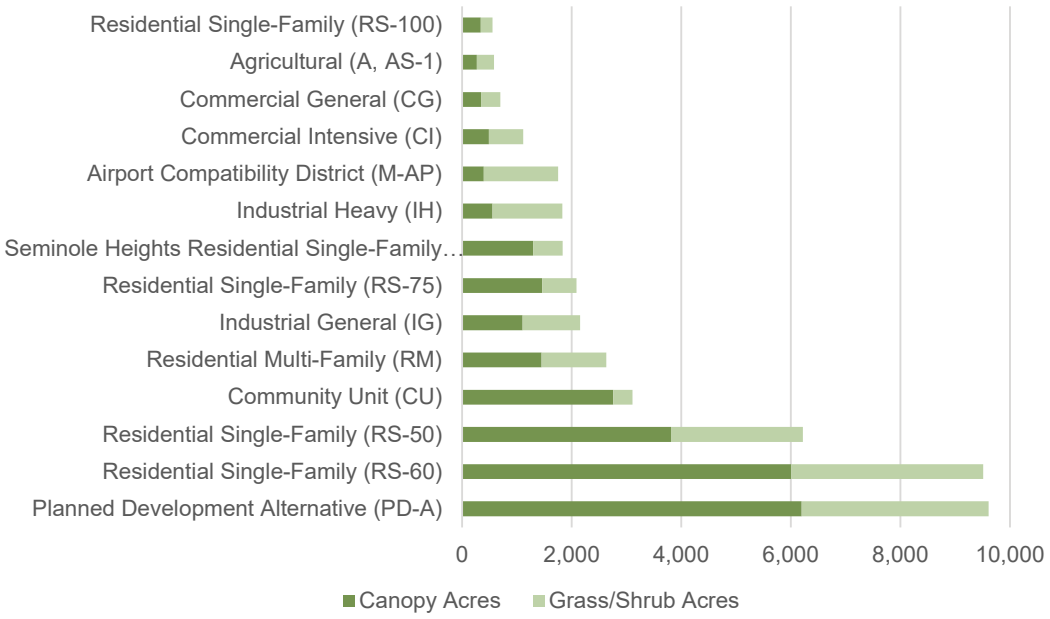


Figure 41. Zoning District and Special District Categories with more than 500 total acres of vegetation.

Table 14. Breakdown of 2016 and 2021 land cover within each Zoning District and Special District category.

Zoning District and Special District Category	Total Acres	2016 Tree Canopy	2016 Grass/ Shrub	2016 Impervious	2021 Tree Canopy	2021 Grass/ Shrub	2021 Impervious	Canopy Change
Agricultural (A, AS-1)	589	49%	50%	1%	46%	53%	1%	-3%
Airport Compatibility District (M-AP)	3,290	11%	43%	45%	12%	41%	45%	1%
Central Business District (CBD)	539	7%	12%	76%	10%	9%	77%	2%
Channel District (CD)	156	4%	15%	80%	7%	9%	80%	2%
Commercial General (CG)	2,194	16%	18%	65%	16%	16%	67%	0%
Commercial Intensive (CI)	3,267	15%	21%	63%	15%	19%	65%	0%
Commercial Neighborhood (CN)	139	27%	26%	46%	28%	22%	49%	1%
Community Unit (CU)	3,485	78%	12%	8%	79%	10%	9%	1%
Industrial General (IG)	4,174	26%	28%	41%	27%	25%	42%	0%
Industrial Heavy (IH)	4,766	12%	27%	56%	12%	27%	56%	-1%
Neighborhood Mixed Use (NMU)	78	12%	34%	41%	11%	30%	41%	-1%
Office Professional (OP)	305	14%	18%	66%	16%	13%	68%	2%
Planned Development (PD)	0.1	30%	23%	41%	28%	21%	44%	-2%
Planned Development Alternative (PD-A)	13,153	48%	28%	17%	47%	26%	19%	-1%
Residential Multi-Family (RM)	4,479	33%	29%	35%	32%	26%	38%	-1%
Residential Office (RO)	247	30%	17%	52%	31%	15%	54%	1%
Residential Single-Family (RS-100)	811	41%	30%	25%	42%	27%	27%	1%
Residential Single-Family (RS-150)	499	52%	23%	12%	58%	16%	14%	5%
Residential Single-Family (RS-50)	9,225	43%	27%	29%	41%	26%	31%	-1%
Residential Single-Family (RS-60)	13,976	43%	27%	27%	43%	25%	29%	0%
Residential Single-Family (RS-75)	3,048	47%	22%	27%	48%	20%	28%	1%
Seminole Heights Commercial General (SH-CG)	124	26%	17%	55%	26%	15%	58%	-1%
Seminole Heights Commercial Intensive (SH-CI)	261	17%	11%	71%	16%	9%	74%	-1%
Seminole Heights Commercial Neighborhood (SH-CN)	8	13%	16%	71%	12%	15%	73%	-1%
Seminole Heights Planned Development (SH-PD)	16	40%	25%	35%	29%	20%	51%	-11%
Seminole Heights Residential Multi-Family (SH-RM)	69	46%	20%	32%	45%	18%	34%	0%
Seminole Heights Residential Office (SH-RO)	3	47%	13%	40%	42%	21%	38%	-5%
Seminole Heights Residential Single-Family (SH-RS)	2,524	52%	23%	22%	51%	21%	25%	-1%
Seminole Heights Residential Single-Family Attached (SH-RS-A)	0.3	58%	27%	16%	49%	26%	25%	-9%

Table 14 (continued). Breakdown of 2016 and 2021 land cover within each Zoning District and Special District category.

Zoning District and Special District Category	Total Acres	2016 Tree Canopy	2016 Grass/ Shrub	2016 Impervious	2021 Tree Canopy	2021 Grass/ Shrub	2021 Impervious	Canopy Change
University Community District (UC)	814	29%	27%	41%	28%	25%	44%	-1%
Ybor City - Central Commercial Core (YC-1)	74	8%	8%	84%	8%	7%	85%	0%
Ybor City - Community Commercial (YC-6)	89	9%	22%	68%	10%	18%	73%	1%
Ybor City - General Commercial (YC-5)	74	12%	18%	69%	14%	15%	71%	2%
Ybor City - Hillsborough Community College (YC-3)	32	17%	22%	59%	20%	20%	60%	2%
Ybor City - Mixed Use (YC-7)	59	14%	23%	63%	14%	19%	67%	0%
Ybor City - Mixed Use Redevelopment (YC-4)	64	16%	25%	59%	17%	16%	67%	0%
Ybor City - Residential (YC-2)	188	24%	31%	44%	24%	29%	47%	0%
Ybor City - Residential Single-Family (YC-8)	87	31%	26%	42%	31%	24%	44%	0%
Ybor City - Site Plan Controlled (YC-9)	4	4%	24%	72%	5%	15%	79%	1%

Neighborhood Associations

The City of Tampa maintains a neighborhood registry that is the official list of active neighborhood associations. A neighborhood is defined as an integrated area related to a larger community of which it is a part, and may consist of residential districts, a school or schools, shopping facilities, religious buildings and open spaces. Neighborhood associations are formed by residents and the boundaries of these neighborhoods are defined by the association members, based on approval by the City of Tampa's Neighborhood Services Department. The summary of tree canopy by neighborhood was created using the neighborhood association boundaries provided by the City. There are many areas within the City that are not defined by an official neighborhood association, and these areas are therefore not included in these summaries.

The proportion of neighborhood land area covered by tree canopy ranged from 7% in the Channel District and 9% in the Tampa Downtown Partnership to a high of 73% in Tampa Palms, 60% in Hunter's Green - Pinnacle and 57% in New Suburb Beautiful. The largest decrease in percent tree canopy between 2016 and 2021 occurred in the Gray Gables (-6%), Armory Gardens (-5%), Riverbend (-4%) and Bon Air (-4%) neighborhood associations. The largest increase in percent tree canopy between 2016 and 2021 occurred in the Southtown Park (8%) and Hunter's Green – Pinnacle (4%) neighborhood associations.

The graph shows the acreage of tree canopy and grass/shrub for all neighborhoods with at least 500 acres of total vegetation. The total area covered by tree canopy and other vegetation is closely related to the total land area within the neighborhood. The four largest neighborhood associations (i.e., Tampa Palms, Old Seminole Heights, Gandy Civic Association and Hunters Green) also have the most acreage of tree canopy. In fact, 30% of the total acres of tree canopy within all neighborhood associations is within these four areas.

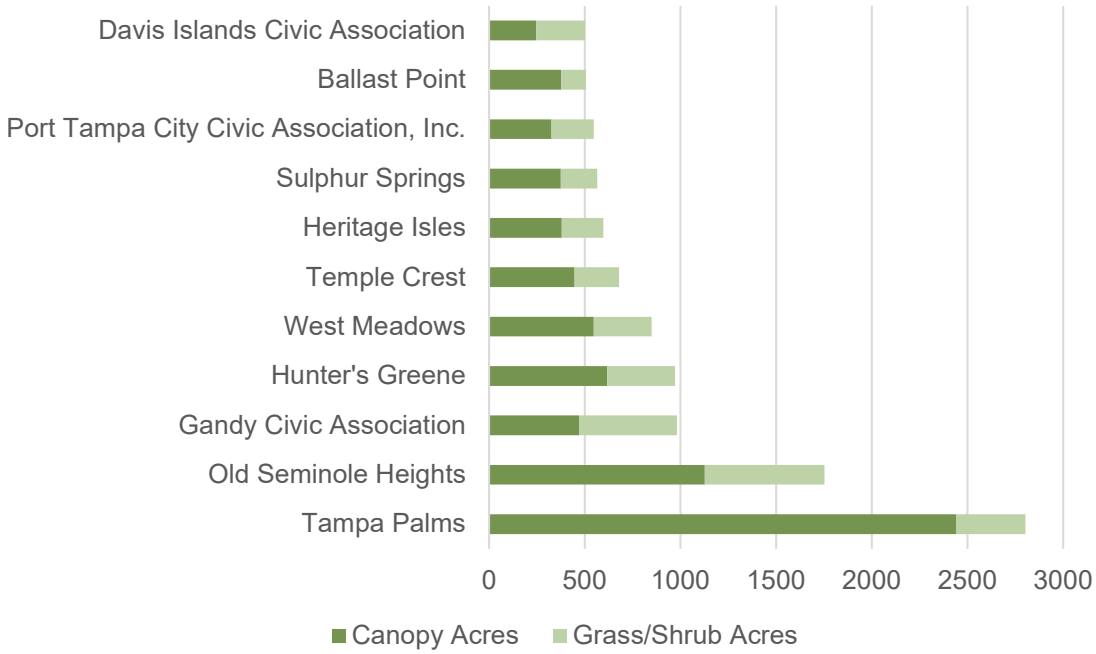


Figure 42. Neighborhood Associations with more than 500 total acres of vegetation.

The table below summarizes 2016 and 2021 tree canopy, grass/shrub and impervious land cover classes within each Neighborhood Association. Once again, in order to provide a meaningful comparison based on current Neighborhood Association definitions, the amount of 2016 canopy, grass/shrub or impervious within a neighborhood is based on the acreage and locations as defined in 2021, not 2016. Tree canopy percentages shown in the 2016 City of Tampa Tree Canopy and Urban Forest Analysis may differ slightly as a result of how the data in this section were calculated.

Table 15. Breakdown of 2016 and 2021 land cover within each Neighborhood Association area.

Neighborhood Association	Total Acres	2016 Tree Canopy	2016 Grass/ Shrub	2016 Impervious	2021 Tree Canopy	2021 Grass/ Shrub	2021 Impervious	Canopy Change
Armory Gardens	161	32%	30%	38%	27%	31%	42%	-4.8%
Ballast Point	745	50%	22%	26%	51%	17%	30%	0.4%
Bayshore Beautiful Neighborhood Association, Inc.	655	51%	18%	31%	50%	16%	34%	-1.1%
Bayshore Gardens	150	35%	17%	47%	35%	14%	50%	-0.6%
Bayside West	620	28%	31%	38%	29%	28%	36%	1.0%
Beach Park	608	45%	18%	37%	47%	15%	37%	1.7%
Bel Mar Shores	79	38%	20%	42%	40%	18%	41%	2.4%
Bon Air	81	36%	22%	42%	32%	24%	44%	-4.0%
Carver City / Lincoln Gardens	554	13%	26%	59%	15%	25%	59%	1.4%
Channel District	90	4%	15%	80%	7%	8%	85%	2.3%
College Hill-Belmont Heights	376	27%	32%	41%	29%	24%	46%	2.0%
Cory Lake Isles	590	28%	21%	28%	25%	24%	29%	-3.2%
Culbreath Heights	112	32%	26%	42%	35%	22%	43%	2.4%
Davis Islands Civic Association	873	31%	29%	38%	28%	29%	40%	-2.9%
Drew Park	828	18%	24%	58%	18%	20%	60%	0.6%
East Arbor Heights Neighborhood Association	323	48%	23%	28%	48%	18%	32%	0.2%
East Tampa Business & Civic	830	32%	28%	40%	30%	25%	42%	-1.8%
East Ybor Historic	541	16%	25%	58%	15%	24%	54%	-1.8%
Easton Park	520	16%	56%	15%	19%	49%	16%	3.3%
FairOaks/Manhattan Manor	659	23%	28%	48%	25%	24%	49%	1.7%
Florence Villa/ Beasley/ Oak Park	162	22%	28%	41%	22%	26%	43%	-0.6%
Forest Hills Neighborhood	506	42%	35%	19%	43%	32%	21%	0.7%
Gandy Civic Association	1,813	24%	34%	39%	26%	28%	42%	2.2%
Golfview	340	45%	29%	25%	44%	28%	26%	-0.7%
Grant Park	158	35%	30%	36%	35%	26%	38%	0.8%
Gray Gables	46	43%	18%	39%	38%	20%	42%	-5.6%
Hampton Terrace	162	53%	18%	28%	53%	15%	31%	-0.1%
Hampton Terrace Community Association (HTCA)	162	53%	18%	28%	53%	15%	31%	-0.1%
Harbour Island	186	32%	9%	54%	30%	11%	55%	-2.2%
Heritage Isles	763	50%	29%	15%	50%	28%	16%	-0.3%
Highland Pines	447	26%	31%	40%	26%	28%	43%	-0.4%

Table 15 (cont'd.). Breakdown of 2016 and 2021 land cover within each Neighborhood Association area.

Neighborhood Association	Total Acres	2016 Tree Canopy	2016 Grass/ Shrub	2016 Impervious	2021 Tree Canopy	2021 Grass/ Shrub	2021 Impervious	Canopy Change
Historic Hyde Park	207	42%	17%	40%	42%	14%	42%	0.6%
Historic Ybor	405	12%	21%	67%	13%	17%	70%	0.9%
Hunter's Green - Cypress Ridge	13	50%	20%	30%	52%	17%	31%	2.2%
Hunter's Green - Heather Downs	14	55%	16%	29%	52%	16%	32%	-3.1%
Hunter's Green - Pinnacle	7	55%	15%	30%	60%	11%	29%	4.4%
Hunter's Greene	1,387	47%	25%	18%	44%	26%	19%	-2.3%
Hyde Park Preservation	142	44%	15%	40%	40%	17%	41%	-3.1%
Hyde Park Spanishtown Creek	265	20%	16%	61%	22%	13%	62%	1.9%
Jackson Heights	621	32%	25%	43%	29%	25%	46%	-2.5%
Live Oaks Square Neighborhood Association	245	44%	25%	31%	43%	22%	34%	-1.1%
Macfarlane Park	1,000	23%	30%	47%	21%	28%	50%	-2.2%
New Suburb Beautiful	82	58%	12%	31%	57%	14%	30%	-1.1%
New Tampa - The Sanctuary	80	54%	20%	23%	53%	19%	25%	-1.3%
North Bon Air	174	23%	25%	52%	23%	26%	51%	-0.2%
North Hyde Park	308	19%	25%	56%	18%	21%	61%	-0.6%
North Tampa Community	693	36%	24%	40%	36%	24%	39%	-0.4%
Northeast Community Crimewatch & Civic Association	283	43%	21%	29%	42%	18%	32%	-0.7%
Northview Hills	86	29%	36%	36%	28%	29%	33%	-0.3%
Oakford Park	244	31%	24%	45%	29%	23%	48%	-2.3%
Old Seminole Heights	2,612	44%	26%	26%	43%	24%	28%	-0.7%
Old West Tampa	239	25%	26%	49%	26%	22%	51%	1.1%
Palma Ceia	585	41%	20%	39%	41%	17%	41%	0.5%
Palma Ceia Pines	280	29%	15%	55%	28%	14%	58%	-1.5%
Palma Ceia West	249	35%	22%	42%	35%	20%	44%	-0.2%
Palmetto Beach	557	26%	28%	42%	26%	25%	47%	-0.2%
Parkland Estates	174	45%	15%	39%	44%	15%	40%	-0.9%
Plaza Terrace	488	31%	20%	44%	31%	18%	47%	-0.3%
Port Tampa City Civic Association, Inc.	789	41%	34%	23%	41%	28%	28%	0.6%
Rainbow Heights	164	42%	26%	32%	39%	25%	36%	-2.7%
Ridgewood Park	83	39%	21%	24%	37%	21%	27%	-1.5%
Riverbend	442	49%	23%	23%	45%	24%	26%	-4.4%
Riverside Heights	446	43%	25%	26%	40%	25%	29%	-2.7%
Seminole Heights East	322	34%	24%	41%	36%	20%	44%	2.3%
South Howard	196	21%	14%	65%	21%	12%	67%	0.1%
South Seminole Heights	387	44%	21%	29%	44%	18%	32%	-0.3%
Southeast Seminole Heights	427	47%	20%	33%	48%	18%	35%	0.4%
Southtown Park Homeowners Association	11	18%	40%	39%	26%	41%	31%	8.3%

Table 15 (cont'd.). Breakdown of 2016 and 2021 land cover within each Neighborhood Association area.

Neighborhood Association	Total Acres	2016 Tree Canopy	2016 Grass/ Shrub	2016 Im-pervious	2021 Tree Canopy	2021 Grass/ Shrub	2021 Im-pervious	Canopy Change
Stadium Area	329	26%	25%	45%	24%	24%	49%	-1.7%
Sulphur Springs	930	41%	21%	37%	40%	20%	38%	-0.5%
Sunset Park	513	48%	18%	32%	50%	17%	32%	1.9%
Tampa Downtown Part-nership	351	7%	12%	79%	9%	9%	80%	2.0%
Tampa Heights	926	31%	26%	40%	32%	22%	42%	0.6%
Tampa Palms	3,341	73%	12%	11%	73%	11%	13%	0.2%
Temple Crest	1,120	41%	21%	26%	40%	21%	28%	-1.3%
The Marina Club Of Tampa	22	12%	22%	38%	11%	18%	42%	-0.5%
University Square Civic Association, Inc.	655	36%	25%	37%	37%	24%	38%	0.3%
Virginia Park	456	46%	20%	34%	46%	18%	35%	0.6%
VM Ybor	266	33%	22%	45%	33%	19%	48%	0.0%
Wellswood	600	35%	26%	36%	34%	25%	38%	-0.8%
West Meadows	1,180	49%	23%	19%	46%	26%	19%	-2.3%
West Riverfront Neigh-borhood Crimewatch Association, Inc.	135	22%	28%	49%	23%	23%	53%	0.7%
Westshore Palms	162	26%	25%	48%	25%	27%	47%	-0.7%

Potential Planting Areas

Despite the recent loss of tree canopy, the City of Tampa has many locations where new trees could be planted. If planting sites are chosen wisely, the new trees could grow and remain healthy in order to contribute to a future sustainable urban forest and tree canopy.

According to the concept of Possible Urban Tree Canopy developed by the US Forest Service, areas of grass/shrub and bare earth would be the easiest locations to plant a new tree (i.e., without removal of roads, buildings, or other impervious surface). The Tampa Tree Canopy Map shows the exact location of these areas. The map was used to identify areas of grass/shrub or bare earth that would provide a minimum of 6-foot radius of open space around the trunk of a tree (i.e., one tree per 12-foot diameter circle). Although specific tree species might be suitable in smaller areas and other species might require larger areas, the 6-foot radius around a tree is a reasonable starting point for the analysis. In addition to the size requirement, this analysis also excluded specific types of property parcels based on identifiable land use (i.e., DOR codes). Properties excluded from the potential planting areas, when possible, included airports, golf courses, MacDill Air Force Base and major sports facilities.

It is very important to consider additional factors when choosing a planting location. The Tampa Tree Matrix was developed as part of the Urban Forest Management Plan to help people choose suitable planting locations based on tree characteristics, drought tolerance, wind resistance and several other important factors (https://tampatreemap.org/tree-matrix). In addition, the location of above and below ground utilities, stormwater and wastewater infrastructure, sidewalks, signage and other factors often prevent the planting of trees in specific locations. This analysis and corresponding map products can help guide the identification of potential planting areas, but site-specific factors always need to be considered.

Figure 43. Volunteers planting trees with Tampa Parks and Recreation Summer Camp.

Based on this determination of potential planting areas, there are 15,071 acres of land within the City of Tampa upon which trees could potentially be planted, or approximately 5.8 million trees with 6-foot of open space surrounding each tree. Planting in all of these areas, albeit not realistic, could possibly increase Citywide tree canopy by approximately 20%. The map below shows the areas of with the City that meet these criteria.

Properties owned by the City of Tampa can be excellent locations for tree planting. The City of Tampa owned 1,228 properties with a total area of 4,565 acres as of the 2021 date of the tree canopy mapping. However, for this analysis, properties were excluded from consideration if there was an athletic field, golf course, cemetery, or event venue (e.g., Julian B. Lane Riverfront Park) on a portion of the land area. The remaining 3,271 acres of City properties have approximately 263,769 potential planting sites with a 6-foot radius, for a total of at least 685 acres of new tree canopy.

The figure and table below show the existing percent of tree canopy within each Planning District based on the (dot-based) Tree Canopy Change Analysis, as well as the potential planting areas based on the criteria above (grass/shrub or bare earth greater than 6-foot radius (@ 113 square feet). Despite the recent decrease in tree canopy within each District, the Potential Planting Area data clearly show that there are more than enough planting locations to regrow health and sustainable tree canopy throughout the City of Tampa.

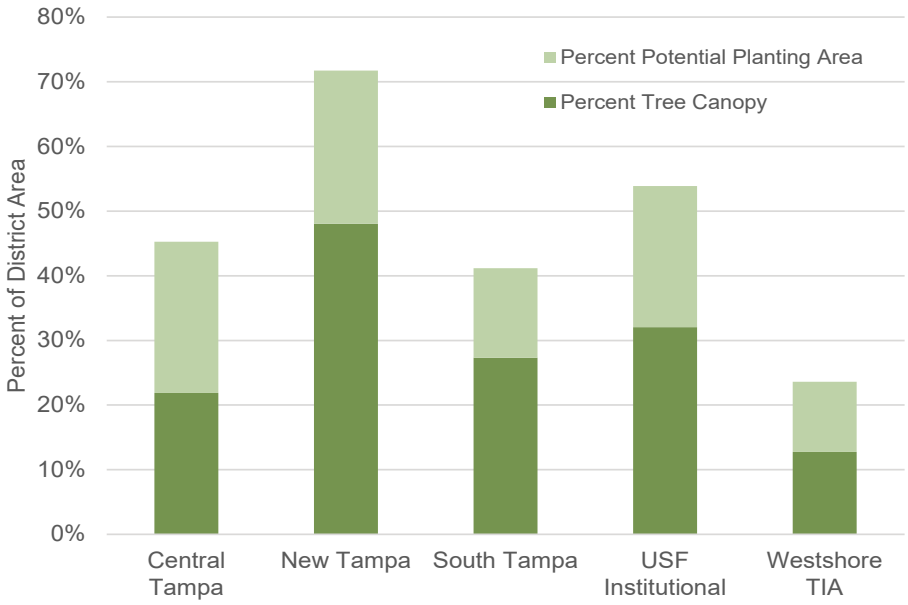


Figure 44. Percentage of each Planning District covered by Tree Canopy in 2021, and the percentage of the District with additional Potential Planting Area.

Table 16. Acres 2021 Tree Canopy, acres of additional Potential Planting Area, and estimated number of potential planting sites within each Planning District.

District	Current Canopy in District		Potential Planting Areas in District		
	Percent Tree Canopy	Acres Tree Canopy	Percent of District	Acres in District	Estimated Number of Planting Sites
Central Tampa	22%	4,775	23%	5,104	1,966,782
New Tampa	48%	8,561	24%	4,220	1,626,043
South Tampa	27%	4,502	14%	2,276	877,182
USF Institutional	32%	4,029	22%	2,743	1,056,863
Westshore TIA	13%	798	11%	679	261,495

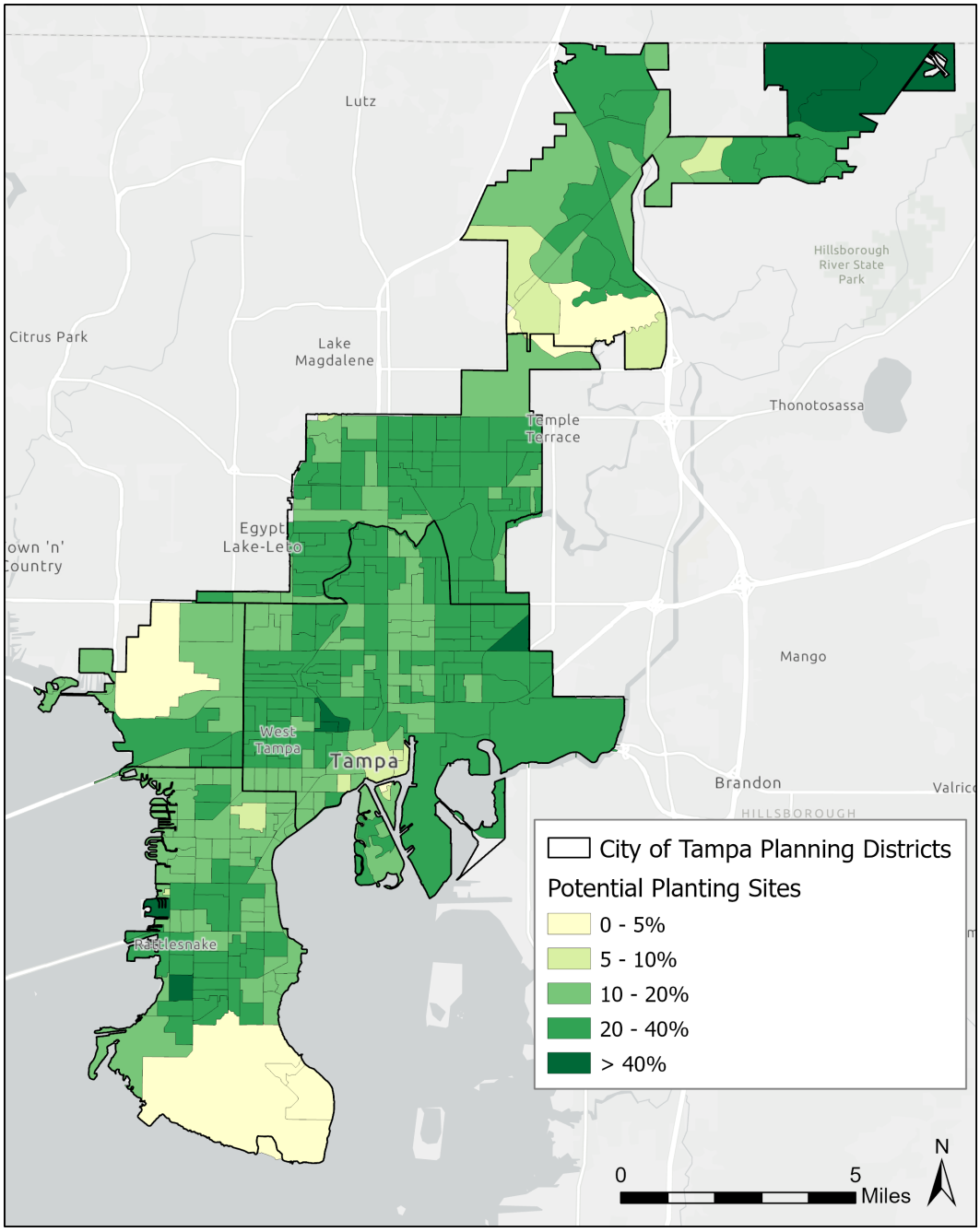


Figure 45. Map of Potential Planting Locations within City of Tampa Census Block Groups.

Urban Heat Mapping

The City of Tampa, like all cities in the southern US, experiences a large number of extremely hot summer days. Summertime heat is even hotter in some areas of Tampa than other areas. However, urban heat is something than can be mitigated by several strategies, such as planting trees to increase tree canopy, minimizing impervious surfaces, and installing “cool” surface coatings that reflect sunlight, among others.

The map on the next page indicates the variation of daytime temperatures within a typical summertime in Tampa. Although the map is based on satellite-derived daytime land surface temperate, research has shown that land surface temperature is a very strong indication of the air temperatures people would feel.

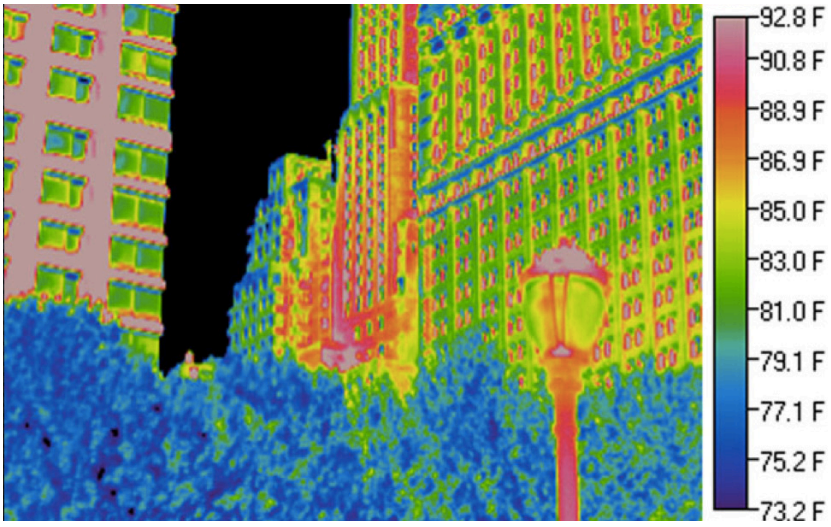


Figure 46. Building and road surfaces generally have higher temperatures than vegetation.

The figure below shows how urban heat is related to specific land cover categories. Land surface temperatures are obviously lowest in areas with open water. Areas with tree canopy are nearly 6-degrees F lower than areas with more impervious surfaces. These results clearly show the importance of tree planting as a strategy to address urban heat.

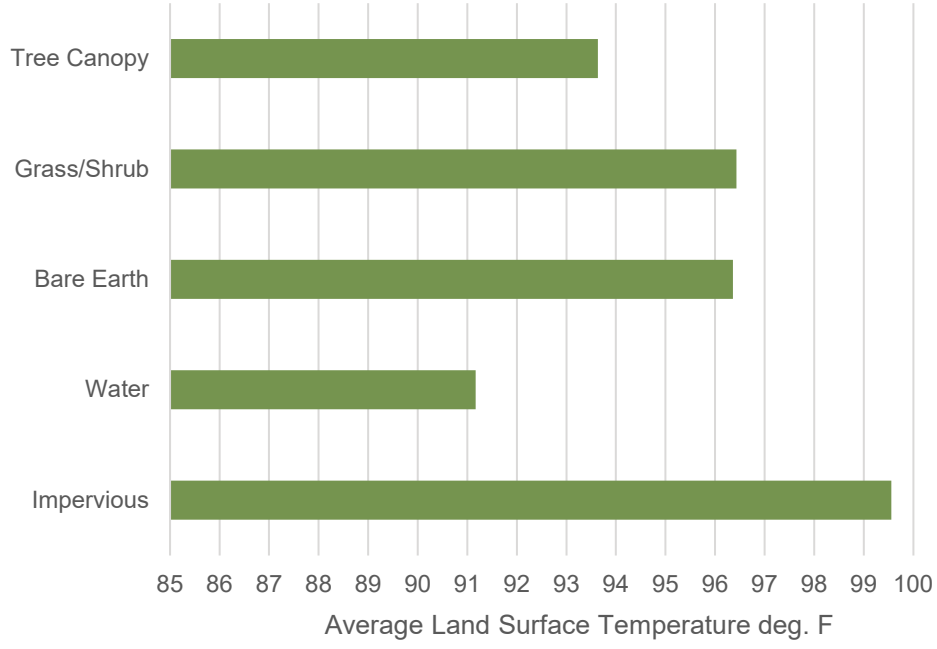


Figure 47. Average land surface temperature (degrees F) within the 2021 land cover categories.

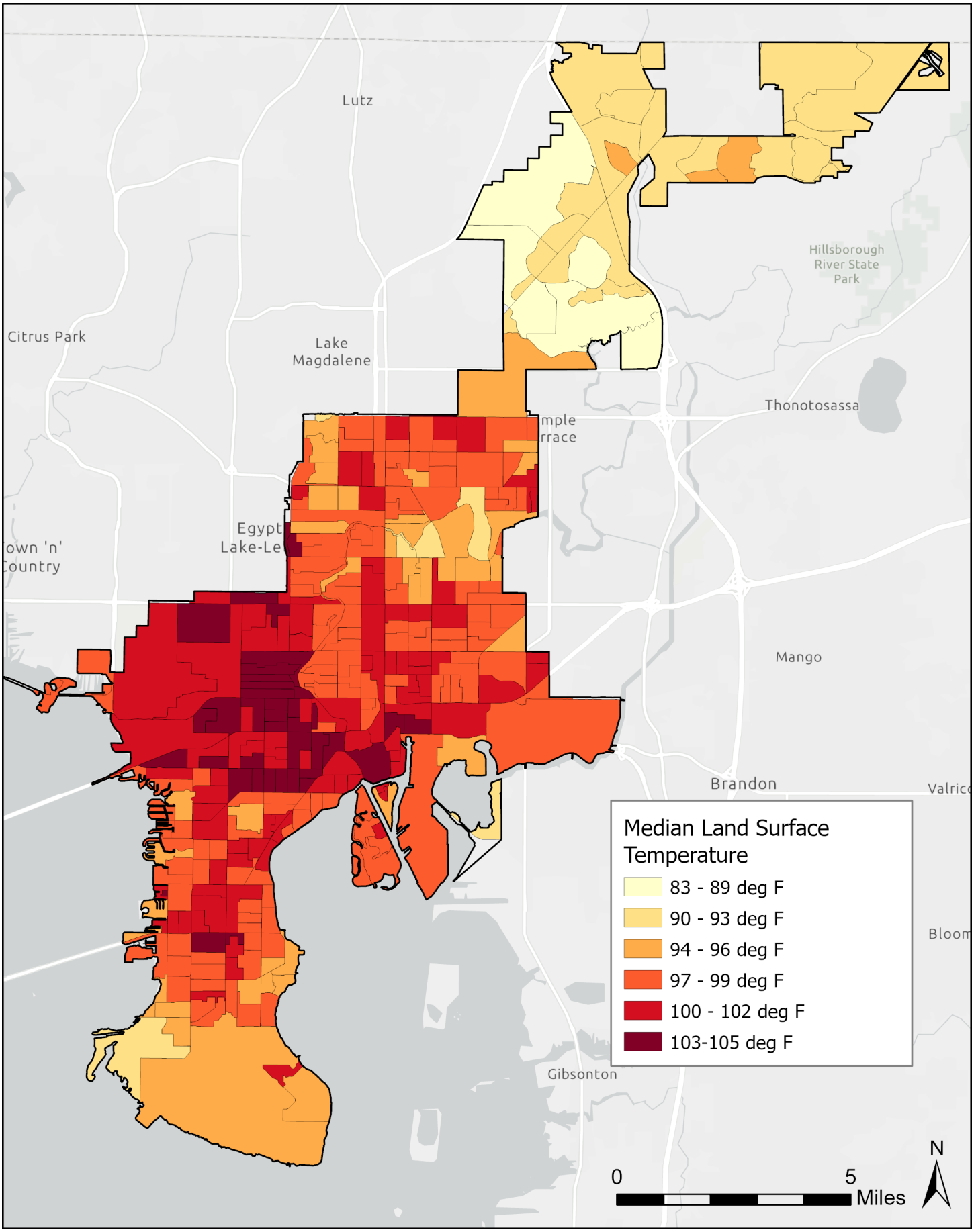


Figure 48. Median Land Surface Temperature within City of Tampa Census Block Groups.

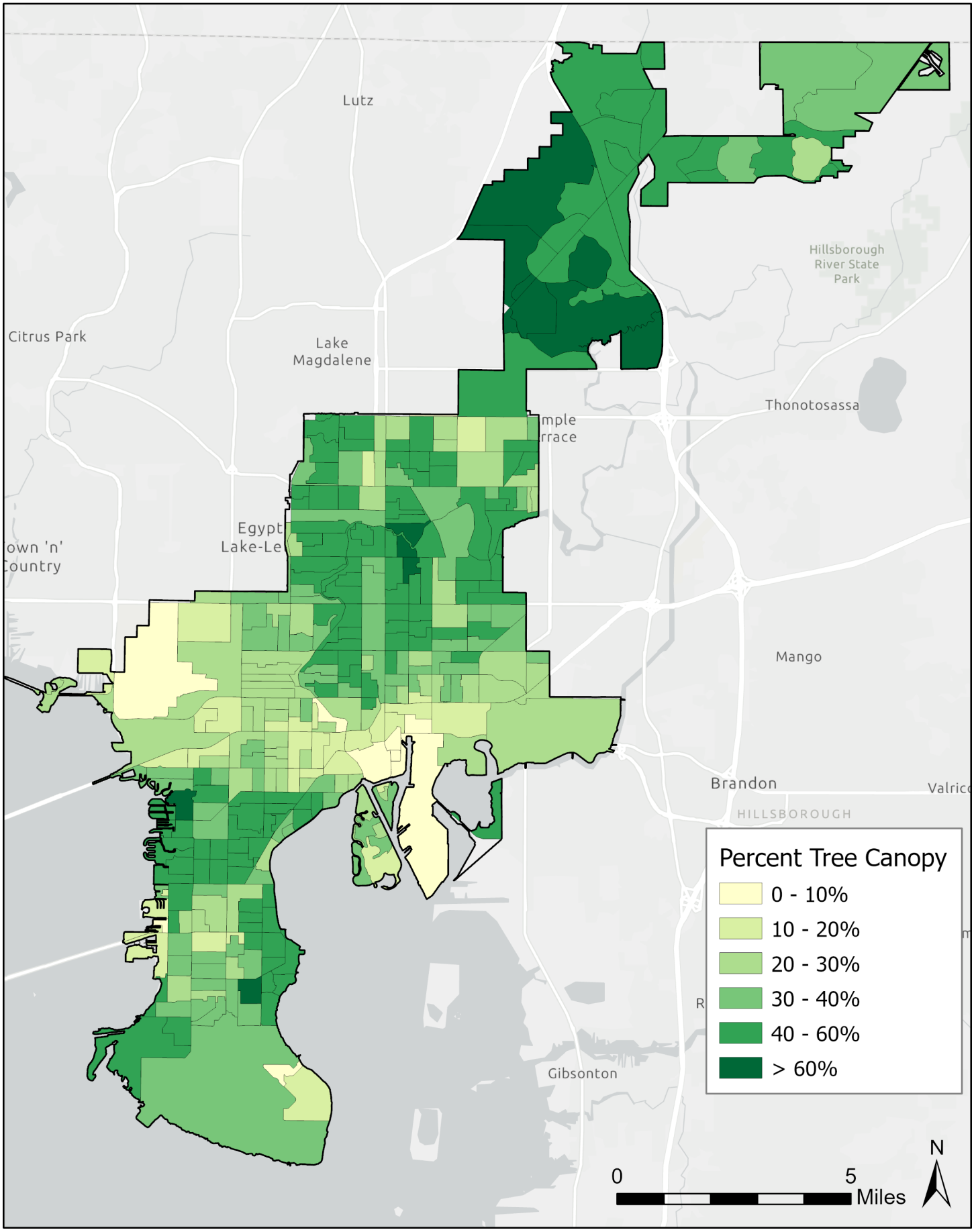


Figure 49. Average Tree Canopy within City of Tampa Census Block Groups.

Equity Analysis

Equity is the idea that people from all backgrounds should benefit from city services and public amenities, and that no community should be disproportionately impacted by negative aspects of living in the city. Unlike the term "environmental justice" which connotes the idea that a deliberate action may have resulted in some communities lacking amenities or being exposed to hazards, the term "equity" simply characterizes the current situation regardless of the cause. Identifying possible issues of inequity (i.e., lack of equity) can help cities plan future projects that can ensure that all residents will benefit from urban amenities.

Trees can be an amenity, assuming the right tree was planted in the right place. As shown in the "Values of Trees" section of this report, trees provide benefits such as shade, air pollution mitigation, rainfall interception and stormwater reduction, and more. The City of Tampa has recognized the importance of equity in their Resilient Tampa planning document, including the tree canopy goal that ensures that the benefits provided by trees are available to all residents, including low-income communities (Action 3.3.3; https://www.tampa.gov/resilience).

One way to consider the issue of equity within a city is to examine how the distribution of an amenity differs within communities with different sociodemographic characteristics. There are numerous research articles that have examined issues related to equity and trees, including several from one of the authors of this report. This report used 2016-2020 US Census data (https://www.census.gov/programs-surveys/acs) to examine how the amount of tree canopy and the amount of potential planting areas within different areas of Tampa varied in comparison to the sociodemographic characteristics within those areas. The relationship with urban heat (land surface temperature) is also shown when there was a strong relationship with the sociodemographic variable.

Specifically, the analysis considered the typical Census variables that are used for equity analysis, including: population density; median household income; percentage of residents who are renters; % of residents who identify as black; % of residents who identify as Hispanic; % of people who are children (under age 18); % of people over age 65; and % of residents with higher education (bachelor's degree).

Equity Analysis Results

The figures below show the relationship between each equity variable and tree canopy, amount of potential planting areas, and urban heat (when applicable). The dots on each graph show the average percent tree canopy or percent potential planting areas, or average land surface temperature with each binned sociodemographic variable. The line on each graph shows the linear relationship between variables as well as the R-squared value. R-squared is a statistical measure that indicates the strength of the relationship (from 0 to 1). For the purpose of this equity analysis, it could be argued that an R-squared above $R^2=0.25$ might be worth further consideration by City planners.

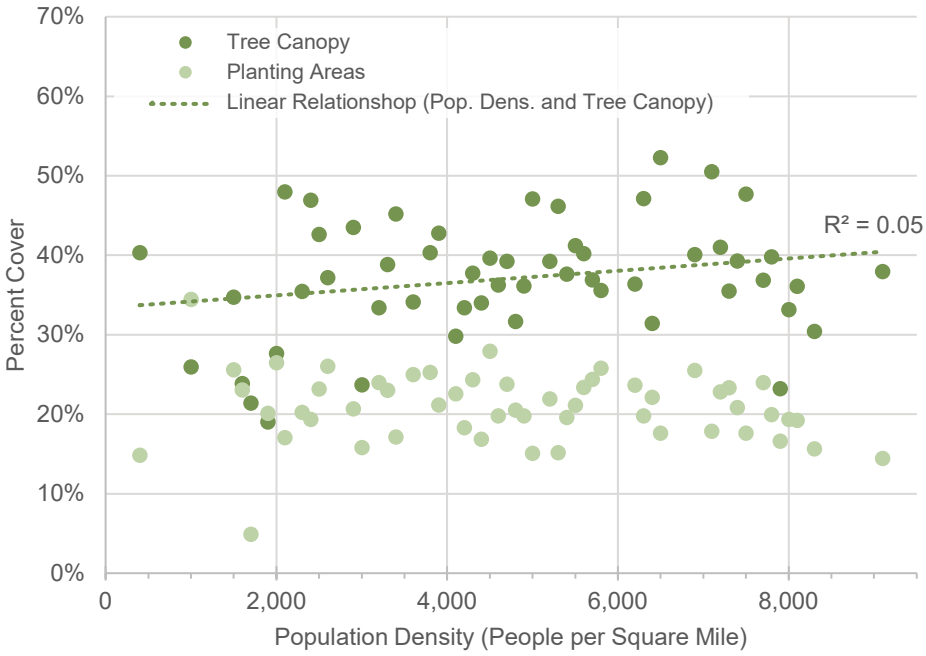


Figure 50. Tree Cover & Potential Planting Area by Population Density

When we compare cities around the world, we generally find less tree canopy in urban areas with greater population density. However, as indicated by the very low R^2 value, there does not appear to be a strong relationship between population density and average tree canopy within the City of Tampa. There was also not a strong relationship with potential planting areas or urban heat. These results show that it is possible to have a lot of tree canopy planting opportunities even within high density areas of the City.

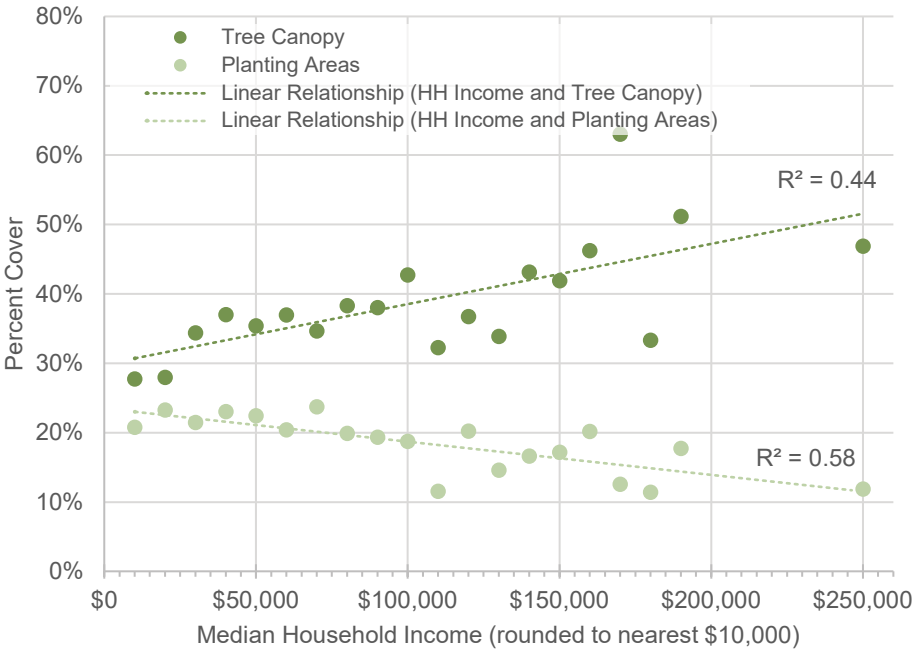


Figure 51. Tree Cover & Potential Planting Area by Median Household Income

Research from many cities around the world suggests that tree canopy is greater in wealthier neighborhoods, and the results from Tampa suggest a similar trend. In the context of an equity analysis, neighborhoods with a higher median household income may receive greater tree canopy benefits than areas with lower incomes. However, the relationship with planting areas shows that there is greater potential for planting in lower income areas to address any potential inequity.

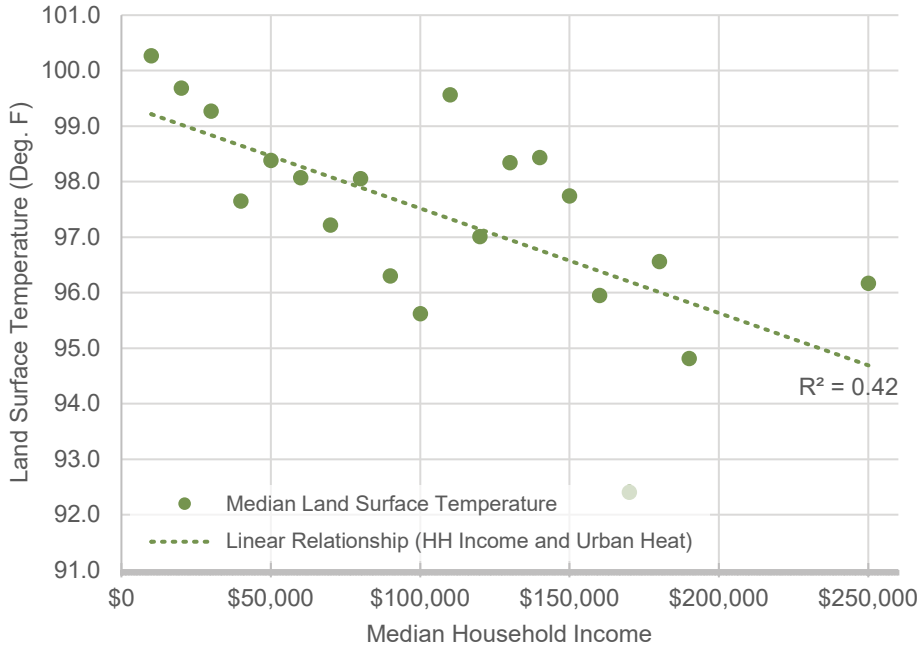


Figure 52. Urban Heat (Surface Temp.) by Median Household Income

The relationship between urban heat and median household income shows that wealthier neighborhoods are subjected to lower summertime temperatures when compared to lower income areas. The City could consider tree planting and other cooling strategies to address this possible inequity.

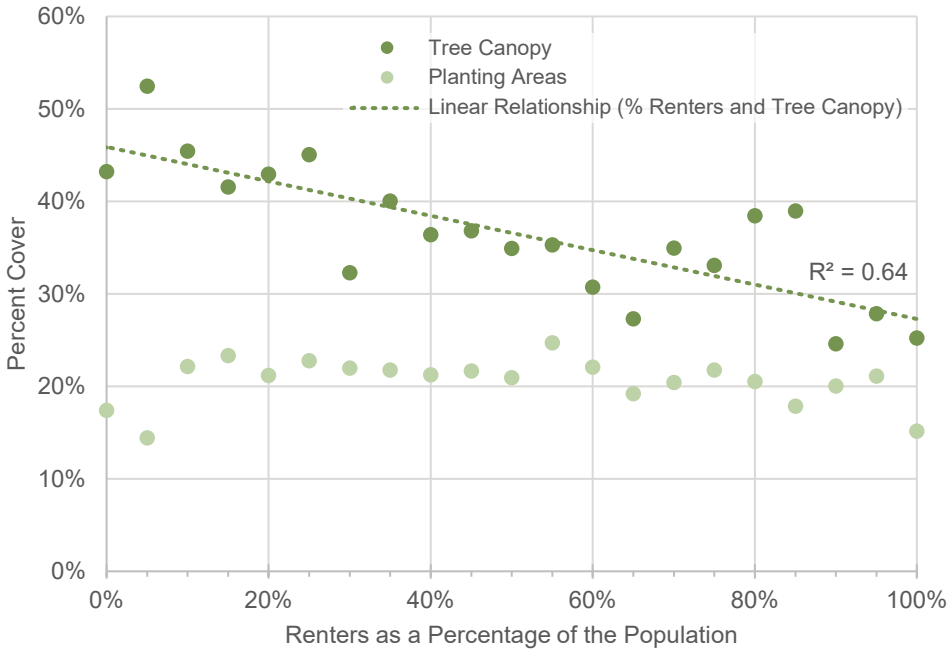


Figure 53. Tree Cover & Potential Planting Area by Percentage Renters

People living in rental housing typically have less control over tree planting and other landscape decisions, thus it is not too surprising that areas with a higher proportion of renters have less tree canopy. Although the line is not shown, there is not a linear relationship between renters and planting area, which means that neighborhoods with a higher proportion of renters do not necessarily have more opportunities to increase tree canopy than other areas. However, the potential to increase canopy seems to be approximately 20% in all areas (i.e., potential planting areas).

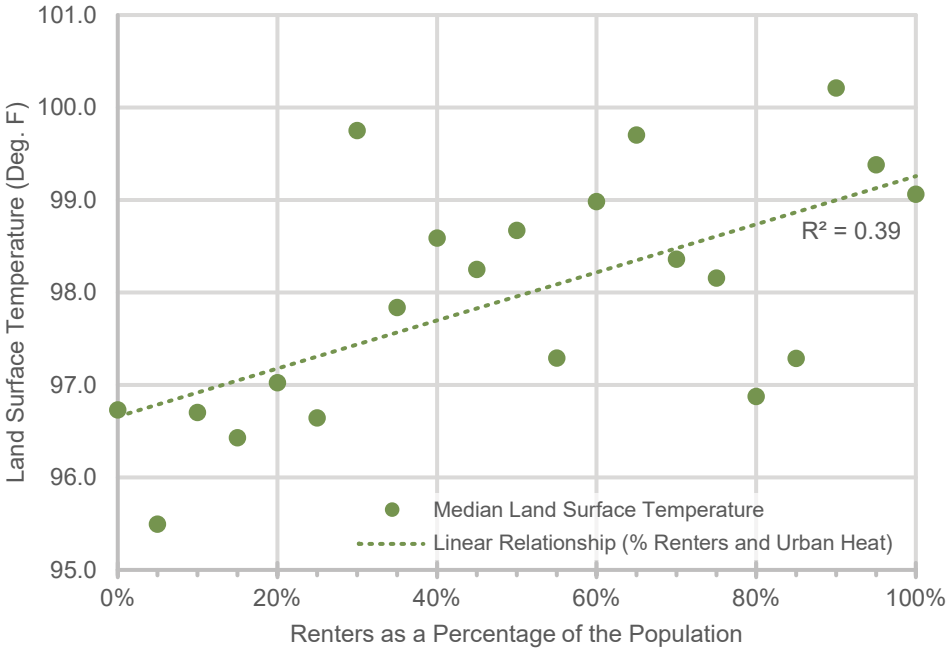


Figure 54. Urban Heat (Surface Temp.) by Percent Renters

Areas within Tampa with a high percentage of renters are also subjected to higher average urban heat than areas of the city with more owner-occupied housing. Again, the City could consider tree planting and other cooling strategies to address this possible inequity.

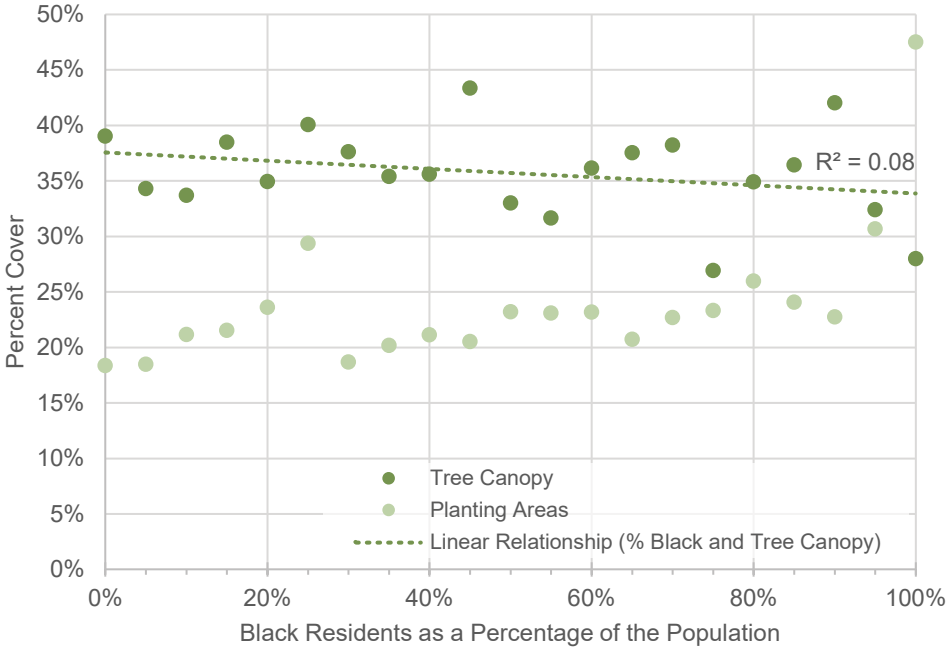


Figure 55. Tree Cover & Potential Planting Area by Percentage Black Residents

Scientific research findings have been mixed on the relationship between tree canopy and specific ethnic or racial groups. In the City of Tampa, the 2021 data does not indicate a potential inequity concern with regards to tree canopy and the proportion of residents who identify as black to the US Census.

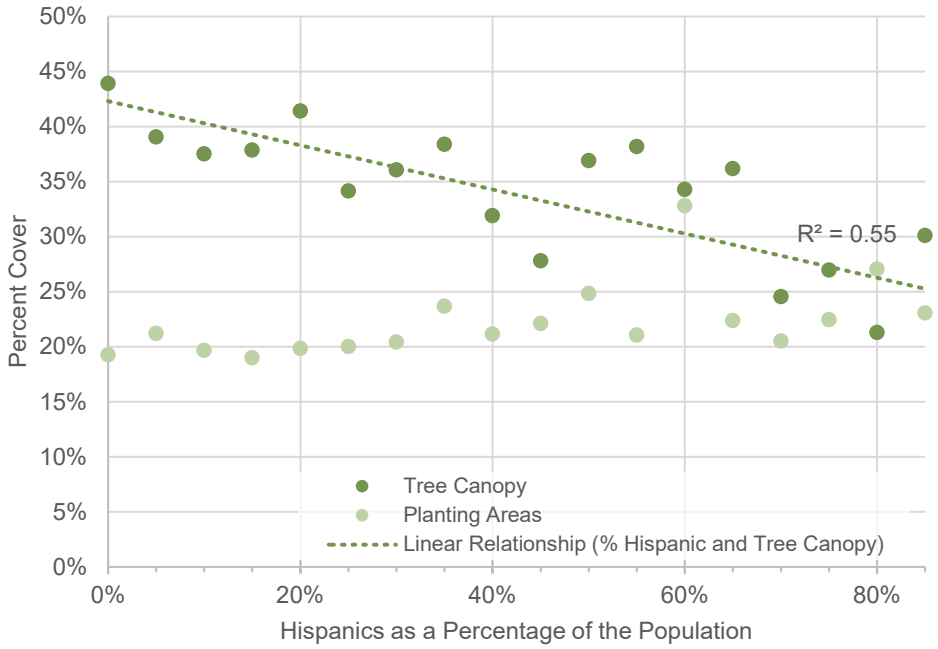


Figure 56. Tree Cover & Potential Planting Area by Percentage Hispanic

Neighborhoods with a higher proportion of residents who identify as Hispanic have less tree canopy than areas with fewer Hispanic residents. There is no apparent relationship with the percentage of potential planting areas, but there is an average potential planting area of approximately 20% in most areas to address any inequity concerns.

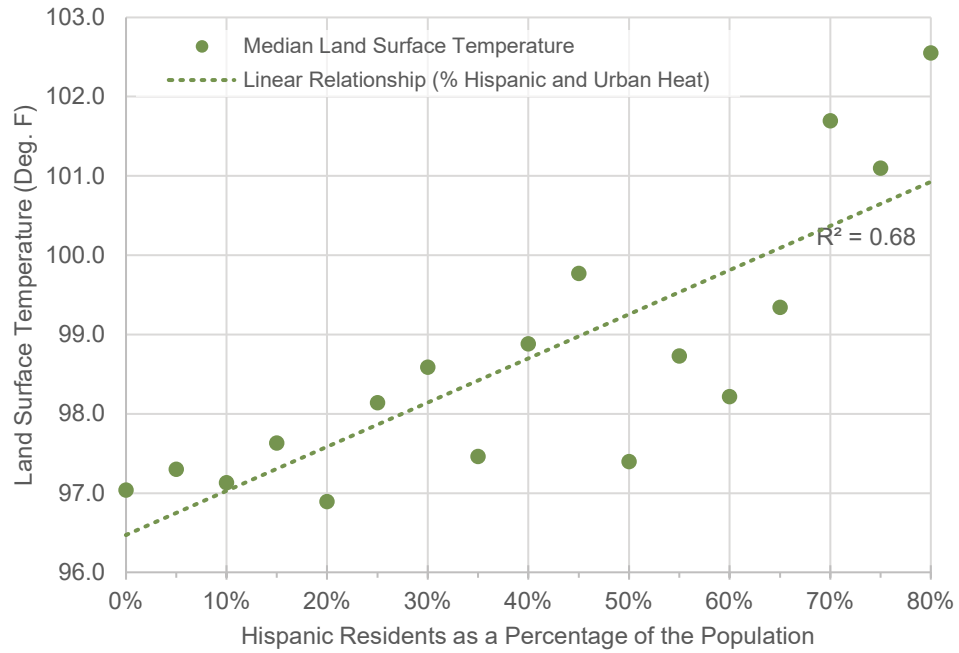


Figure 57. Urban Heat (Surface Temp.) by Percent Hispanic Residents

Land surface temperatures in the City of Tampa are generally hotter for neighborhoods with a greater proportion of residents who identify as Hispanic. Given the health concerns associated with urban heat, especially in the face of climate change, the City should consider addressing this apparent inequity.

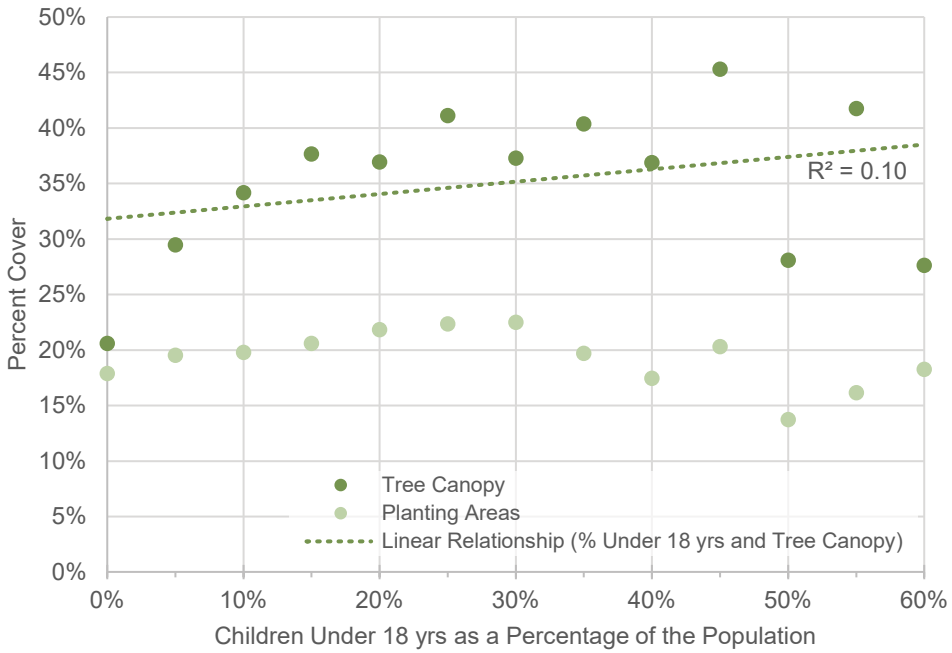


Figure 58. Tree Cover & Potential Planting Area by Percent Children Under age 18

Most cities treat children as a vulnerable population whose needs are considered when planning amenities (e.g., parks). Fortunately, the amount of tree canopy does not appear to be an equity concern in terms of the relationship with the proportion of children in Tampa's neighborhoods. In fact, tree canopy appears to be very slightly higher in areas with a higher proportion of children under 18 years old.

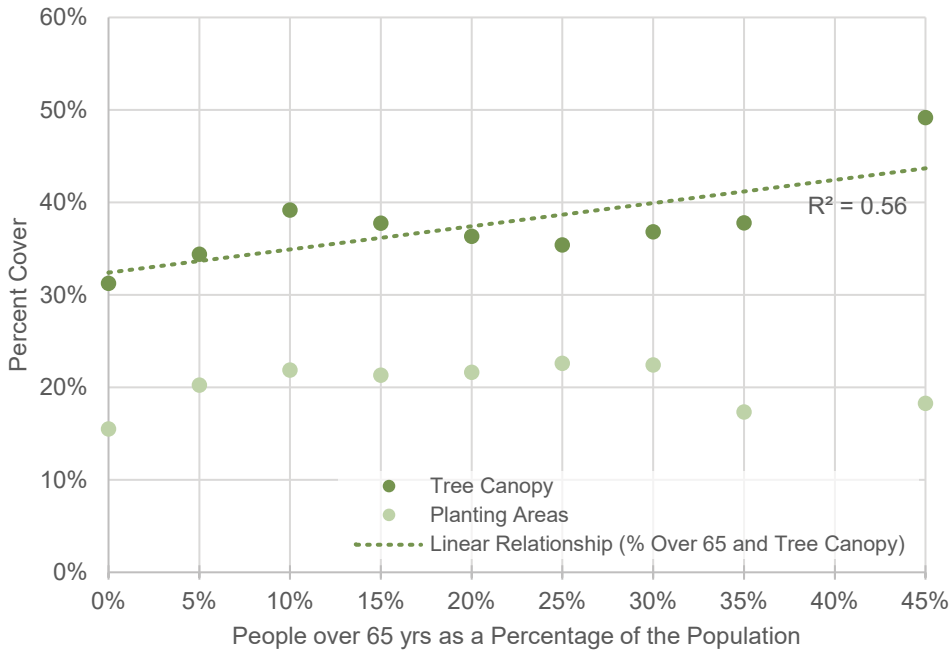


Figure 59. Tree Cover & Potential Planting Area by Percent Over age 65

Residents over the age of 65 are also considered a vulnerable population in certain contexts. In the City of Tampa, there is a fairly strong relationship between tree canopy and the proportion of residents over 65 years of age. Areas with more residents over age 65 appear to have a higher percentage of tree canopy. If trees are viewed as an amenity, there certainly do not seem to be any equity concerns. However, if the tree canopy in these areas represent older, unhealthy or hazardous trees then the relationship might be one for concern.

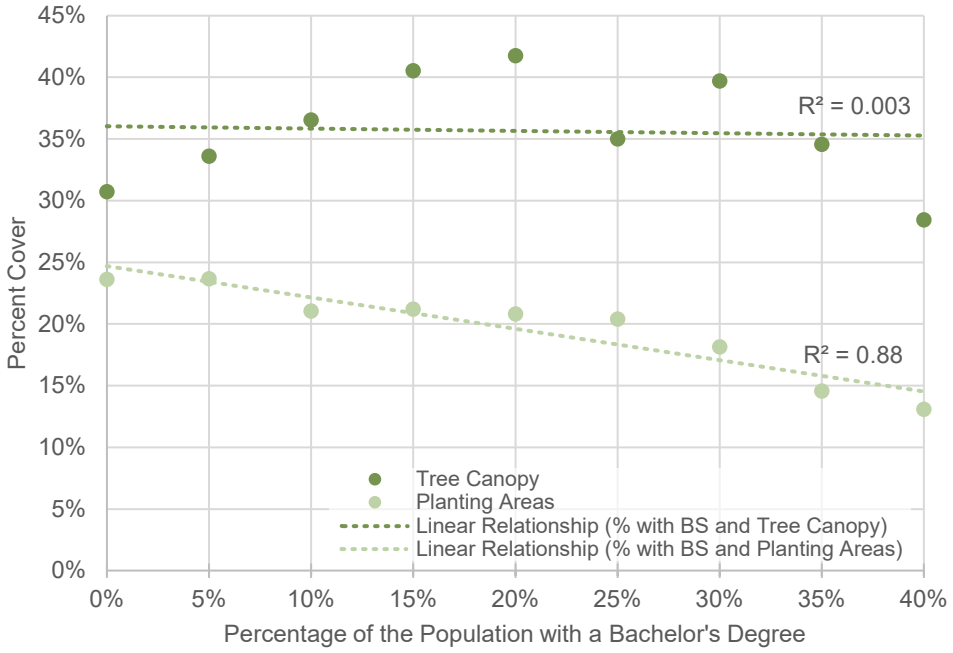


Figure 60. Tree Cover & Potential Planting Area by Percent with BS Degree

Although some scientific studies have found a positive relationship between the amount of tree canopy and the education level of residents, there does not appear to be much of a trend within Tampa. However, there does seem to be a strong relationship between planting areas and education level, with somewhat fewer potential planting areas in neighborhoods that have a higher proportion of residents with a bachelor's degree. The reason or implications of this relationship are unclear.

Equity Analysis Conclusions

The results shown above suggest a few potential concerns when considered in the context of environmental equity. First, as has been shown in many equity studies, wealthier neighborhoods in Tampa appear to have more tree canopy and cooler summertime temperatures. Areas in Tampa with a greater proportion of renters generally have less tree canopy and more urban heat. In addition, neighborhoods with a higher proportion of Hispanic residents do have both less tree canopy and hotter urban heat. Areas of Tampa with more children under the age of 18 seem to have slightly more tree canopy, but the relationship is not strong. Neighborhoods with more older residents (people over age 65) also have a slightly larger percentage of tree canopy. In contrast, there does not appear to be a relationship between the amount of tree canopy and the population density, percentage of black residents, or education level of residents (% with a bachelor's degree).

Some of these results might be a cause for concern from the perspective of environmental equity with the distribution of tree canopy and urban heat in Tampa. However, in most cases there appears to be a sufficient amount of potential planting areas to proactively target tree planting activities to address the equity concerns.

Preparation to move a very old, large Live Oak at University of Tampa.

Urban Forest Economic Benefits and Ecosystem Services

The urban forest provides countless benefits, including serving as a habitat for plants and animals (Goddard et al. 2017), decreasing human stress (Jiang et al. 2016), and providing ecological functions such as air filtration (Chen et al. 2017) and stormwater management (Xiao and McPherson 2017). In the following sections we will discuss the benefits of energy conservation, air pollution removal, carbon storage and sequestration, structural values, and avoided stormwater runoff, all considered to be ecosystem services due to their positive impact on human health and welfare (Escobedo et al. 2011). The i-Tree Eco model helps calculate an economic value for these more tangible services, which in turn allows managers and citizens to gauge the importance of the urban forest. In 2021 Tampa's urban forest provided an estimated $306 million/year worth of ecosystem services and an additional $2.04 million in overall structural value (Tables 17 and 18).

Table 17. Summary of ecosystem services and annual values of Tampa's trees in 2021.

Ecosystem Services	Annual Value (million $)
Building energy savings[a]	$5.9
Avoided carbon emissions[b]	$1.6
Gross carbon sequestration[b]	$12.9
Carbon storage[b]	$264.0
Air pollution removal[c]	$6.8
Avoided health care costs	$9.9
Avoided stormwater runoff[d]	$4.9
Total Annual Benefits	$306.0

a Energy saving value is calculated based on the prices of $117.10 per MWH and $22.34 per MBTU.

b Carbon is valued at $170.55 per ton.

c Pollution removal value is calculated based on the prices of $1,327 per ton (CO), $3,016.24 per ton (O3), $480.30 per ton (NO2), $175.41 per ton (SO2), $157,456.24 per ton (PM2.5), and $6,237.90 per ton (PM10*).

d Avoided runoff value is calculated by the price $0.067/ft³ and 51.7 inches of total annual precipitation.

Structural Values

Structural value is based on local estimates of the cost of replacing a tree that has been lost intentionally or unintentionally (e.g., storm) with a similar tree. Structural value of an urban forest often rises as the number and size of healthy trees increases. Structural values are estimated in i-Tree Eco using valuation procedures of the Council of Tree and Landscape Appraisers. Tampa's urban trees had a total structural value of $2.03 billion, with live oaks and laurel oaks making up around 45% of the total structural value of the forest (Table 18).

Table 18. The structural values of 10 species in Tampa's urban forest in 2021.

Species	Structural Value ($)*	Percentage of Forest's Total Structural Value (%)
Live oak	$ 677,410,447	33%
Laurel oak	$ 249,423,267	12%
Cypress species	$ 158,167,737	8%
Cabbage palm	$ 72,478,406	4%
Brazilian pepper	$ 52,436,093	3%
Swamp tupelo	$ 23,026,763	1%
Carolina laurelcherry	$ 6,322,032	0.3%
Longleaf pine	$ 21,886,647	1%
Mexican fan palm	$ 14,936,797	1%
Earpod tree	$ 26,674,374	1%
All Other Species	$ 729,510,274	36%
All species citywide	**$ 2,032,272,837**	

*Structural value is the compensatory value calculated based on the local cost of having to replace a tree with a similar tree.

Figure 61. Shading of buildings and air conditioning units can reduce cooling costs.

Energy Conservation

Urban trees play a role in energy consumption and can contribute to reduced energy usage in adjacent buildings by providing shade, serving as windbreaks, and through evaporative cooling (Pataki et al. 2011). This reduction in energy consumption can result in financial savings for residents and an overall decrease in the demand for fossil fuels. Trees that were at least 20 feet tall and within 60 feet of a residential building under 3 stories were included in calculations (McPherson and Simpson 1999). The i-Tree Eco model provides energy conservation estimates in megawatt hours (MWh; electricity use) and million British thermal unit (MBtu; natural gas use), as well as the related carbon emissions avoided due to a reduction in fossil fuel use. Energy conservation estimates were calculated for residential buildings using the average statewide consumption rates of $117.10 per MWh, $22.34 per MBtu, and a sequestration value of $170.55 per ton of carbon.

Tampa's trees are estimated to reduce annual energy consumption by a total of 53,769 MWh of energy valued at $6.3 million (Table 19). Tree shading of homes also led to an increase in energy usage for heating by an estimated 16,456 MBtu and 753 MWh, valued at a cost of $455,803. The City's trees also provide an extra $1,568,138 in value by decreasing the amount of carbon released by fossil-fuel based power plants by 9,195 tons.

Table 19. Annual energy savings and associated dollar values due to the proximity of residential buildings to trees in 2021.

Type	Heating	Cooling	Total	Price ($)	Value ($)
Natural Gas (MBtu)[a]	(16,456)	n/a	(16,456)	$ 22.34	($ 367,573)
Electricity (MWh)[b]	(753)	54,523	53,769	$ 117.1	$ 6,296,387
Carbon Avoided (ton)	(478)	9,672	9,195	$ 170.55	$ 1,568,138
Net Savings ($):	-	-	-	-	$ 7,496,952

Estimates that represent an increase in energy use, carbon emissions, and costs are represented by the red colored values in parentheses. Energy and carbon savings are calculated based on the prices of $117.10 per MWh, $22.34 per MBtu, and $170.55 per ton carbon. (a Million British thermal units; b Megawatt-hours)

Air Pollution Removal

Airborne pollutants are a concern as they can harm both living components (e.g., human health) and non-living (e.g., built infrastructure) components, alter ecosystem processes, and reduce visibility. Some of the most toxic pollutants include carbon monoxide (CO), nitrogen dioxide (NO_2), ground-level ozone (O_3), fine particulate matter ($PM_{2.5}$ and PM_{10}*), and sulfur dioxide (SO_2). Carbon monoxide is a gas that is released into the atmosphere through the burning of fossil fuels, including activities such as driving. Nitrogen dioxide is a respiratory irritant which reacts with other volatile organic compounds in sunlight to form ground-level ozone (O_3 or smog), which can also cause respiratory problems. Fine particulate matter under 2.5 micrometers in size ($PM_{2.5}$) describes inhalable particles that can penetrate the lungs and create respiratory issues. Finally, sulfur dioxide is a compound that can harm the respiratory system and react to form other sulfur oxides, acid rain, and components of particulate matter.

Trees in the urban forest can help combat these airborne pollutants by removing pollutants directly through uptake or deposition (Chen et al. 2017) and indirectly reducing pollutant emissions from power sources by decreasing energy consumption (Simpson 2002). Additionally, the rate of ground-level ozone formation increases with rising temperatures, therefore trees can reduce the rate of ozone creation by helping lower urban temperatures (Livesley et al. 2016; Nowak & Dwyer 2007). Trees regularly uptake gaseous pollutants such as carbon monoxide (CO), nitrogen dioxide (NO_2), ozone (O_3), and sulfur dioxide (SO_2) through specialized openings on their leaves called stomata. Particles that cannot be taken up by stomata can still get caught on leaf surfaces and thereby removed from the air (Grantz et al. 2003).

In 2021, the trees and shrubs of Tampa's urban forest removed a total of 1,412 tons of pollutants from the atmosphere at an estimated value of $9.4 million (Table 20). The i-Tree Eco model calculates the amount of pollution eliminated based on local incidence of adverse health effects and national median externality costs using the 2013 Environmental Protection Agency (EPA) air pollution and weather monitors in Tampa. Value estimates for CO are based on the median externality value and producer price index following guidelines by Murray et al. (1994). The number of adverse health effects and associated value estimates for NO_2, O_3, $PM_{2.5}$, PM_{10}* and SO_2 were calculated using US EPA's Environmental Benefits Mapping and Analysis Program (BenMAP) (US EPA 2015).

The BenMAP model used by i-Tree Eco estimates the reduction in health impacts and associated economic benefits, including potential savings in health care costs that result from fewer pollutants in the City's atmosphere. The estimated reduction in airborne pollutants caused by Tampa's trees and shrubs results in approximately $8,005,510 in savings in health care costs (Table 21).

Table 20. Average annual tonnage and associated dollar values for pollutants removed by trees and shrubs in 2021.

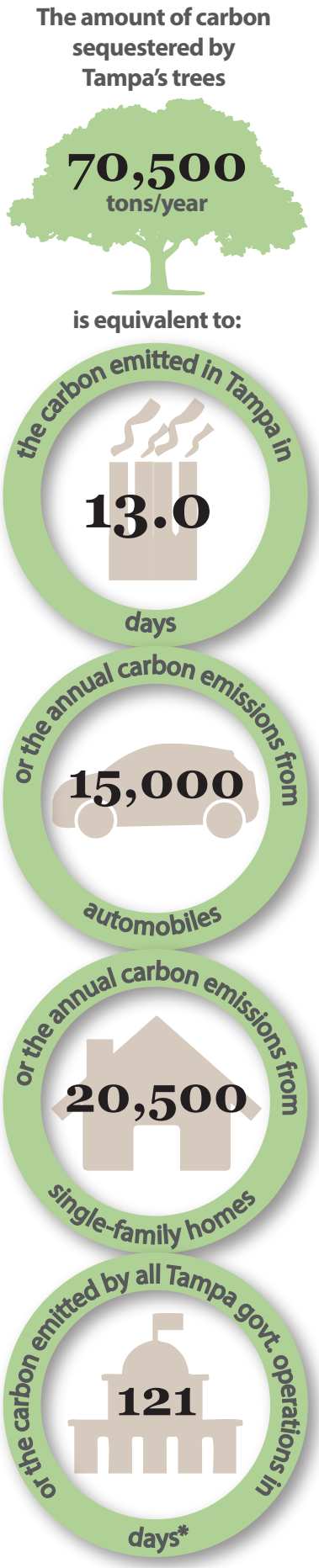
Pollutant	Removal (US short ton)	Value ($)*
CO	23.30	$ 30,915
NO_2	104.93	$ 50,396
O_3	996.71	$ 3,006,331
PM_{10}*	225.86	$ 1,408,877
$PM_{2.5}$	31.40	$ 4,943,494
SO_2	30.15	$ 5,289
Total	**1,412**	**$ 9,445,302**

* Pollutant prices are based on the figures $1,327 per ton carbon monoxide (CO), $3,016.24 per ton ozone ($O_3$), $480.30 per ton nitrogen dioxide (NO_2), $175.41 per ton sulfur dioxide (SO_2), $157,456.24 per ton particulate matter less than 2.5 microns ($PM_{2.5}$), and $6,237.90 per ton particulate matter less than 10 microns and greater than 2.5 microns (PM_{10}*).

Table 21. Estimated annual economic benefits of reduced health impacts from airborne pollutant reduction by trees and shrubs in 2021.

	Value ($/year)			
	NO_2	O_3	$PM_{2.5}$	SO_2
Trees	$ 35,754	$ 2,131,890	$ 3,538,253	$ 3,735
Shrubs	$ 14,642	$ 874,441	$ 1,405,241	$ 1,554
Total	**$ 50,396**	**$ 3,006,331**	**$ 4,943,494**	**$ 5,289**

"Value" is the economic value is associated with the incidence of adverse health effects.



* City of Tampa Greenhouse Gas Inventory, 2019

Carbon Sequestration and Storage

Carbon dioxide (CO_2) is a major greenhouse gas and contributor to global climate change. Urban trees help mitigate climate change indirectly by reducing energy consumption and associated emissions from fossil-fuel burning energy plants and directly by removing and using atmospheric carbon (Abdollahi et al. 2000; Nowak & Crane 2002). Trees process carbon dioxide during photosynthesis and incorporate it into their tissue, thereby sequestering or holding the carbon until the tree dies. Since carbon is incorporated into new tissue, vigorous, healthy trees often sequester carbon at higher rates than unhealthy ones. Sequestration rates also vary by tree species and size. Using wood from deceased trees for energy production or recycling it into long-term use items can also help decrease carbon emissions from tree decomposition.

Gross carbon sequestration is the total amount of carbon sequestered (i.e., removed) by trees, whereas net carbon sequestration is the amount of carbon sequestered minus the amount that is released back into the atmosphere once the tree dies. The annual gross carbon sequestration of Tampa's urban trees in 2021 was about 76,061 tons with an associated value of $12,972,293. Net carbon sequestration in the urban forest was approximately 70,501 tons with an associated value of $12,023,946, indicating that Tampa's urban forest is a carbon "sink" which removes more atmospheric carbon than it releases. Net carbon sequestration varies by species with cypress as the top species (15,065 tons net carbon sequestration), followed by white mangrove (9,394 tons), and laurel oak (8,394 tons) (Figure 62).

Tampa's urban trees stored approximately 1.4 million tons of carbon at a value of $238 million. Live oak stores the most carbon (approximately 27% of the total carbon stored) followed by cypress (25%) and laurel oak (12%) (Figures 59 and 60). Residential single-family areas have the greatest amount of storage with 406,145 tons of carbon stored (29% of the total). These were followed by Natural and Conservation Lands (403,580 tons and 28.8% of total stored) (Table 22). Natural/conservation lands have the greatest carbon storage on a per area basis—76 tons CO_2 per acre—compared to 20 tons per acre in single-family residential. Public Communications Utility, Agricultural, and Water land use areas store the least amount of carbon. The sequestered carbon is stored in the tree's tissue until the tree dies and decomposes, so keeping trees healthy and alive slows the release of carbon.

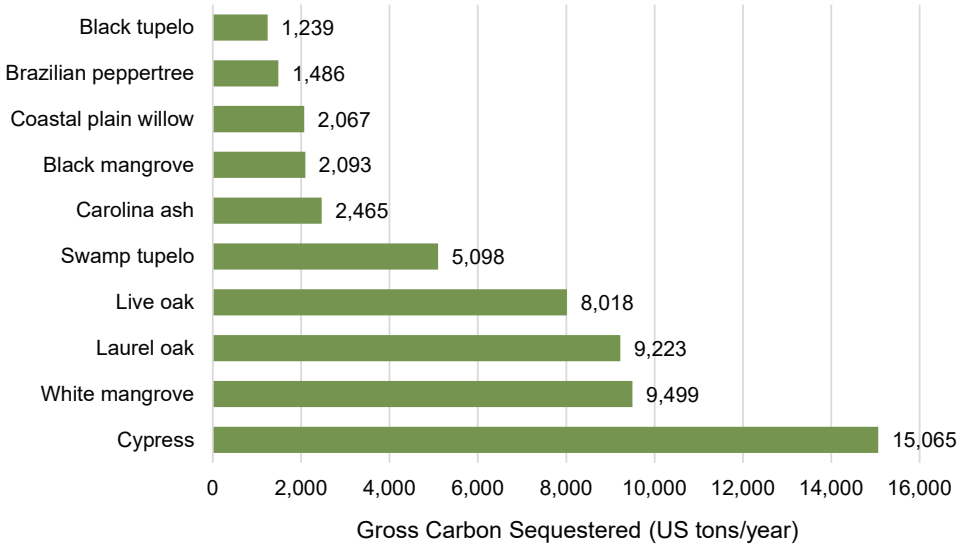


Figure 62. The 10 species in Tampa's urban forest which sequestered the most gross carbon in 2021.

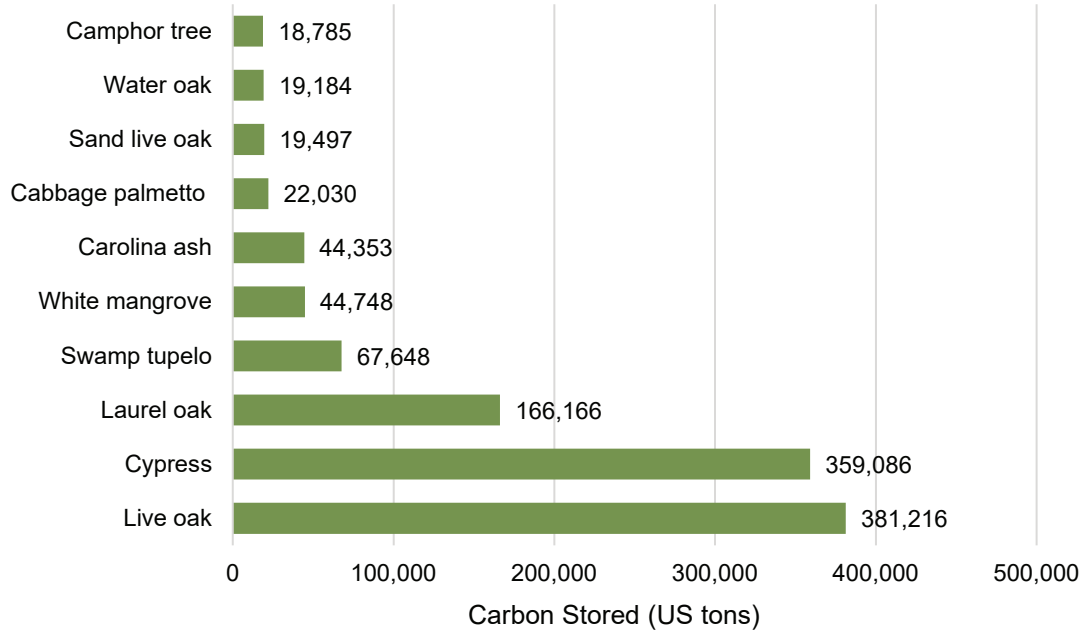


Figure 63. The 10 species in Tampa's urban forest which stored the most carbon as of 2021.

Table 22. Carbon storage of trees by land use and percent acreage.

Carbon storage (%) is the percentage of citywide carbon storage within that land use, and percent of city (%) is the percent of land area represented by that land use.

Land Use	Carbon Storage (tons)	Carbon Storage (%)	Percent of City (%)
Residential Single-Family	406,146	29.00%	27.2
Natural / Conservation Lands	403,580	28.80%	7.1
Right-of-Way / Transportation	124,946	8.90%	17.3
Public Institutional	107,699	7.70%	16.9
Commercial	83,795	6.00%	9.3
Residential Multi-Family	76,203	5.40%	4.7
Industrial	53,486	3.80%	3.8
Private Institutional	49,056	3.50%	2.8
Parks / Recreation	46,393	3.30%	3.3
Mangrove	24,666	1.80%	1.6
Water	24,525	1.80%	4.0
Public Communications Utility	725	0.10%	1.5
Agricultural *	0	0.00%	1.5
Total	**1,401,222**	**100%**	**100%**

* Note: Agricultural category is represented by only one sample plot.

Avoided Runoff

When precipitation falls onto the land some of it is intercepted by trees and other vegetation, another portion of it infiltrates ground, and the rest becomes surface runoff. In urban environments impervious surfaces like paved roads and parking lots prevent infiltration, thus increasing surface runoff. Some of this runoff flows towards the nearest body of water, picking up pollutants along the way. Urban trees can help mitigate the negative effects of excessive and polluted surface runoff by catching precipitation before it hits the ground (Livesley et al. 2014; Inkiläinen et al. 2013; Xiao and McPherson 2011). Additionally, tree roots can help encourage infiltration into urban soils that are often hard to penetrate (Bartens et al. 2008).

The i-Tree Eco model estimates avoided surface runoff as the difference between annual runoff with and without vegetation based on the rainfall intercepted by vegetation. The model also takes into account estimated number of trees and their associated leaf area and local weather data. In 2021 Tampa's urban forest (trees and shrubs) reduced the amount of runoff by 74.8 million cubic feet with an associated value of $4.9 million. Live oak, laurel oak, and cypress trees contributed to the most runoff avoided for a combined amount of 35.7 million cubic feet per year (51% of the total runoff avoided by trees) at a value of $2.6 million (Table 23). These species also make up 51% of the total leaf area. The land use category where the most runoff was avoided by trees was Residential Single-Family, which accounted for approximately 30% of the total runoff avoided at a value of $1.5 million (Table 24). The second highest land use category with avoided runoff by trees was natural/conservation lands, providing a total runoff avoided value of $1.4 million.

Table 23. Amount of avoided runoff and water intercepted by 10 tree species in 2021.

Species Name	Water Intercepted (ft^3/yr)	Avoided Runoff (ft^3/yr)*	Avoided Runoff Value ($/yr)
Live oak	71,663,793	14,257,046	$ 953,024
Cypress	61,893,464	12,313,302	$ 823,093
Laurel oak	58,935,382	11,724,811	$ 783,755
Brazilian pepper	14,815,787	2,947,504	$ 197,028
Swamp tupelo	12,270,389	2,441,114	$ 163,178
Water oak	10,331,412	2,055,367	$ 137,393
Carolina ash	9,886,708	1,966,896	$ 131,479
American elm	7,991,930	1,589,943	$ 106,282
Cabbage palmetto	7,648,318	1,521,583	$ 101,712
Longleaf pine	7,499,027	1,491,883	$ 99,726

*Avoided runoff value is calculated by the price $0.067/$ft^3$ and the user-designated weather station report of 51.7 inches of total annual precipitation.

Table 24. Avoided runoff and water intercepted by trees within each land use (excluding the Water category) in 2021. Note: Agricultural category is represented by only one sample plot.

Land Use	Water Intercepted (ft^3/yr)	Avoided Runoff (ft^3/yr)*	Avoided Runoff Value ($/yr)
Single-family residential	114,127,742	22,704,972	$ 1,517,733
Natural/conservation lands	103,589,756	20,608,508	$ 1,377,593
Public institutional	29,060,667	5,781,431	$ 386,465
Right-of-way/transportation	27,331,339	5,437,392	$ 363,467
Industrial	21,587,369	4,294,667	$ 287,081
Commercial	20,712,460	4,120,609	$ 275,446
Multi-family residential	17,210,225	3,423,862	$ 228,871
Parks/recreation	16,335,067	3,249,755	$ 217,233
Private institutional	13,913,300	2,767,961	$ 185,027
Water	6,774,536	1,347,750	$ 90,091
Mangrove	4,447,575	884,816	$ 59,146
Public communications/utility	653,810	130,071	$ 8,695
Study Area	**375,743,845**	**74,751,794**	**$ 4,996,847**

*Avoided runoff value is calculated by the price $0.067/$ft^3$ and the user-designated weather station report of 51.7 inches of total annual precipitation.

Social Science Study

This subsection of the report focuses on the findings from research on urban forest social equity and values of residents, business and property owners, neighborhood associations, organizations, and other stakeholders. Details on the methods used are described below and included a public online and in-person survey (1067 responses), 35 interviews, 4 focus groups, and participation in public meetings and events related to Tampa's tree canopy between April 2021 and December 2022.

Understanding the Social Life of Trees in the City of Tampa

Trees are part of the fabric of life in the City of Tampa, like many cities around the U.S. However, results of our study indicate a very profound link between the urban forest in Tampa and residents' sense of place. For this study, researchers integrated a citizen's component in order to understand the importance of trees in our neighborhoods and public spaces, to determine where more information is needed, as well as to hear challenges residents may face with trees.

The Social Equity and Values components of the Tampa Tree Canopy and Urban Forest Study is a qualitative and quantitative anthropological study design that focuses on the human relationships with trees that make up the "urban forest" within City boundaries. The number, species, and locations of trees has changed significantly since the City of Tampa was founded and reflects many complex social decisions and trends, as well as environmental factors. Including diverse values and perspectives through the survey and interview data collection informs future plans for our urban forest. The diversity, health, and distribution of trees, among many other aspects, are detailed in prior sections of the study. This portion focuses on what people living, working, and playing in the City think about our trees. This includes values, concerns, challenges, priorities, experiences, and imagined futures for trees as a fundamental part of the landscape in our city.

In her book, *Nature, Culture, and Big Old Trees*, Kit Anderson explains that in many cities and towns in the Southeastern U.S., particularly in coastal areas, Live Oaks and other large, "Grand" trees are "integral to a local sense of place, because personal, community and natural events and memories" are tightly linked to trees; in some cases, even individual trees (2003). She also explains that trees "tell stories" about the people who live with them: which species are planted, their location, their size and shape, and ultimately, their return back to the earth or removal.

The concept of an "urban forest" is a relatively new idea, but relationships between trees and city-dwellers have changed over time and tree canopies continue to be a significant feature for many cities around the world (Roman et al. 2018). "Social equity" related to trees and tree canopy is important because of the roles that trees play in the social, economic, and ecological well-being of urban areas. Trees provide many important amenities and services in the city: aesthetics, shade from heat, increased biodiversity, improved air quality, and numerous others (Landry and Chakroborty 2009). However, trees also have negatives for many urban residents too: contributing to allergies, risk of losing branches or trees coming down in storms, as well as yard debris, among others (Conway and Yip 2016). The benefits of trees and the drawbacks all need to be considered for maintaining or increasing urban tree canopy (Battaglia et al. 2014).

We know there is neighborhood variability in the City of Tampa with regards to tree canopy, and that the results of previous studies (Landry and Chakroborty 2009, Previous Tree Canopy Study reports) indicate that there is a "significantly lower proportion of tree cover on public right-of-way in neighborhoods containing a higher proportion of African-Americans, low-income residents, and renters (Landry and Chakroborty 2009, p. 2651)." Addressing "tree equity" is a component of the City's Urban Forest Management Plan and forms a key part of the study. But, beyond that:

- What would residents in different neighborhoods of Tampa like to see for the future of trees in the City?
- How do people in the varied and diverse areas in Tampa think about trees in their yard, their neighborhood, and across the City?
- How do values and concerns impact Tampa's urban forest and decisions about trees in the City?

- What are public perceptions about benefits or drawbacks to the urban forest?
- What priorities do residents have related to trees, and how do priorities and concerns vary by demographic factors such as age, ethnicity and race, occupation, and location in the City?
- How do participants view the City's management of trees and key challenges facing our urban forest?

We sought to answer each of these questions, but ultimately, this portion of the study focuses on what trees mean for residents, policy makers, resource managers, developers, business owners, and others who make Tampa their home. To study this, we carried out research to contextualize the online/in-person public survey, including interviews, focus groups, presentations at public meetings, neighborhood association meetings, and media content analysis, following a definition of what Ogden et al. term, "forest ethnography," a "research approach that specifically explores the ways ecological and social processes interact to produce our environments and shape the experience of being human in those environments over time (Ogden et al. 2018)."

Purpose of the Social Equity Survey and Interviews

The scope of work for this study included a plan to "conduct a survey (in English and Spanish) of business owners, homeowners, the general public" as well as speaking with the City of Tampa's Internal Technical Working Group and the Natural Resources Advisory Committee to evaluate the Community Framework performance indicators specified by the Urban Forest Management Plan, including: neighborhood cooperation; awareness of trees as community resource; citizen-municipality-business interaction; and support by private land holders. The City of Tampa agreed that our team would conduct a social survey to understand opinions about trees and urban forest management. As mentioned above, to supplement the survey and ensure participation by residents from across the City's neighborhoods, in-depth interviews (typically 30 minutes to an hour) were also conducted.

The main questions the study addresses are listed in the previous section describing the background for the study. Although urban forest canopy research has been carried out for decades in many cities in the U.S., it is less common for studies to draw on qualitative or mixed-methods approaches, which according to a recent review of Nature-based solutions (NbS, such as urban tree planting) and environmental justice implications, is needed to "provide more complex information for…practitioners and planners (Kato-Huerta et al. 2022:129)." This type of data is "needed to account for experiential, tacit, or local knowledge that may be key for community-based…planning or to explore the diversity of values among stakeholder groups. Moreover, in combination with quantitative methods, qualitative research could provide more information on the narratives from collective or individual experiences with environmental risks and hazards in different urban contexts (Kato-Huerta et al. 2022: 129)." In another study of public values of urban forests, Ordóñez et al. (2017) also suggest that more research that integrates values and uses mixed-methods and open-ended study design, such as used in our study, has the potential to enhance management of the urban forest as values of urban residents are better understood. These previous studies shaped our aims and methods.

Social Science Methods of Data Collection and Analysis

Anthropological social science methods guided our research approach and we prioritized an iterative study design (Bernard 2017), where each phase built on data collected and what we learned from the previous one (see Table 25 for a summary of all methods used for this portion of the study).

Data Collection, Analysis and Write-Up Process and Timeline

During Phase 1, we developed a survey based on a systematic review of existing survey study findings from the urban forestry literature, as well as four digitally-recorded focus groups between April-May 2021 with City staff from the Natural Resources Planning Department, Forestry, Parks and Recreation, and Office of Sustainability, conducted via virtual meetings (on Microsoft Teams) and informal interviews with members of the Natural Resources Advisory Committee as well as residents and business owners.

The data collected in Phase 1 informed Phase 2 development and distribution of an online survey and informational website hosted by the USF Water Institute, which was available in English and Spanish, as well as 35 half hour to an hour-long semi-structured interviews with residents, business owners, local environmental organizations, and developers over 15 months. Phase 3 involved data analysis of survey results and qualitative data analysis of interview transcripts through coding for important themes and understanding patterns of variation across demographic characteristics, geography, and other social categories (Bernard 2017). Phase 4 includes data and report dissemination.

Table 25. Social Equity and Values Social Science Methods of Data Collection.

Phase 1: Survey development (April-May 2021)
• Interviews with Key Stakeholders from the City of Tampa (4 recorded focus group discussions)
• Development of closed and open-ended survey questions based on interview transcripts and previous research on urban tree canopy in Tampa and in other cities
• Feedback and edits from City staff; Pre-testing and revision of survey with residents; translation of survey and flyer to Spanish
• Official launch of online Qualtrics survey on Earth Day April 22, 2022
• Three rounds of social media distribution of survey by City and study team, with specific outreach to all Neighborhood Association leaders by email
Phase 2: Survey and Interview Data Collection (May 2021-August 2022)
• Online survey was open between April 22, 2022 and August 7, 2022
• Recruitment of interviewees from survey respondents (300+ individuals completing the survey, close to 40%, volunteered to be interviewed), and referral sampling including residents, developers, community leaders across all neighborhoods, many on site (total of 35 interviews).
• Attendance at public meetings and events (tree giveaway, two neighborhood association meetings, public markets, surveying in person)
• Completed survey responses (n=1067) analyzed by zip code to ensure systematic interview representation by all areas of the City to address equity goals
Phase 3: Quantitative and Qualitative Data analysis of Survey Responses & Interview Transcripts (August 2021-August 2022)
• Tables, graphs, figures of responses (Qualtrics)
• Analysis of data across age, race and ethnicity, socio-economic status, gender, zip code, homeowner vs. renters, etc.
• Export of survey open-ended responses to Dedoose Qualitative Data Analysis software
• Transcripts of interviews created with thematic coding in Dedoose Qualitative Data Analysis software
Phase 4: Summary of Findings, Recommendations & Sharing Results (August 2022-Dec. 2022)
• Recommendations for future urban forestry management plan implementation
• Formal report and presentation to the City of Tampa's City Council and City Staff
• Sharing results at public meetings and events
• Emphasis on understanding variation in values, priorities, and concerns across all areas of the City to address equity goals
• Consideration of overlapping and synergistic factors from tree canopy analysis findings with social science and equity findings

Public Survey on Social Equity and Values

Our team of social scientists from the University of South Florida (Zarger, Rib, and Landry) developed and conducted a mixed methods online/in-person survey of business owners, homeowners, and the general public with input from numerous City of Tampa staff. The online survey, which was created in online survey software Qualtrics, took on average 15 minutes to complete, with closed-ended and open-ended questions. Participants could complete the survey using personal computers, tablets, or mobile devices; the format of all questions was tested for readability on mobile devices assuming that is how most participants would engage with the survey.

Online and in-person survey techniques were employed (with identical questions) in order to collect the opinions of a large sample of all the public residing in the City of Tampa, with strategic effort to include minority and underrepresented groups as participants and to represent diverse geographies and viewpoints across areas of the City. Surveys were completed in person with participants on four separate dates, in downtown Tampa, along the Riverwalk, at Water Works Park, in Ybor City, and in Hyde Park. We presented information about the study at the Hampton Terrace Neighborhood Association meeting and a monthly meeting of the East Tampa Community Redevelopment Partnership, and at a Neighborhood Association event in Ybor City, where attendees were encouraged to complete the survey at that time. The use of an online survey decreased costs while also improving accessibility. The survey was available in English and Spanish, and the online survey met website ADA accessibility standards.

Distribution of the Survey

There were three separate waves of social media posts encouraging the public to take the online survey, led by City of Tampa communications and media staff as well as the study team, including Facebook and Instagram, a dedicated link on the Natural Resources Web page, and news media coverage on local TV and print media. Flyers for the Tree Canopy Study Survey in English and Spanish were distributed in digital, paper, and postcard form to residents to encourage participation from all areas of the City of Tampa (see Figure 65). The survey was promoted at the Mayor's Tree Giveaway in concert with Earth Day, 2022 and at other public meetings in the City. As mentioned above, a second survey technique used was an intercept in-person survey at selected public locations in Tampa, such as the Riverwalk, Ybor City and others. Members of the research team asked members of the public using those public spaces to take the survey, and they used a mobile device to complete the answers on their own or as the research team asked them each question on the survey.

Participation in the survey continued throughout the time it was available (April-early August 2022), with some spikes in interest after each wave of information-sharing or public event. Distribution of the survey link also included specific outreach to all Neighborhood Association leaders by email with a text announcement with a survey link and a digital flyer to send to their members. A follow-up reminder was also sent, and study staff mentioned that if Neighborhood Association leaders were interested in setting up an interview with us, we encouraged them to do that. This target outreach and distribution of the survey resulted in participation in the majority neighborhoods of the City. Completed survey responses (n=1067) analyzed by zip code prior to the survey closure date to ensure systematic representation by all areas of the City to address equity goals. For areas where fewer survey participants had completed the Qualtrics survey, we contacted participants in that zip code who had expressed willingness to participate in an interview, to do so. This ensured more detailed representation of concerns by all zip codes, neighborhoods, and planning districts than is reflected in the survey alone.

Figure 64. City Planning Senior Forester Examiner Brian Knox with members of the organization CLEO-Tampa at the Mayor's tree giveaway, April 2022. Photo by R. Zarger.

Figure 65. Flyers for the Tree Canopy Study Survey in English and Spanish were distributed in digital, paper, and postcard form to residents to encourage participation from all areas of the City of Tampa.

The survey instrument was deployed within an online program called Qualtrics and collected voluntary data from participants on self-identified race, ethnicity and gender, broad categories of household income, education level, status as homeowner or renter, and general location (i.e., zip code and/or Planning District). Survey data were analyzed through qualitative and quantitative methods of analysis, including data cleaning and recoding for statistical analysis using quantitative data analysis software SPSS to test for patterns of agreement and disagreement as well as variability across survey responses. Tables and graphic figures of responses were generated in Qualtrics responses from survey open-ended questions and were exported verbatim for additional analysis in Dedoose Qualitative Data Analysis software.

The results from the survey are compiled and summarized in this report in order to evaluate the Community Framework performance indicators specified by the Urban Forest Management Plan, including: neighborhood cooperation; awareness of trees as community resource; citizen-municipality-business interaction; and support by private landholders. The results provide information to understand the extent to which the community values trees and the urban forest in terms of environmental, social and economic well-being. Results also provide information about public opinions of the Tree and Landscape code and the City's tree management and permit processes. The survey results provide valuable information about how people view the positive and negative aspects of trees in the City of Tampa. Using data from the survey, the analysis shows how public opinions differ based on race and ethnicity, age category, broad categories of household income, business owners, homeowners compared to renters, and geographic location (i.e., zip code and/or Planning District).

Interviews with Key Stakeholders in the Urban Forest

As described above, study team members Kira Rib and Rebecca Zarger carried out 35 semi-structured audio-recorded interviews with residents, business owners, local environmental organizations, and developers and others throughout the City over a number of months. An additional seven interviews were completed and recorded by small teams of undergraduate and graduate students in the Environmental Anthropology fall 2022 course taught by Dr. Zarger. Sample interview questions are listed in Figure 66. The interviews were typically between a half hour to an hour long, but some were much longer. We received around a dozen emails independently from residents asking to participate in an interview who had seen the information on the survey and wanted to reach out to us to share their views—an unusually high response.

The study team met with interviewees on their front porches, walked and talked with interviewees in their yards and along the streets in their neighborhoods, met at coffee shops and places of business, or at public parks to discuss their views and concerns about trees in our City. The interviews were targeted to represent the geographical and demographic variation across all parts of the City and were particularly valuable to contextualize the survey results and to strive to meet the equity aims of the study, a component of the study that went beyond the original scope of work. Interviews were transcribed in their entirety, and thematic analysis using Qualitative Data Analysis software known as Dedoose (see Figure 67) was used to gain a better understanding of patterns of agreement and disagreement across interviewees.

Figure 66. Sample list of interview questions for the qualitative portion of the study.

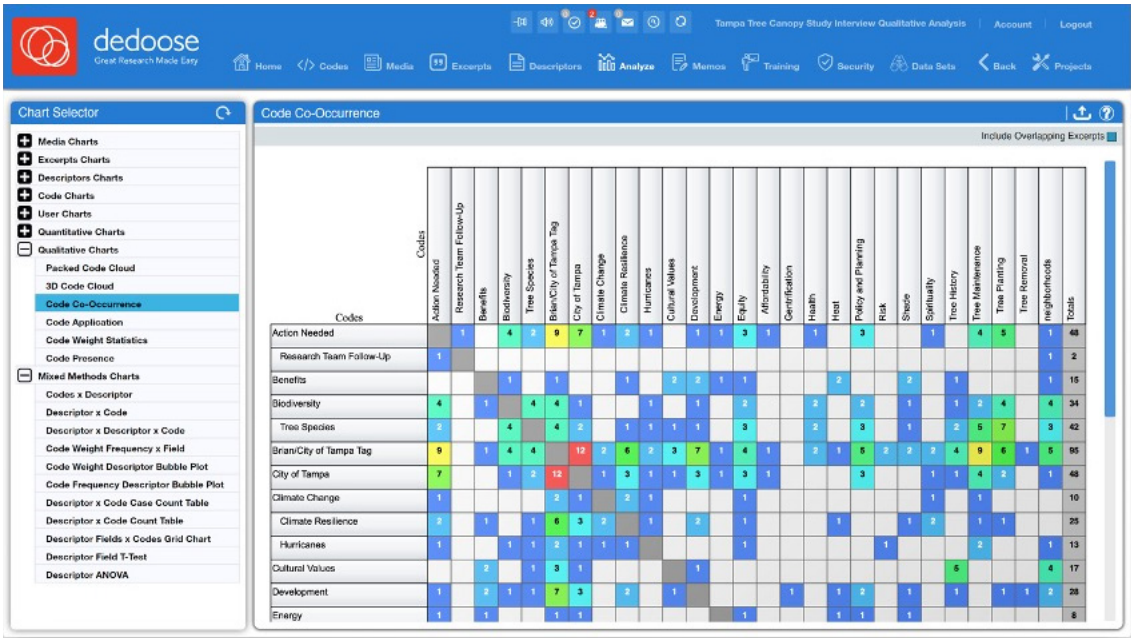


Figure 67. Code correlation analysis using qualitative data analysis software Dedoose.

Who Participated in the Public Survey?

The public survey provides a robust, representative sample of the City of Tampa. Participation in the survey was higher than expected and as mentioned elsewhere in the report, more than a third, or 300+, of survey participants volunteered for an interview, which is an unusually high number. Demographic representation with regards to age, income level, length of residence, and gender was reflective of the City census data as a whole, though more participation with the Spanish version of the survey (13 people completed the survey in Spanish) and with African American/Black, Asian, and Hispanic/Latino residents was clearly needed and is a limitation. Demographics of the participants of the survey portion of the project are described below.

The survey captured both newer and longer-term residents in the City of Tampa, with a mean of 7.16 for number of years participants had lived in their neighborhood.

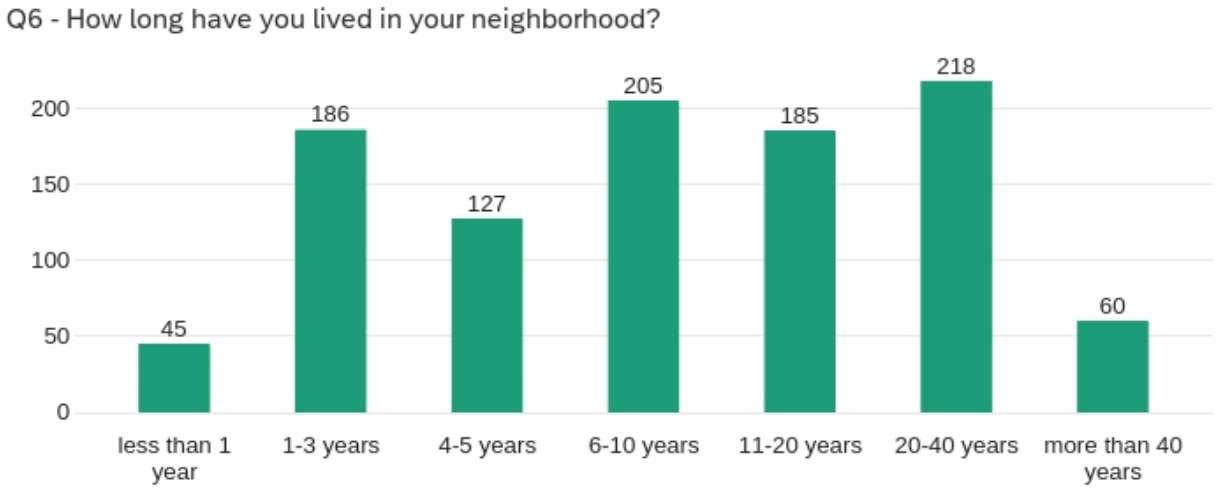


Figure 68. The public survey sample was fairly evenly distributed between newer and longer-term residents in the City of Tampa, with a mean of 7.16 for number of years participants had lived in their neighborhood.

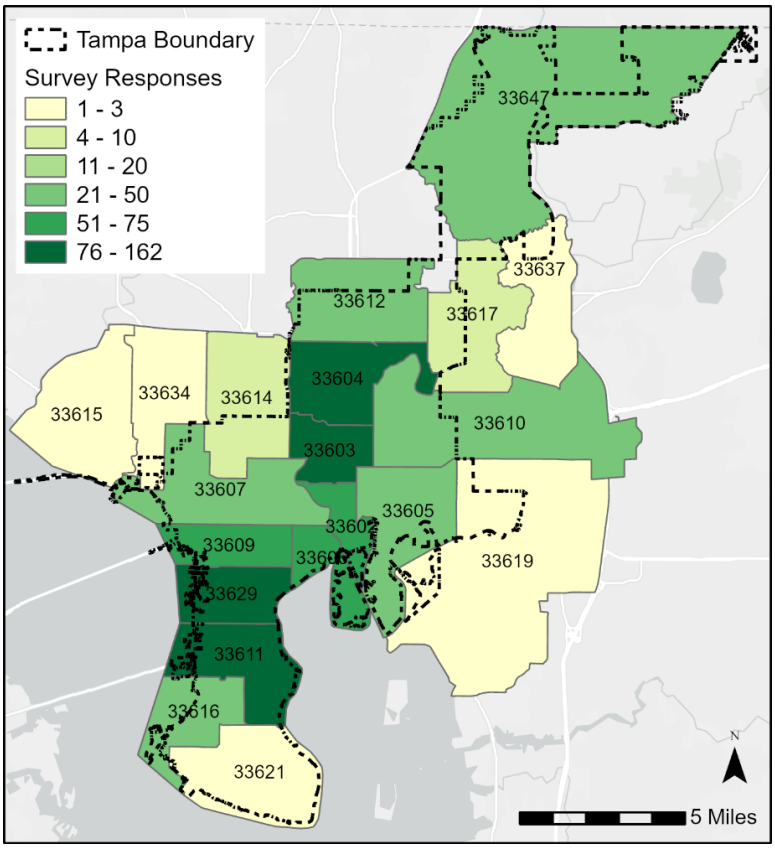


Figure 69. Number of respondents to public survey by zip code, with darker shaded areas having the most participants. As the study progressed, additional interviews were completed in targeted zip codes with fewer survey participants (lighter green areas) to ensure public views from all areas of Tampa are represented. This was a key way to ensure equity and demographic variability were captured by our methodology.

The following graphs and tables provide a summary of additional demographic information that was provided by participants who completed the survey.

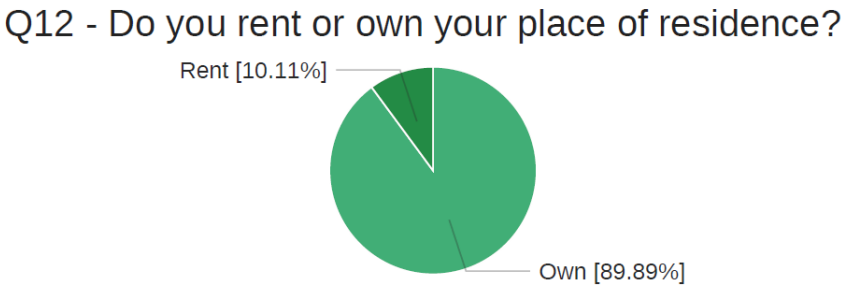


Figure 70. Participants in the survey were predominantly homeowners.

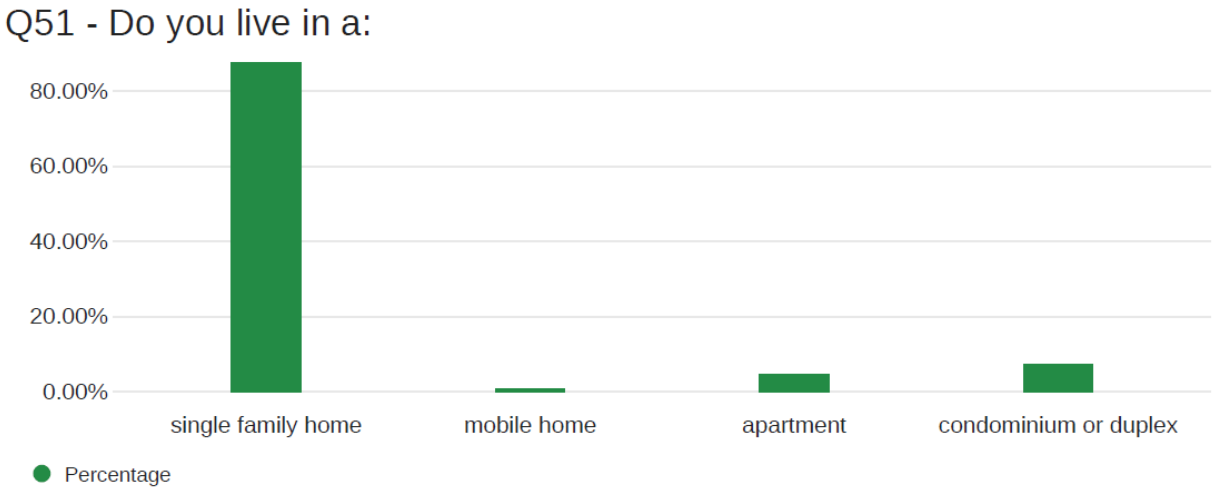


Figure 71. Type of residence of survey participants.

Table 26. Age of survey participants. The largest percentage (24%) were 35-44 years old, and smallest percentage (1%) were 18-24 years old.

Age	Number of Participants	Percent of Participants	Census Estimates for Tampa
Under 18	1	0.1%	21.4%
18 - 24	12	1.1%	10.1%
25 - 34	94	8.8%	17.2%
35 - 44	256	24.0%	13.9%
45 - 54	176	16.5%	13.0%
55 - 64	166	15.6%	11.6%
65 - 74	124	11.6%	7.6%
75 and over	34	3.2%	5.2%
Declined to Answer	204	19.1%	
Total	**1,067**	**100%**	

Table 27. Income levels of survey participants. Participation was relatively even across income levels.

Household Income	Number of Participants	Percent of Participants
Less than $10,000	2	0%
$10,000 - $29,999	33	3%
$30,000 - $49,999	57	5%
$50,000 - $69,999	75	7%
$70,000 - $89,999	91	9%
$90,000 - $109,999	81	8%
$110,000 - $149,999	98	9%
$150,000 - $199,999	89	8%
More than $200,000	156	15%
Declined to Answer	385	36%
Total	**1,067**	**100%**

Household Income	Census Estimates for Tampa
Less than $10,000	8.5%
$10,000 - $24,999	12.9%
$25,000 - $34,999	9.4%
$35,000 - $49,999	12.0%
$50,000 - $74,999	15.8%
$75,000 - $99,999	10.8%
$100,000 - $149,999	13.3%
$150,000 - $199,999	6.2%
More than $200,000	11.1%

Table 28. Race and ethnicity of survey participants. While approximately 50% of respondents were White and 3.4% Black or African American, 4.3% were Hispanic or Latino/a, with the remaining participants listing more than one race/ethnicity (3.0%), American Indian/Native, or other. Thirteen participants took the survey in Spanish, the remainder in English.

Race and Ethnicity Categories	# of Responses	Percent of Participants	Census Estimates for Tampa
African American/Black	36	3.4%	22.4%
Asian	13	1.2%	4.6%
White	548	51.4%	58.8%
Hispanic/Latino	46	4.3%	26.2%
American Indian/Native	2	0.2%	0.2%
More than one	32	3.0%	10.1%
Other	7	0.7%	0.1%
Declined to Answer	383	35.9%	
Total	**1,067**	**100%**	

Experiences of Trees in the City

Resident Histories of the Tampa Tree Canopy

One important take-away from this study is that people who participated in the study have strong opinions on trees. These views may be positive or negative, but often the story is more complex and shows great variability across demographic categories, which the study findings will demonstrate. The history of trees and tree planting in Tampa is one of growth over many decades, since the early twentieth century and especially since the City of Tampa's 1972 tree ordinance was passed, particularly in those areas of the city sometimes referred to as the "urban core," Tampa's oldest neighborhoods; but tree canopy changes vary by neighborhood over time (Landry et al. 2014). Tree canopy is found throughout the city, but the combination of large oaks, draped with Spanish moss, shading single-family houses and sidewalks, and providing a home to birds, squirrels, and ferns is a frequent narrative when we asked residents about what they think of when they consider urban trees in Tampa.

Trees and Sense of Place

Trees are a fundamental part of many Tampa residents' sense of place, as one resident explained,

> *"This neighborhood's symbol is the grand oak [referring to Seminole Heights]. And a lot of people do move here for that, it's kind of the same as in parts of South Tampa, you know? These trees are such…they're beyond curb appeal. To me, I think they hold a very intense and a very rich natural history."* —Seminole Heights resident

Some of our interviewees expressed the fact that trees also contribute to their sense of risk during storms or severe weather, as explained in more detail later in the report. Regardless of their views on the positives and negatives of trees, many residents are experiencing rapid changes in that sense of place since the last Tree Canopy Study was conducted in 2016. The following quote conveys the point of view of many longer-term residents who have seen housing development that replaces typical mid-twentieth century, 1500-square foot single-family homes with larger footprint single-family homes of 3500 square feet or sometimes much larger in size. Many single-family homes built in the 1920s to 1960s with trees planted near lot lines now have older, grand trees. Those older, smaller homes and associated trees are being removed and replaced with larger homes. This change is often reflected upon when asked about values of trees in the city. One man explained to us:

> *"I've got a lot of neighbors who have just moved in and they're fixing up the existing houses or, you know, even investors who come in and do a flip. And, you know, I know that the demographics are changing, and all of that is fine. I can accept that, but don't just come in and just raze all the local plants and then expect this to be the same beautiful neighborhood that people wanted to move to when they bought the property to build the house."* —South Tampa resident

Another resident shared her views on the future of trees and how they contribute to sense of place in the city:

> *"We have so many beautiful parks in Tampa. And I mean, even one like Al Lopez, that's a beautiful place to go and spend time…You can bike, you can jog, there's a dog park, but there's also small, forested bits in there as well… We have these really great things, but I feel like they're constantly at risk for being developed. I would like to see people fight against that a little bit. I understand that we quote unquote, 'have to grow', even though I don't think we do. We have to develop, we have to build up, but at some point, we also have to protect what we have. And if Tampa wants to stay Tampa, that's really the heart of what we have."* —Central Tampa resident

One resident explained to us her own personal history with trees:

> *"I'm a fourth generation Tampa native, my daughter is fifth… I grew up with Tampa's Urban Canopy as just something that was so distinct… And then I've kind of watched that get severely reduced, since the state legislature, you know, passed the bill that allows residents to kind of take down any tree. And so yeah, so I've been like, involved in tree advocacy then in response to that… I'm wanting to do whatever I can do to help preserve the trees that we have and plant new ones. We've been in our home for a year and a half. I've planted five already. And then I've been trying to work to get some more in our green spaces in the neighborhood and kind of like the right of way spaces."* —South Tampa resident

Another resident who was born and raised in Ybor City shared that she is currently in the process of having a very large tree removed due to its age and falling limbs as a risk to her home. She was very sad about that and explained,

> *"My daddy planted this tree when I was a little girl and now it outgrew me. I want to replace it because I have a grandson, so he will have a tree too." She also reflected, referring to the fruit trees that she grew up with in "the Bottoms" in Ybor City, "people who don't grow up with many trees around don't understand their value."*

Based on both survey and interview data collected, the participants expressed in a variety of ways that trees contribute significantly to sense of place. Of the close to 1100 residents who completed the public survey about Tampa's trees, more than 300 volunteered to participate in an interview, which is an extraordinarily high proportion of participants, compared to similar studies on environmental topics completed by members of the social science study team in Tampa. Interviewing all of the residents who volunteered was beyond the scope of the study but would be an opportunity for future research. As described in the methods section, residents who volunteered to be interviewed who were from under-represented zip codes and neighborhoods in the survey were prioritized for interviews (35 total).

Benefits of the Urban Forest

Benefits of the urban forest are well documented in peer-reviewed academic literature on the topic (Avolio et al. 2015; Conway 2016). Scientists, urban forest managers, and many other experts agree that healthy trees in a cityscape contribute to overall human and urban ecosystem well-being as well as other benefits classed as "ecosystem services," such as improving air quality and providing shade (de Vries et al. 2013).

But, what do Tampa residents think about the benefits of trees? In our survey and interviews, we asked just that: "What are the top benefits that you associate with trees in the City of Tampa?" This "open-ended" question was at the start of the survey so as not to bias participants. We received hundreds of responses on this question, and the most often listed responses are in Table 29.

Table 29. Top survey responses on the benefits of the urban forest in Tampa.

Top benefits of the urban forest in Tampa, according to public survey participants
• Shade and heat reduction
• Birds, native species habitat
• Beauty/aesthetics
• Noise reduction
• Oxygen/reduce air pollution
• Water retention
• Carbon storage

One Central Tampa resident explained to us, as she sat on her porch and pointed out the trees in her own yard, that to her, trees provide,

> *"Beauty, shade, protection for wildlife, like all the migratory birds that we have. They keep the soil stable. They sequester carbon dioxide. So that means that they help us with tackling climate change. They give us fruit to eat or the animals, most of the loquats we have has been eaten by crows. They are from this land, so they maintain what Florida is if we allow them to be and stay here."*

Other residents who were interviewed also shared their thoughts about the ways trees relate to major storms and hurricanes. One woman interviewed told us:

> *"There's the environmental impact, which has to do with making our neighborhood more hurricane proof. It helps resist soil erosion. It helps with wind mitigation during, you know, huge wind events, which obviously, with us being right on the water is a major concern. It hosts a lot of unique species, both Florida flora and fauna. It's a carbon sink, it's a heat sink. It protects our oxygen, makes the air quality better. It helps reduce the heat of us being in an urban environment, it creates a microclimate. So, it's a little bit cooler than if you go into other neighborhoods that are bereft of trees. Yeah, so there's a ton of different benefits."*

Overwhelmingly, the most often mentioned benefit in both survey and interview results was the shade that trees provide for homes, businesses, even parking lots. This major benefit impacts many aspects of daily life for those living in Tampa, improving areas aesthetically, but also making spaces better for recreation, for shopping, for walking from one area to another, reducing air-conditioning bills, and generally making a hot, humid environment much more livable.

As one man we interviewed, who is also a water sector professional, explained:

> *"What the tree canopy to me does is, it does a couple of things, you know, that I think are huge. One, it provides a lot of shade and, you know, not just baking asphalt and concrete and roads. That's huge, probably the biggest thing. I deal with stormwater in my design and what I do as a professional, so there's a huge asset to, especially, the oak trees throughout the city and how they reduce our stormwater loading and discharges to the bay. So there's a pollution standpoint, there's a stormwater standpoint, there's just a sheer shade standpoint, and heat standpoint, and especially here in Florida, those are huge things."*

Another resident from South Tampa shared his knowledge of the fact that not all large trees have the same resilience in the face of hazardous weather:

> *"The live oaks are not a hurricane hazard. They break up the wind shear. They help save your home because they're strong enough trees. Laurel oaks, you got to make sure that there's… they've only got a 50-year lifespan. Anyway they can be a problem, but live oaks, leave 'em alone. They're protection from hurricanes."*

Figure 72. Location of first interview for the Social Equity and Values portion of the study, in Forest Hills, North Central Tampa.

The Intangible Benefits of Trees

The benefits of trees for residents go beyond the tangible economic or practical benefits such as shade, however. Many participants in the survey and interviews expressed the non-tangible positive impacts that trees have on their lives. These were expressed as "spirituality," "sacredness," and "wisdom" of trees. One example of this was when a woman we interviewed in her Seminole Heights home described an interaction around tree removal on her street:

> *"One day [my neighbor] hired a company and cut a big tree that was full of avocados… [we felt that] this is a community tree, it's not just anybody's, it's everybody's tree. I wanted to ask him, can we just save that one tree at least please? Not because I love eating avocados every day, but because it was really part of the life of the community."*

This quote not only captures a common sentiment about the importance of trees, but that they contribute to the overall quality of life of a community, and are often viewed as a shared resource, even when located on private property. However, it is important to note that there were also study participants, particularly those in the housing/building sector, who expressed dismay at how "attached" some people are to trees, sharing their view that sometimes it is definitely "ok" or "necessary" to remove trees, whether for building new housing that is in high demand in the city, or because they are "not healthy and losing limbs;" and furthermore, that if trees are removed, they can easily be replaced by new trees. The variation in opinions on desirability of trees, tree planting and removal is discussed in more detail in later sections.

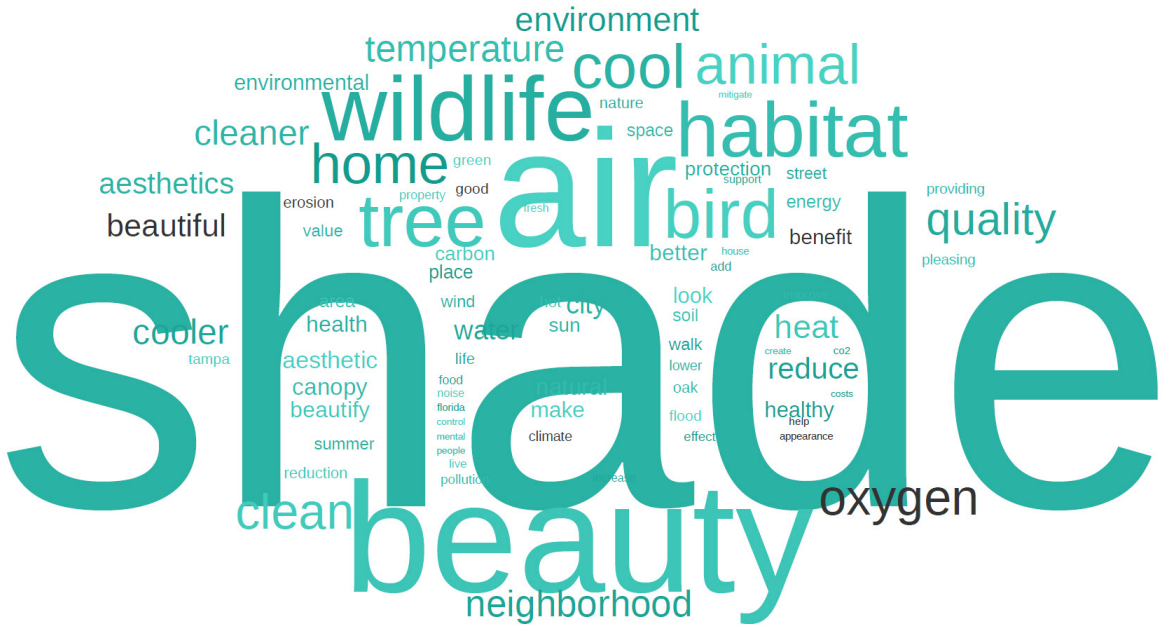


Figure 73. Word cloud of survey responses to "What are the top benefits that you associate with trees in the City of Tampa?"

Public Views on Desirability of Trees in the City

The overwhelming majority of residents who participated in the online survey consider trees extremely important for the city and would like to see more trees in their neighborhoods and throughout the city.

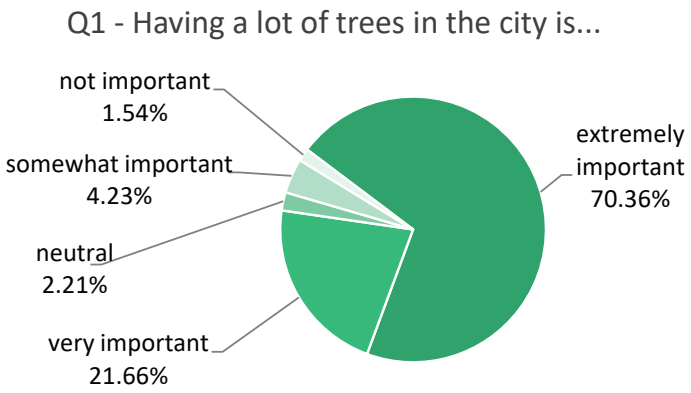


Figure 74. Public survey responses on importance of having a lot of trees in the city.

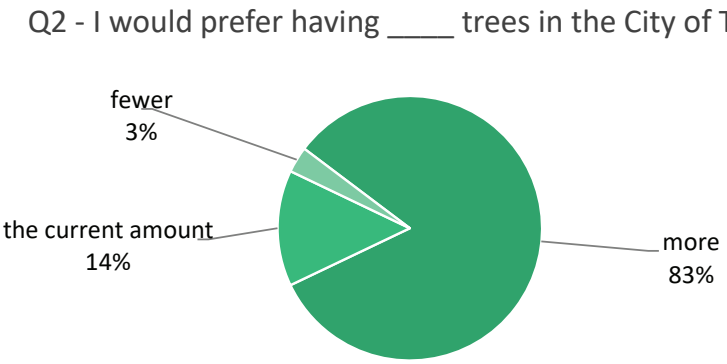


Figure 75. Participant preference on number of trees in the City of Tampa.

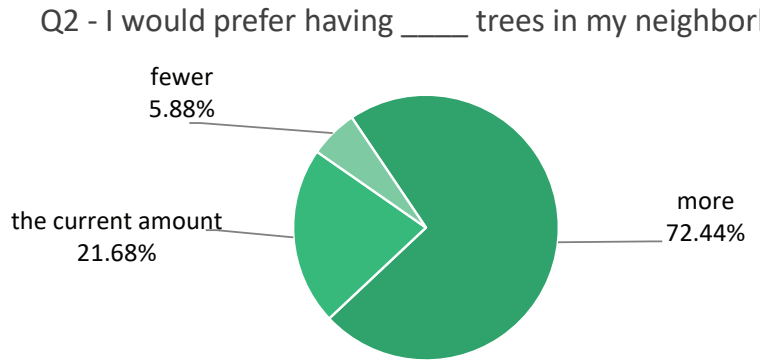


Figure 76. Participant preference on number of trees in their neighborhood.

It is interesting to note that a follow-up question on whether participants would like to see more, fewer, or the current amount of trees in their yard was more evenly split between those who preferred more trees in their yard (47.3.%), while the majority of other participants said they preferred the current amount of trees in their yard (42.57%) or fewer trees in their yard (10.14%).

Tree Canopy Concerns: Drawbacks of Trees in the City

Although many of the participants in the study have a strong preference for more trees in the city and their neighborhoods, and they appear to share a wide degree of consensus about many of the benefits of trees, it is important to note that the responses to the open-ended survey question about drawbacks of trees in the city included dozens more participants sharing their views than we received about the benefits. The comments range across a variety of observations about the negative aspects of trees, but generally are grouped into the following categories:

1. the different ways trees can damage property—from limbs or branches falling on single-family homes or in yards, to roots impacting sidewalks and roads;
2. the ways trees contribute to allergies;
3. the ways trees may create conflict between neighbors;
4. the risks that trees pose to structures and infrastructure during severe weather or hurricanes;
5. the maintenance and everyday clean up required from leaves and falling branches.

The most often-listed responses are captured in Figure 77 in a word cloud and listed in Table 30 below.

Table 30. What do residents see as the biggest drawbacks of trees in the city?

Most often Listed Risks and Drawbacks of Trees from Survey participants
• Costs of maintenance and pruning, removal if needed
• Costs of permits to remove or prune
• Damage to private and city property (sidewalks, homes, powerlines)
• Branches or trees falling in storms and clean-up of leaves
• Roots causing damage to pipes, foundations, homes
• Need for more maintenance to avoid above issues

Figure 77. Word Cloud of Survey Responses: Biggest Drawbacks of Trees in Tampa.

Some representative elements of many comments about drawbacks of trees include this explanation from one resident that trees, “can’t be cut back without expensive permits, roots destroying sidewalks and foundation of home. Hazards during hurricanes. Horrible allergies during pollen season from surrounding live oaks, giant amounts of leaves and debris accumulation.” Another set of observations is about pruning trees due to proximity to power lines: “trees can interfere with power lines that requires awkward pruning,” or that trees damage property due to falling limbs. One person noted, “Roots can cause dangerous or uneven spots on the sidewalks.”

Maintenance labor and costs are viewed as an important drawback of trees, as one survey participant described the “difficulty of finding someone for pruning/root maintenance that will do a good job and is reasonably priced.” The costs of clean up after storms as well as seasonal leaf and limb clean up were often mentioned. Several survey responses also mentioned aging trees and the need for the City to better maintain those older trees and to take steps to “ensure the actions are in the best interest of tree.”

Finally, some respondents were not willing to admit any drawbacks to trees: “There are none. We need more trees!” Or, they acknowledged drawbacks while also mentioning that the trade-off was worth it.

Allergies: “Pollen, but it’s worth it”

One widely shared response from the survey on drawbacks of trees related to the ways trees contribute to allergies for residents in the City. For example, one survey participant described this drawback as, “pollen, but it’s worth it,” while another resident stated that a negative aspect of so many trees is, “Pollen season, but it’s a small price to pay.”

One woman interviewed shared with us this situation:

> *“People don’t like the mess, I’ve heard people say that, well, I just don’t like the mess of the trees or they think they’re allergic. You know, my neighbor when I got my oak tree said, well, I’m allergic to oak trees. And I said, well, I think I am too. But I’m allergic to a lot of things that I have to face every day.”*

One of the other most-commonly listed concerns about trees was the fact that trees were being rapidly lost with development, but this topic is discussed later in the report.

Damage from Trees: Hazardous Trees, Falling Limbs, and Root Damage

Another aspect of the urban forest that residents and business owners worry about is what damage will be caused by trees falling, limbs falling on houses, cars, or even people living inside of structures. Some see this as a minor issue that is easily dealt with through regular/proper maintenance, but those participants who have less knowledge about the known risks of trees relative to size, specific species of trees, location of trees, likelihood of resilience to severe weather, and other factors, tend to worry more about the personal damages and costs due to damage.

> *“You know, people worry about tree branches falling down during terrible thunderstorms or hurricanes, which...I would be terrified if there was a massive tree branch over my house. I mean, I completely understand that.”*

This resident’s concerns reflect a broad understanding by participants that there are clear risks from falling limbs or trees. However, it tended to be less widely understood that these risks do vary by the type, age, and size of the tree. Often there is no distinction being made when individuals may think about current or future risk in their yard or neighborhood. Better information about resilience of particular species such as live oaks or certain palms to severe storms could be beneficial.

Figure 78. Debris that requires City and resident clean up as a result of Hurricane Ian at Lake Roberta in central Tampa. Photo by R. Zarger.

Variations in Values and Priorities for Tampa's Urban Forest

There are some aspects of the urban forest that residents agree very strongly about, while other opinions on trees are more mixed across survey participants. The graphics below help to distill where participants agree the most, and which characteristics of trees they have differing opinions about. This type of information may be useful to consider for information sharing about the urban forest, and for social media campaigns. Additionally, there are some emerging patterns from the data that suggest that perceptions of values and drawbacks of trees do vary somewhat by neighborhood and demographic variables, but the situation is complex and discussed in other sections of the report.

As presented in Table 31, participants have high levels of agreement (at least 70% agreement) that they "strongly agree," or "agree," that trees, "cool the neighborhood", "clean the air", "provide shade", "produce oxygen," "make a place good for exercise", and "are calming." Those completing the survey also strongly disagreed with the statements that trees "are ugly," "use too much water", or "take up too much space," suggesting high levels of agreement that trees do not have these specific drawbacks.

Table 31. Residents' perceptions on the values, benefits, drawbacks, and other aspects of trees, in response to the question: "*Take a moment to think about the trees around you, trees that you see every day in your city or neighborhood where you live. How much do you agree that the trees in your city or neighborhood ...*", where participants rated their agreement with each characteristic of trees.

Characteristic of trees	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
Cause allergies	11.2%	8.1%	20.6%	40.4%	19.8%
Block the visibility of road signs	32.8%	28.6%	13.9%	21.2%	3.4%
Damage property, including concrete paths and powerlines	14.1%	18.7%	18.5%	37.7%	11.0%
Create mess	31.6%	20.5%	18.8%	22.4%	6.7%
Are ugly	84.6%	7.4%	3.9%	3.1%	1.1%
Use too much water	69.0%	16.1%	12.2%	1.6%	1.2%
Block water pipes and drains	25.9%	23.0%	27.7%	19.3%	4.1%
Block the sun	19.0%	6.2%	16.2%	27.0%	31.6%
Are expensive to maintain	36.5%	20.0%	21.2%	16.0%	6.3%
Drop branches	10.2%	15.3%	21.2%	43.5%	9.8%
Take up too much space	63.9%	15.8%	12.3%	5.0%	3.0%
Cause expensive clean up after storms	16.6%	18.5%	24.9%	31.5%	8.6%
Attract undesirable animals	52.7%	23.7%	14.2%	6.1%	3.3%
Attract desirable animals	4.0%	2.8%	15.9%	25.3%	52.0%
Screen unattractive views	8.5%	4.4%	16.2%	29.2%	41.8%
Make streets and parks safer	2.2%	4.2%	35.4%	24.5%	33.7%
Are calming	1.4%	0.3%	3.9%	15.6%	78.8%
Clean the air	1.0%	1.0%	1.9%	9.6%	86.6%
Provide shade	0.7%	0.1%	1.2%	7.0%	91.1%
Produce oxygen	0.6%	0.2%	1.8%	7.6%	89.9%
Cool the neighborhood	1.0%	0.9%	3.3%	10.1%	84.7%
Reduce floodings	2.0%	3.7%	30.5%	22.4%	41.4%
Make a place good for exercise (walk, run, cycle)	1.5%	1.5%	7.4%	18.2%	71.5%
Make a place good for shopping	2.7%	3.0%	24.9%	18.4%	51.0%
Increase property values	2.6%	2.2%	14.2%	20.8%	60.2%
Are spiritual	4.4%	1.8%	31.3%	18.1%	44.4%

For other characteristics of trees, there were more diverging views, such as whether trees contribute to allergies (40% somewhat agree, while almost 20% strongly agree; 19% disagreed), or whether trees "block water pipes and drains" (20% either somewhat agreed or strongly agreed, while 48.8% either strongly disagreed or somewhat disagreed), or "cause damage to property" such as power lines and sidewalks (48.96% either somewhat agreed or strongly agreed, while the remaining participants were fairly evenly split between "neutral", "disagree", and "strongly disagree"). Finally, clean-up related to trees is not something residents agree on, as 52.14% either "disagree" or "strongly disagree" that trees "create mess", while 29% agree or strongly agree with that statement. In response to the question about whether trees "cause expensive clean up after storms", 35% of residents either "disagree" or "strongly disagree", while 31.46% "somewhat agree" and 8.64% "strongly agree" that storm clean up is expensive when you have trees on your property.

One local housing developer who we interviewed explained that there are often competing priorities and ideas for directions development should take in the city. He said:

> *"Some people just are tree lovers. That's what they love about their lot. They love the shade. And they're okay designing around it. Others say, 'I don't like the fact that they're dropping leaves in your gutters and leaves in my pool, and I don't get any sort of sun in my pool.' So some people don't want trees. Otherwise, it's like, they'd like trees, but on somebody else's property. They don't want to deal with them, maintain them, have them affect their house. So, they kind of liked the idea of their lot not having trees, but they certainly enjoy shady streets and shady sidewalks."*

This comment encompasses many of the sentiments we heard from residents, business owners, and developers on the benefits and drawbacks of trees. Very few people who participated in this study are "against trees," but may not actually want more trees on their property due to expense, upkeep, or storm risks. As a city staff member also shared with us, it's not just about planting more trees, it's really about "right tree, right location, right maintenance," in order for the tree canopy to carry reduced risks and increased benefits for all residents of the City.

Experiences of Tree Planting and Removal

Tree planting is widely practiced and embraced by residents throughout the City of Tampa. Of the survey respondents, approximately 63% reported that they have planted trees in their own yards. While many residents plant a variety of trees independently, survey respondents were also in favor of supporting city tree planting programs. If the city were to plant a tree in their front yard, 89.35% of respondents indicated they would be willing to water the tree,79.63% would prune the tree, and 66.3% would fertilize it. This may indicate that a substantial number of residents would be receptive to active participation in the Tree-mendous program, and with some support and the expansion of that program, would maintain the trees planted by the City.

One interview participant described their experience with the Tree-mendous program as amazing, after receiving two trees from the city. They said, “as a homeowner, I think it’s wonderful. And it’s funny, because I’ve heard people bring it up in passing. And it’s just a complete surprise with everybody else. They’re like, ‘what? We didn’t know that program existed.’” Yet, even with the low program visibility reported in this resident’s conversations with friends and neighbors, they also reported waiting nine months to receive their trees. In a public post on social media in Seminole Heights (Feb. 2023), an excited resident shared that after a year on the waiting list, she received “the call” from the Tree-mendous program. She posted a photo of the flyer from the City and asked for advice from the community on which tree she should select. There were dozens of replies on that post. This shows individual and community interest in tree planting programs, but also the need for additional resources to scale up the current program. Given the long waits currently experienced and the growing interest in the city’s tree planting program, Tree-mendous would require expanded operational capacity to meet the increasing level of demand. As one survey participant stated, “we need more, more, more! The Tree-mendous program is really cool, but the waits have gotten so long that it has become inefficient.” Expansion of the city’s capacity for tree planting is desired and supported by many city residents.

Figure 79. Cedar, Live Oak and other young trees ready for resident pick-up at the Mayor’s tree give-away, April 2022. Photo by R. Zarger

While demand for the city’s tree planting program reflects a strong interest in residential planting, the survey results reflect a more complex picture of attitudes toward city, neighborhood, and individual property-level action. According to the survey, while most residents want to see more trees in the city (82.57% of respondents) and neighborhoods (72.28% of respondents), a lower proportion wanted more trees in their own yard (47.65%). Many respondents wanted to maintain the current number of trees (41.93%), while only a small minority preferred fewer trees in their own yards (10.41%).

It is clear from all data collected for this study that participating residents support a more robust canopy, but approximately half of homeowners or property owners may not be as readily supportive of planting on their own lots. However, the discrepancy in attitudes toward planting within residents’ own yards may be influenced by the prior tree planting efforts of many survey respondents. This was reflected in interviews at residents’ homes around the city. When conducting interviews, some participants who already had heavily shaded lots reported that they did not have room for additional trees. But those who had lost large trees recently in their yards, or in neighboring lots on their street, typically wanted to see those trees replaced.

Resident support for further tree planting comes from a wide array of motivations, largely reflective of the benefits of trees reported in the data. Heat mitigation, climate change, wildlife habitat, beauty, and neighborhood aesthetic were all cited as reasons to protect the existing canopy and protect more trees. Residents also specified what type of planting priorities they would like to see more of—more shade trees, more biodiversity, and more fruiting trees. However, one specific topic on tree planting was the most prevalent in the data—the demand for proper protection and replacement of trees removed by development.

The relationship between tree planting and tree removal are deeply intertwined where new development is happening across the city. While trees are being planted by developers, survey and interview data reported that developers are often replacing larger shade trees with smaller varieties that take longer to grow and develop canopy, and that many trees are dying quickly after they are planted. Some study participants, including local developers and arborists, cited powerlines, property owner preferences, and inadequate room in the design plans to replace the existing canopy. When developers replace large shade trees with small magnolias and palm trees, many residents feel the canopy will not recover from the losses, referring to loss of total canopy or trunk inches as measures of loss to development. When speaking on tree planting, the sentiment is often an urgency toward canopy recovery, reflecting on the very visible losses witnessed in everyday life across the city's neighborhoods, particularly increasing over the last 2-3 years as new housing development and the housing market overall experienced a rapid increase in activity.

Resident Experiences of Tree Removal Over Time in the City

Tree removal was a widely discussed theme of the social equity and values-based research, showing up as one of the most often mentioned responses in interviews through qualitative data analysis. This section details resident sentiments on tree canopy loss, reasons for tree removal and how local development and policy have influenced tree removal in the city.

Policy and Tree Removal

As of July 1st, 2022, Florida's tree removal statute changed, allowing a more permissive environment for tree removal in cities across the state. Protective policies in Tampa's existing ordinances have been overruled by the new statute amendments, and what has followed has been noticed by residents across the city. Residents and city officials alike have reported an increase in tree removals since the policy changes. Some residents involved in local tree advocacy efforts attribute the change in policy to state-level advocacy of builders seeking more permissive policies for tree removal in favor of reduced regulation of development activities. In both interviews and surveys, Florida Statute 163.045 has been implicated in removal of many trees around the city, including large live oaks and trees residents perceive to be protected. Residents have also reported a perceived increase in illegal tree removals, and some believe that healthy trees are being labeled as sick by arborists in order to remove unwanted trees. One survey respondent wrote, "the laws are weak and easily worked around. A healthy tree can be deemed sick by a developer's arborist and there is no push back whatsoever." Another respondent commented on the tension between city and state policy: "City of Tampa employees seem to like trees, but they are legally prevented from stopping developers from taking them all down."

Other residents have expressed frustration with low penalties for tree removal, advocating for higher fines for tree removal. One resident reported:

"There needs to be a much higher penalty for cutting down. What happened on Westshore Boulevard down near Gandy was appalling. They were willing to pay a fee and did it without asking. If the penalty was higher, they would not have done it and would be planning a neighborhood with beautiful trees that already existed."

Figure 80. Removal of downed grand oak in the Hampton Terrace neighborhood after Hurricane Ian hit the central Gulf Coast in September 2022. Photo by R. Zarger

This perspective is mirrored in other responses, where the development decisions have been called into question, but accountability is perceived to rest with the city and its regulatory structure. In an interview in Seminole Heights, one study participant weighed the loss of trees in their neighborhood:

> *"I don't necessarily fault the developer for building new homes, because that's their business, right? I do fault the city and our government for not having regulations in place that protect trees from development. And, you know, I guess if you came to me and said, well, was this a good deal? Was this a good trade? These three homes versus probably a centuries old oak and two longleaf pines? I would probably say well... was affordable housing created to solve another social problem? No. So, to me, no, I don't think it was a good trade."*

While these regulatory discussions were thematically present throughout the data, additional commentary focused exclusively on development patterns and tree canopy loss.

Development and Tree Removal

> *"We've been here and one of the things that we love the most from Tampa was the trees, the green canopy, but since we have lived here in Seminole Heights, I've already seen the difference, have already seen the cutting of trees… before building new homes. And so, I can feel already what's happening."*

This resident's sentiments were echoed across interviews and surveys, with many participants lamenting the changes to their neighborhoods—their historic feel, their shaded and cool streets, and their beauty. The pressure of development was observed often across the city and was particularly prominent in neighborhoods experiencing rapid new housing development and tear downs.

Particularly acute in South Tampa, the relationship between older housing stock removal, corner-to-corner single family housing development, and tree canopy loss was one of the greatest issues to report from the survey and interview results. Many participants commented on the removal of trees—especially the clearing of entire lots of all vegetation—for new development. While it is true that trees are often removed for reasons permitted under the state statutes, residents have questioned the likelihood of entire lots of trees being diseased, dying, or dangerous. One survey participant reported a case of a developer "who has been putting two houses on a one house lot and cutting down every grand oak and other tree," further elaborating that this is ruining "the very reason people want to live here and none of his houses are considered 'affordable.'" While increased housing development is expected with the city's population growth, residents have highlighted that the tradeoff of tree canopy loss for new housing has not improved the city's affordable housing availability and is costing the city its environmental resources. Developers were most frequently cited as the source of tree canopy loss over time across neighborhoods, while poor tree pruning practices were cited as causing sick trees that would be lost sooner than their typical lifespan.

Figure 81. Removal of trees and other vegetation for the construction of a new commercial business in the Forest Hills neighborhood in 2022. The lot was previously not developed and covered with large trees similar to that of the canopy in the background of photo. Photo by R. Zarger

While some residents hold the city or state accountable for tree loss and others look to developers, interviews were completed with real estate development companies to understand their perspectives. In an interview with one developer, they expressed that the trend of tree canopy loss is a product of their client's desires and industry perspectives.

> *"It's a hot topic. It's kind of an emotional thing, right? Because you probably have a lot of homeowners and tree lovers that feel one way then you have equally emotionally charged builders and maybe some homeowners on the other side that feel differently about it. What do you do? It's emotional to both."*

Development has been a contentious topic in the city and occupies the most prominent reason for tree canopy loss in public opinion. This, however, does not mean that developers are solely responsible for tree canopy loss, nor the only city actors who would like to remove trees.

Figure 82. Mid-20th century single-family home in South Tampa, with for sale sign out front. These homes are rapidly being torn down and replaced by much larger homes with a larger square footage and trees are often removed as a result. Photo by R. Zarger

Figure 83. New home construction in the same South Tampa neighborhood as in Figure 82 above, with the majority of the lot comprised of the new structure. Photo by R. Zarger

Reasons for Residential Tree Removal

While the survey responses clearly skew toward a desire for greater tree protection and tree planting, 28.7% of survey respondents reported having a tree on their property they wish to remove. A diverse array of motivations for tree removal included: maintenance concerns, aesthetic preferences, room for additions to existing housing, aging and dying trees, concern for safety (either past or predicted damages), the proximity of the tree to the home or driveway, and allergies to the tree species.

Age of residents, affordability, and overall state of canopy maintenance on a lot or within a neighborhood are also associated with motivations for tree removal. Additionally, long-term residents may attribute tree removal with newcomer's inexperience with the local tree species. One interview participant told a story about a new neighbor: "I probably should have mentioned the woman that moved in next door to me within the last few years. She's elderly. And she cleared everything out so that she doesn't have to worry about it. And it was, you know, kind of cherry laurels, and things that most people wouldn't care about." Elder residents may struggle to maintain trees if they are living on lower fixed incomes, and broader issues of equity, affordability, and canopy safety such as these will be elaborated in further sections of this report.

Even residents with deep appreciation for the canopy have removed trees across the course of their home ownership. One interviewee, speaking on trees as the fabric of their community at their heavily wooded home, explained that "it's an absolute painful process for me to have to let a tree go... so when it becomes a true hazard, the trees are taken. I have actually taken five trees on my property over the years, and they have all come to the end of their life." It is important to note here, that in this example, the study participant had also planted many shade trees to replace those they have removed over time. Tree removal, maintenance, preservation, and planting have not been mutually exclusive practices for those who wish to protect the city's canopy.

Figure 84. Lot in Seminole Heights being prepared for new home site. The interviewee who lived nearby to this location shared their experience with tree removal on their street and described several Grand Oaks, pines, and other species that had been removed from the lot as well as others on their street that had been removed and replaced by two new homes built side by side on what was formerly a single-home lot. Photo by R. Zarger

In the survey, we asked about when it would be justified to remove large trees such as grand oaks. The two situations that participants felt most warranted the removal of large trees was if the tree was “diseased and likely to fall” or if the tree was “causing damage to water/sewer lines.” The question did not specify street trees/public trees or private trees. Forty respondents selected “none of the above,” meaning none of these reasons justified the removal of large trees.

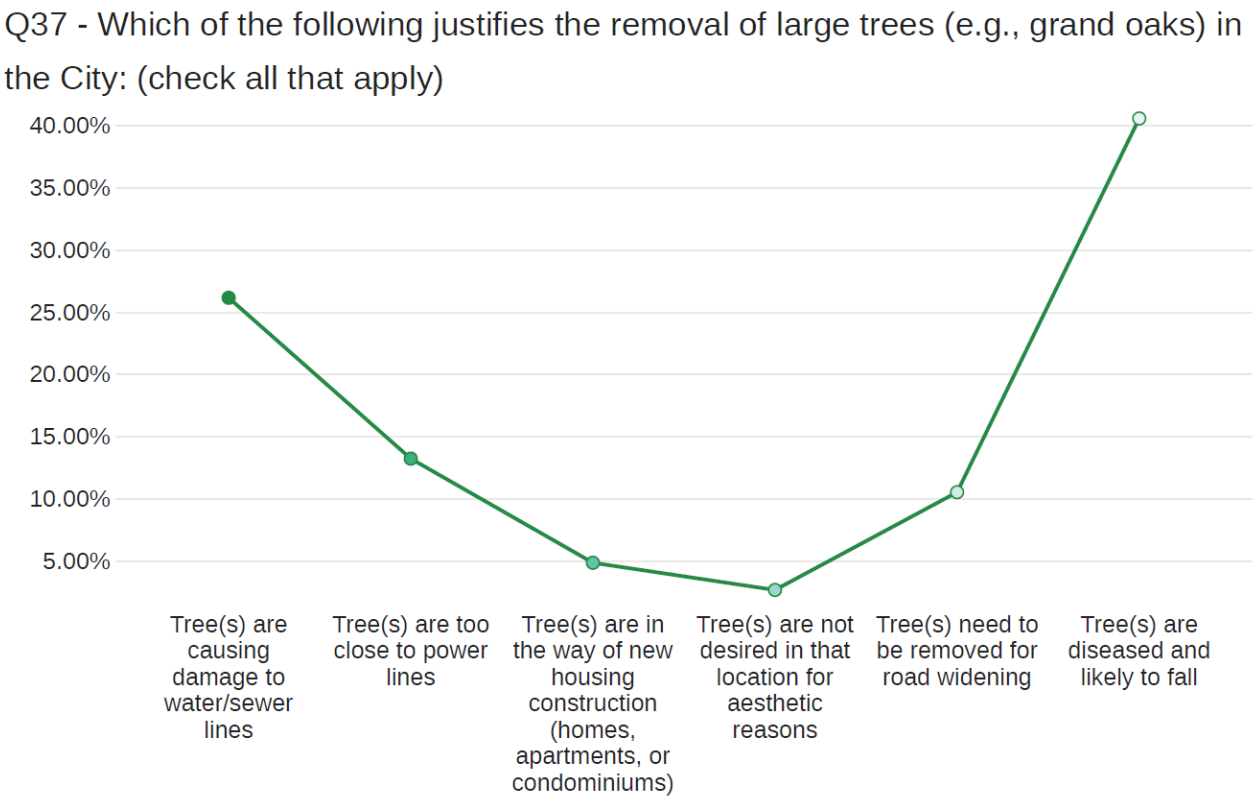


Figure 85. Justification for removal of large trees.

Social Equity in the Urban Forest

Social equity is a broad topic and one that encompasses different definitions in the academic literature on urban forests in the U.S. and around the globe. In the study survey and interviews, we approach this term as defined by participants—how residents, business owners, builders and developers, environmental groups, and other stakeholders see fairness or unfairness, even or uneven distribution of resources related to the care and maintenance of Tampa's urban forest. In Table 32 is a list of the most often mentioned concerns about equity from the public survey results.

Table 32. Public Concerns Related to Social Equity in Tampa's Urban Forest.

Public Concerns Related to Social Equity in Tampa's Urban Forest
• Costs of tree maintenance and/or removal are mentioned often
• Concern about fairness and equity in having trees close by throughout the city (survey-many 1-star responses on that factor)
• Requests for additional tree pruning grants/funding within and beyond East Tampa
• Not everyone wants more trees! This is due to concerns about crime, very high costs to maintain through pruning or removal, lack of maintenance by landlords or City

Social Equity Maps: Key findings by Study Area Zip Code

Throughout this section we present maps that underscore the fact that public perceptions and opinions of maintenance, planting and removal of trees varies by where a person lives in the city. Factors for this are complex, particularly in historically and presently under-resourced, yet socio-economically and demographically diverse and growing neighborhoods within the City. For a variety of reasons, including costs, prioritization of other needs, and desirability of trees, experiences of what it means to have equity in our urban forest vary widely, which we explore in this section.

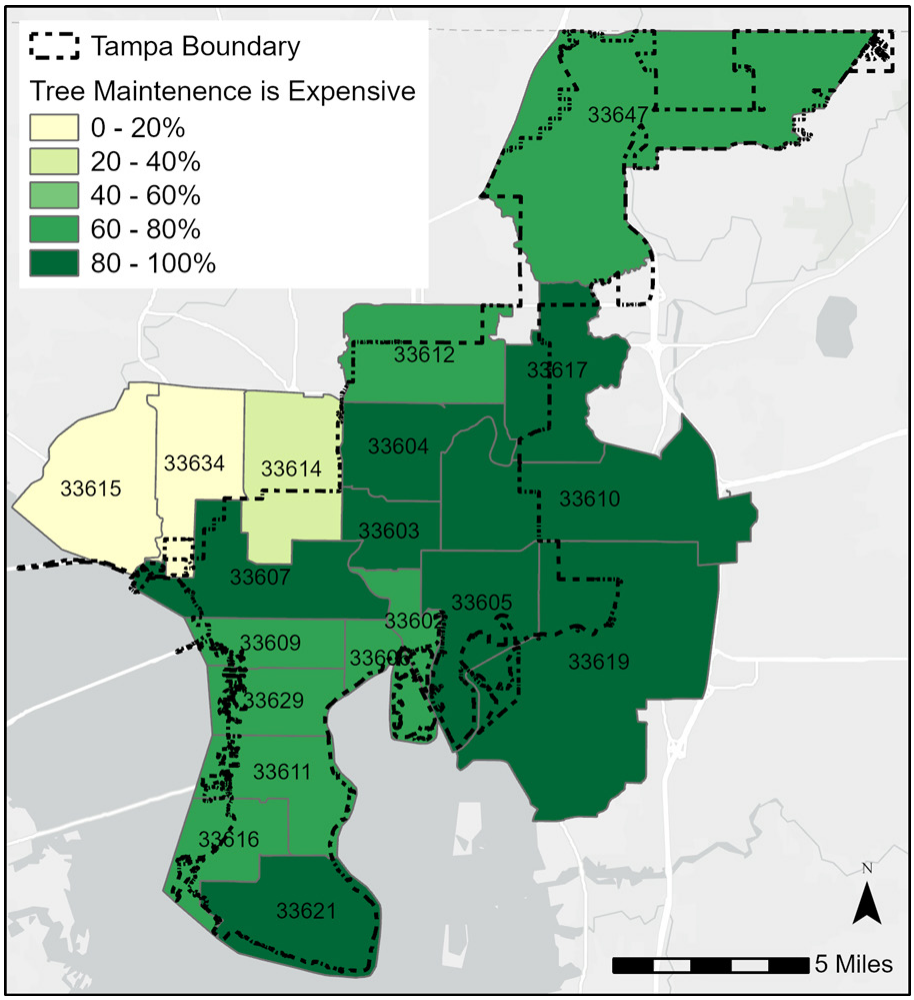


Figure 86. Percentage of respondents who answered "very expensive" or "somewhat expensive" to the question, "How affordable is tree maintenance, if you have to pay for it?"

Tree Maintenance, Risk Perceptions, and Canopy Safety

Aside from diseased and dying trees, perceived property damage and personal safety risks associated with trees are the primary reason for resident-initiated tree removal. Consideration of resident concerns regarding canopy safety is one of the most important equity issues related to the Tampa tree canopy. The nature of these concerns may highlight inequities in the cumulative effects of long-term differences in access to safe and affordable tree maintenance. In neighborhoods comprised of higher proportions of renters, tree canopy maintenance may be the responsibility of property owners outside of the state or country. For homeowners in lower income neighborhoods, tree maintenance affordability may intersect with risk of down trees during severe storm and wind events. Furthermore, if there is inequitable investment in tree maintenance of street trees across the city, this could lead to reasonable concern about risks associated with trees.

One resident, living in Highland Pines and working in Sulphur Springs, spoke to their concerns across these neighborhoods and their perceptions of risk from coexisting with aging and large trees in the area.

> *"We have hurricanes, we're in Florida, some of the homeowners can't afford hurricane insurance. So, a hurricane comes through. They don't have any coverage, this old tree that's been planted for 30 years? Part of the branch falls on their roof. Now they have to figure out where they're getting money from to even, you know, deal with the situation. Now they have a tarp on their roof for five years because they can't afford to replace the roof. That's why I use the term injustice because of the fact that, you know, the neighborhoods that I'm a part of, I see it on a daily basis."*

As this resident has illustrated, trees are a greater threat to those who cannot recover from the damage to their homes. Such risks have been faced in other neighborhoods as well. In East Tampa, the Community Redevelopment Agency has created a program for roof repairs. While this program is a wonderful opportunity to receive support from a neighborhood institution, it does not have the capacity to protect every resident in the neighborhood, nor the entire city, from the risk of cost prohibitive damages. Additionally, during walking interviews in the city, tarped roofs from tree damage were shown to the research team by study participants. Damages were witnessed following hurricane Ian.

In addition to financial damages, some residents also feel unsafe near trees, and this may correspond with lower levels of tree canopy maintenance resulting in more frequent downed limbs. As one resident told researchers,

> *"I know from personal experience, when I'm driving down one of the streets that have oak trees lining the entire street, and it's raining and it's lightning, and these little branches are falling in my car. I don't feel safe. What if a branch falls on my car? Then here I go. I had to file claims in my car insurance. I have to pay a deductible. That in itself makes me nervous driving on roads that have the oaks lined up on both sides of the streets in the hopes of you know, creating that canopy Yes. It looks beautiful. However, it's not safe."*

While negative perceptions and concerns about the tree canopy can be represented as a social and political attitude, it is also important to consider the nature of risk perception and the conditions leading to fear of neighborhood trees.

When tree removal is more affordable than tree maintenance, tree removal is an attractive option for residents in neighborhoods with aging trees, long-term insufficient maintenance, and less ownership and control of maintenance decisions when renting. To address tree canopy loss in lower income neighborhoods, in neighborhoods with higher numbers of renters, and neighborhoods with inequitable attention to canopy maintenance and infrastructure, policies to advance equitable maintenance and planting may prove more protective of the local canopy.

Figure 87. 22nd street Garden Steps Community garden in East Tampa. Photo by R. Zarger

Heat Vulnerability, Shade, and Energy

Heat mitigation is a longstanding and growing priority in the city of Tampa, and the relationship between heat mitigation and the tree canopy are inextricably linked. Shade trees have long provided cool streets for many neighborhoods and commercial areas and are known to reduce the heat index. As noted above, "shade" is by far the number one benefit of trees that survey participants identified. Cooler streets facilitate a variety of health promoting behaviors from exercise to social and communal gatherings. When asked if trees create cooler neighborhoods in the surveys, approximately 85% strongly agreed (n=1055).

Managing heat vulnerability is an issue of equitable urban planning, with public transportation commuters and unhoused populations relying on trees for sun and weather protection. An Ybor resident spoke to the importance of street shade in her community:

> *"We have a larger homeless population here. And these poor people are hanging out on the sidewalks all day, in the summer, in the rain, in the heat. In addition to homeless people, we also just have people who are taking public transportation waiting on the buses, and the buses don't run very much. And so, there's no bus stops here in Ybor. They're waiting on the sidewalk in the baking heat. So, any sort of shade would be really appreciated by all those people who are forced in one way or the other to hang out on the sidewalk for long periods of time."*

This study participant elaborated that neighborhoods with more trees are cooler, and this perspective was repeated throughout the study. While this has been witnessed in ethnographic fieldwork in neighborhoods throughout the city by the research team, it is also supported by the heat data from other parts of this study.

Other participants spoke to the energy cost savings of their shaded homes, where their energy bills were positively impacted by shade trees and adversely impacted by canopy loss. If energy bills are increased by lack of tree coverage, then residents living in homes without canopy shade may face higher energy burdens if they do not live in newer homes with higher efficiency systems and weatherization. If energy cost burdens are layered with the loss of shaded lots to development, and unaffordability to tree maintenance, this may exacerbate inequitable cost burdens of tree canopy gaps in the city. Furthermore, houses flipped for investment and rented following tree removal would place higher energy costs on renters, who do not determine if trees should be planted or removed.

Equity, Affordability, and Tree Maintenance

Perceived risk of tree canopy safety and tree-related damages can independently lead to tree canopy loss and in turn, to greater heat vulnerability in neighborhoods with less canopy shading. This risk perception, however, directly stems from issues of equitable access to tree canopy maintenance. When the cost burden of maintaining the tree canopy as a city-wide asset falls on residents, the only option may be to remove trees. Though many shade trees have been planted historically throughout the city, the ability to equitably maintain the existing canopy varies by neighborhood and household.

For example, one interview participant shared their frustrations with oak canopies:

> *"These oak trees were planted however many ever years ago and of course, they're protected for whatever reasons. As a resident, say if I bought a home, I now have to worry about this oak tree. I can't trim or cut the wood. I can't cut it without getting a permit, which costs money, already having to spend so many hundreds, sometimes thousands of dollars to the arborist to come cut the trees. So, I feel like it's an injustice to communities like the ones that I live in and the one that I serve, for these grand oaks, as we call them, to be planted."* —East Tampa resident

Based on the public survey results, data were entered into SPSS for quantitative analysis of the relationships between responses to particular questions and variables such as income level. In the figures below, histograms show the agreement across all income levels that tree maintenance is seen as either "somewhat expensive" or "expensive," making it clear that for lower income level individuals, the financial burden would be greater than for higher income levels. Furthermore, this illustrates the fact that lower income individuals are much more concerned about expense of trees related to hurricane clean up, with those in lower and middle income brackets stating that they are either very concerned or concerned about clean up costs, while wealthier participants are less concerned about that.

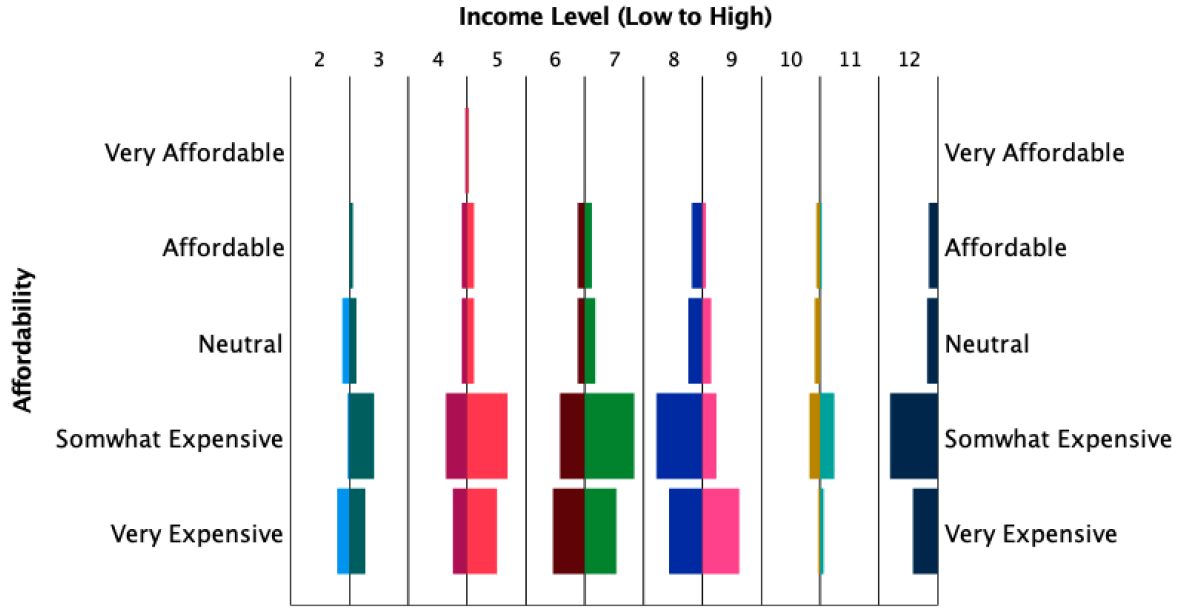


Figure 88. Side-by-Side Histograms of Affordability of Tree Maintenance by Income Level.

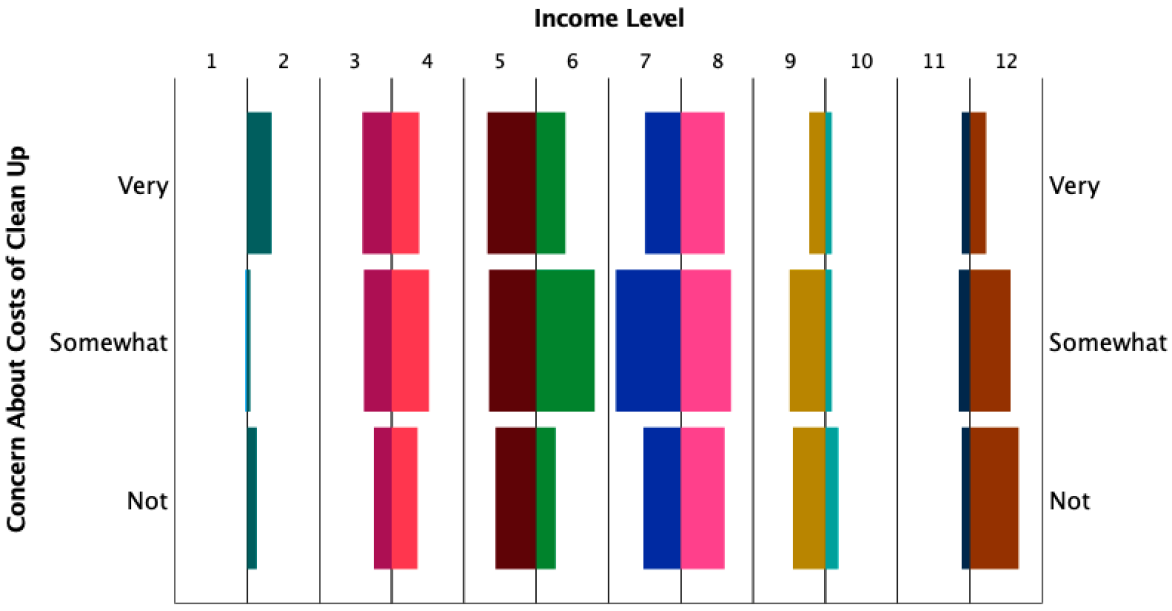


Figure 89. Side-by-Side Histograms of Clean-Up Cost Concern Among Homeowners After Hurricanes by Income Level

The lack of affordable access to tree maintenance was raised across interviews in many neighborhoods, including Highland Pines, Sulphur Springs, Seminole Heights, Ybor, East Tampa, and Live Oaks Square. The costs of maintenance were corroborated across the city by residents who have planted and maintained trees in their yards:

> *I think probably one of the biggest equity issues is that it's not cheap to go and buy a bunch of plants and landscaping and trees for your yard. Not to mention the upkeep, the water...I think a lot of people are just trying to feed themselves, let alone going out and buying trees and planting them and landscaping and all of that.* —Seminole Heights resident

> *It can be expensive when you have a tree on your property. And you have a limb that's threatening your neighbor or something like that, and you've got to hire the service, and they've got to have the trucks and cherry picker, and they have to have a crew down there. I understand why people balk at the expense of it.* —South Tampa resident

The East Tampa Community Redevelopment Agency, with involvement of the City of Tampa Natural Resources and Planning Department, has worked to address this within the bounds of the CRA through their tree pruning grant program. This program has been spoken highly of throughout this ethnographic research process, particularly by several community members of the East Tampa Community Revitalization Partnership (ETCRP). However, like their roof replacement program, the pruning grant does not extend to neighborhoods beyond the East Tampa CRA, nor does it have the capacity to meet the demand. Based on information shared by staff and residents, there is a demand and identified need for further financial support and requests to expand the existing program. One resident even shared that access to maintenance support was the reason they participated in the interview:

> *"I took it [the interview] because as you can see, I have all these trees. And over in East Tampa, they're given grants. They'll pay up to like, $2500. And I'm like, a few blocks north of that. And I didn't think it was fair that I couldn't get the grant to maintain my trees. But back then, when the ordinance was created, I guess the people that lived over here were well off. But yeah, I'm just looking for some type of way to maintain my trees."* —East Tampa resident

Other Tampa residents shared similar sentiments, asking the city to expand the existing program to seniors, additional neighborhoods, or recommended a larger number of people to be covered by similar grants. An example of this concern is shared by one of our interviewees:

> *"If the city provided some type of discounted service for the pruning of those trees, or they provided the pruning of the trees over houses, they don't have to trim the entire tree but the part the part of the tree that's over someone's house."* —Central Tampa resident

Additionally, some residents shared concerns about the visibility of the existing support programs. One resident shared that "some people, they're afraid to take it because they think they're going to have to pay it back. They think it's like a catch somewhere." The relationship between maintenance affordability and tree canopy loss is likely acute in low-income neighborhoods, and the low visibility and availability of assistance programs may create hazardous conditions beneath unmaintained canopy, and eventual loss of more trees over time.

Public Perceptions of Tampa's Urban Forest Management

In this section of the report, we synthesize the information from public survey participants and interview participants about their experiences with the ways Tampa's urban forest is currently being managed. This includes questions on the survey where participants were asked to rate their level of satisfaction for key aspects of tree management, how participants view tree maintenance responsibility and their level of awareness about policies for tree management.

One of the aspects of local knowledge related to tree management that the survey documents is how participants view or define a public tree, or a "street tree." There is some agreement in that regard, as illustrated in Figure 90. Participants were asked, "What is a Street Tree?" and to check as many responses as applied to that term. Understanding local knowledge and perceptions can assist with outreach and education efforts around key topics of concern for City staff such as confusion as to City responsibility for tree removal or pruning, in cases where the responsibility may be a utility or private landowner.

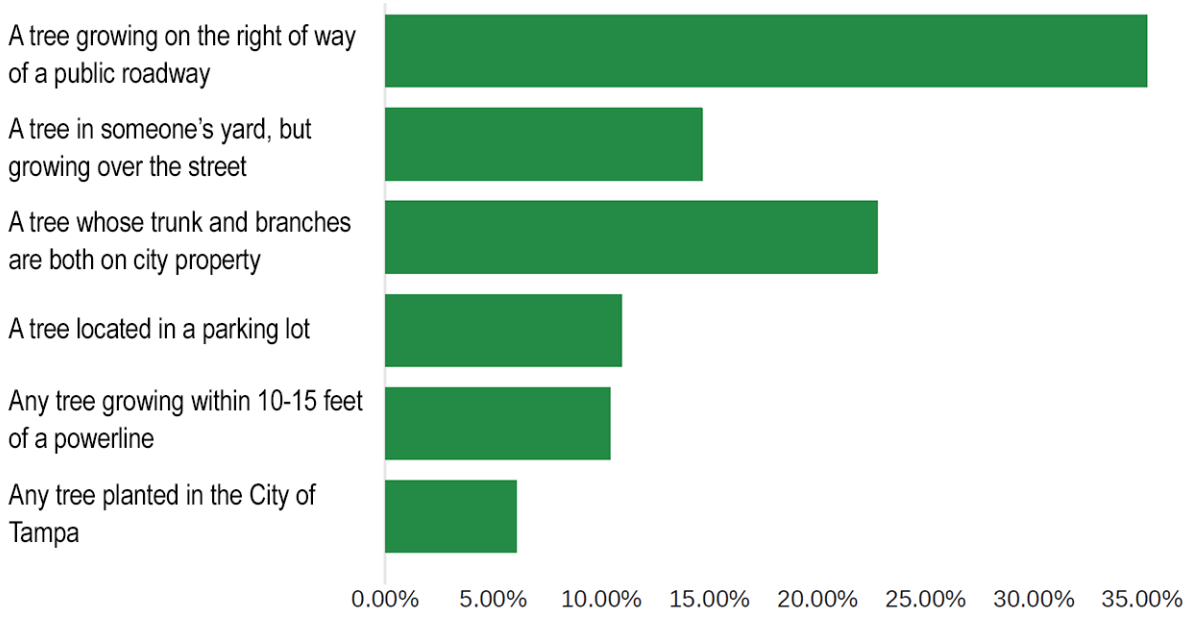


Figure 90. What is a street tree? Respondents were asked to check as many of these options as they thought applied to that term.

Who is Responsible for Trees and How Should They Be Managed?

There are a great deal of confusion and differing opinions on who is responsible for tree management, when, where, and under which circumstances. Furthermore, what should be done about the challenges that arise from that confusion, between neighbors, between residents and the City, between residents and power utilities? The 2019 changes in Florida state statutes about what documentation and permits are required for tree removal, and how that now undermines many aspects of local City tree ordinances, has increased concern and confusion, despite a July 2022 update to the state regulation verbiage. One resident who participated in an interview explained:

> *"I think the city should take back control of the trees. I think they need to have a very transparent commitment to the environment here. Like I said, I see this as sort of a natural history. These trees certainly can tell you more than I ever could tell you, you know. And sometimes they'll do that." —Seminole Heights resident*

Another resident shared with us in an interview:

> *"I think a lot of the development at this moment that has like happened in the last couple of years has been more on Seventh Avenue on the main drag. And because it is so dense, you know, they're basically wanting to maximize their return on the development. So they're, they're maximizing the amount of building that they're putting on the lot. And Ybor has zero lot lines. So you can really build like, basically cover your entire property with a building if you want to. Some of them are doing a decent job of like planting trees, but again, it does seem to be mostly palm trees. I think in the next three to five years, there will be more like residential specific development, whether it's multifamily, single family, more townhouses, things like that. And I'm, I'm hopeful that the folks doing those developments will be planting more like a more of a variety of like shade trees." —Ybor City resident*

Survey participants largely shared the opinion that primary responsibility for removal of dead or dying street trees is “a local government or public agency” at (68% agreement). However, others thought it the responsibility of nearby property owners, a neighborhood association, or “other.” This may reflect those participants who are unsure of the term “street trees.”

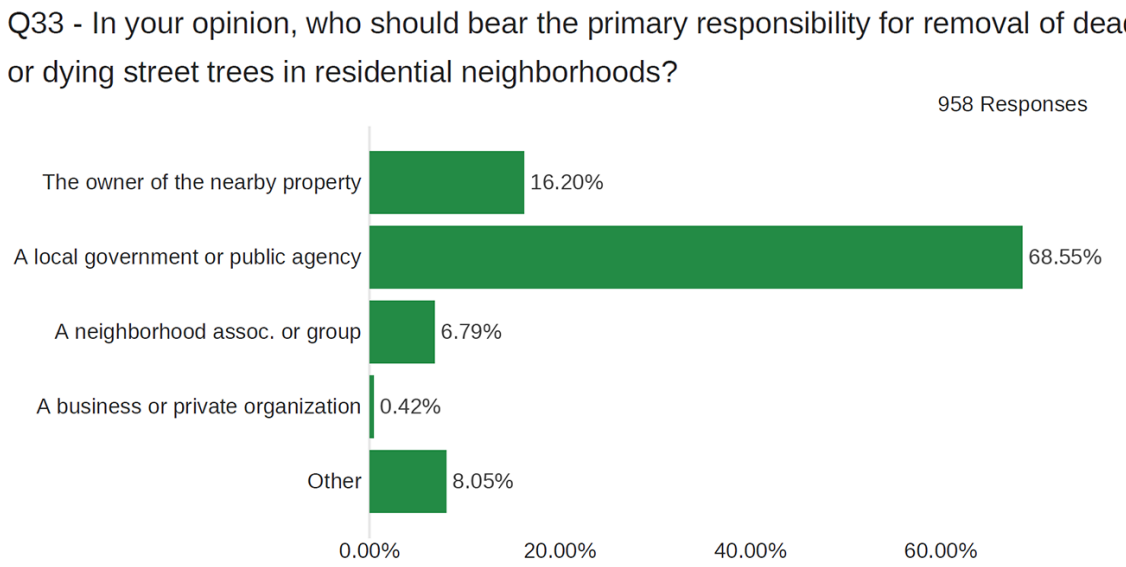


Figure 91. Survey participant opinions on responsible parties for removal of street trees.

Survey questions included asking participants which neighborhood association they may belong to as well as which groups are concerned about tree removal in the City. A total of 513 out of the 1,067 respondents were able to identify the neighborhood association where they lived. The map in Figure 92 shows the number of survey respondents who reported living within specific neighborhood association boundaries. The top 10 neighborhoods represented by survey respondents included: Old Seminole Heights (66), Davis Islands (29), Bayshore Beautiful (24), Virginia Park (23), Palma Ceia (22), Tampa Heights (21), South Seminole Heights (18), Southeast Seminole Heights (17), Beach Park (15), and Sunset Park (14).

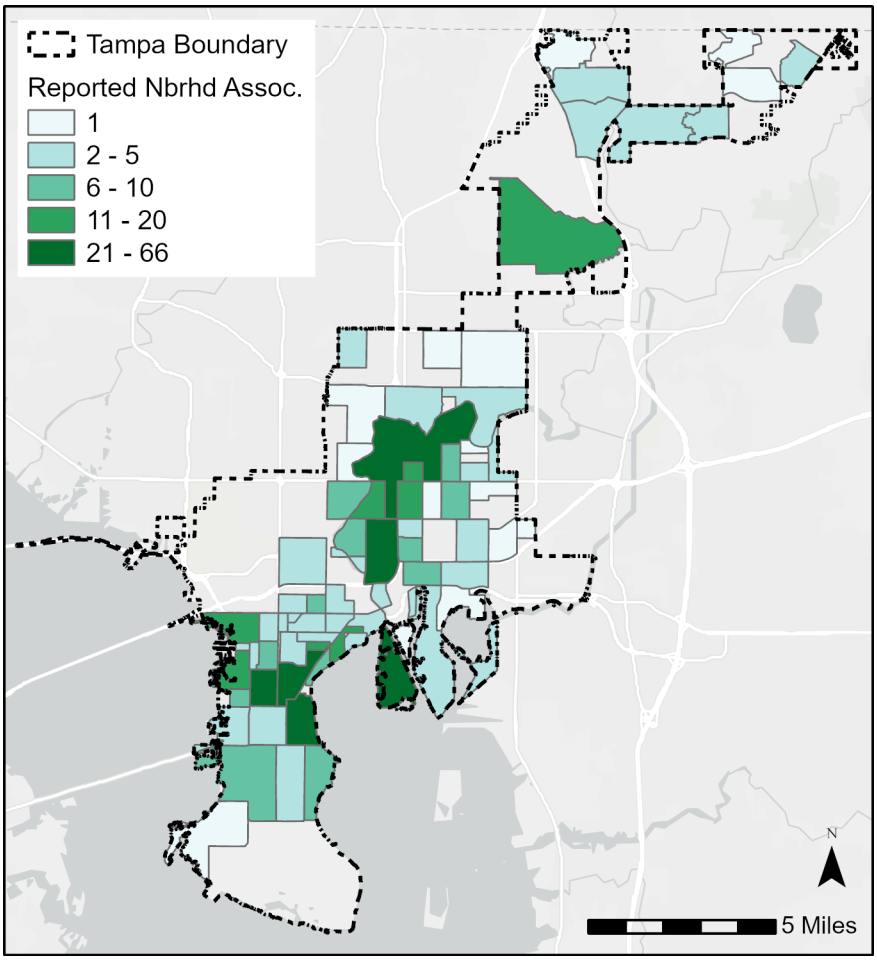


Figure 92. Map of the number of survey respondents who reported living within each neighborhood association (Question 39).

The word cloud in Figure 93 illustrates some of the most common responses to the open-ended question about which groups are concerned about tree removal.

Figure 93. Word cloud of survey responses about which organizations are concerned about tree removal in the City.

Tree Pruning Practices

Survey and interview responses on tree pruning comprise a large proportion of feedback from participants on their experiences and opinions about management of Tampa's tree canopy. This is a topic that came up frequently if participants expressed dissatisfaction with current tree canopy management.

Survey and interview participants at times expressed confusion about whether the City or TECO or other public utilities were responsible for pruning trees, who to contact when they had questions about that, or whether they could influence how tree pruning was taking place. Some participants were very knowledgeable about the regulations on right-of-way, what "counts" as a street tree, and which entities would be responsible for pruning or removal.

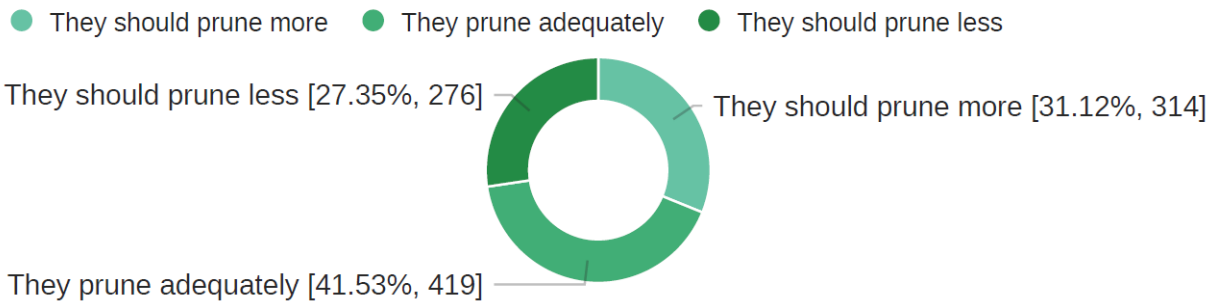


Figure 94. Satisfaction with amount of pruning by power utilities. Percentages of responses to survey Q11 – "Power utility line clearance is done separately from City of Tampa tree management. How satisfied are you with utility power line clearance pruning?"

Views on Urban Forest Management, Policy, and Planning

Awareness of current forest management regulations and policies varies widely across study participants. For example, 60% of survey participants were aware of the City's Tree Preservation Ordinance, while 40% were not aware of that policy. Additionally, the majority of residents have not had any interaction with the City regarding trees on or in front of their place of residence. Finally, there is confusion about what is or is not a street tree.

Figure 95. Interactions with the City about trees on or in front of residences.

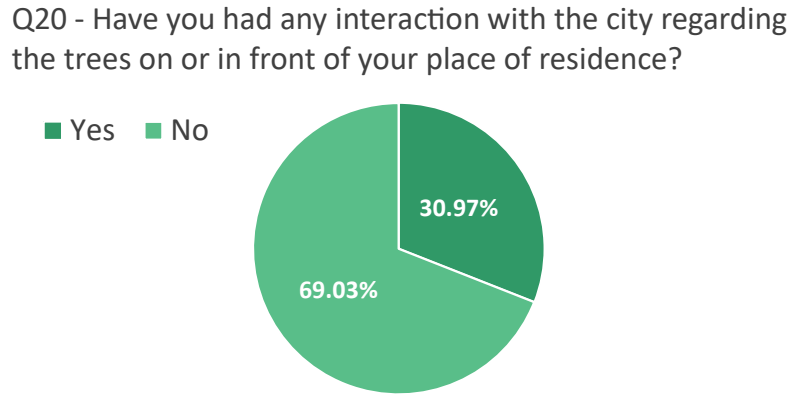
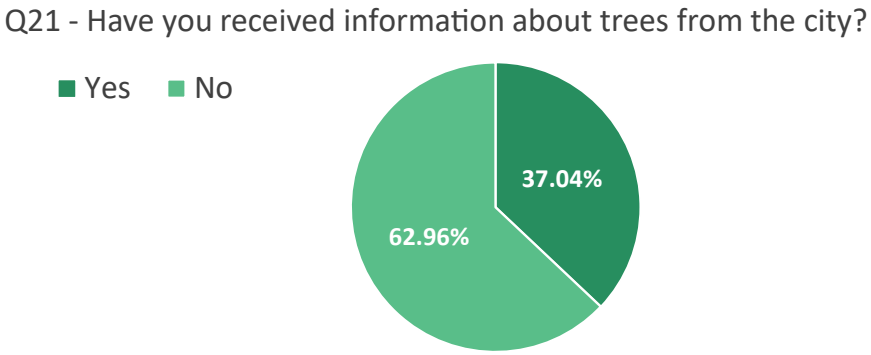


Figure 96. Survey participants who have received information about trees from the City.



Perceptions of the Management of Public Trees by the City of Tampa

In the survey we had a question that asked participants to rate how satisfied they are with specific aspects of tree management for public trees that the city is responsible for maintaining. For ease of completion, the participants were asked to rate between 1-5 stars their level of satisfaction. Figures 97-104 below break down the responses for each category in a visual form.

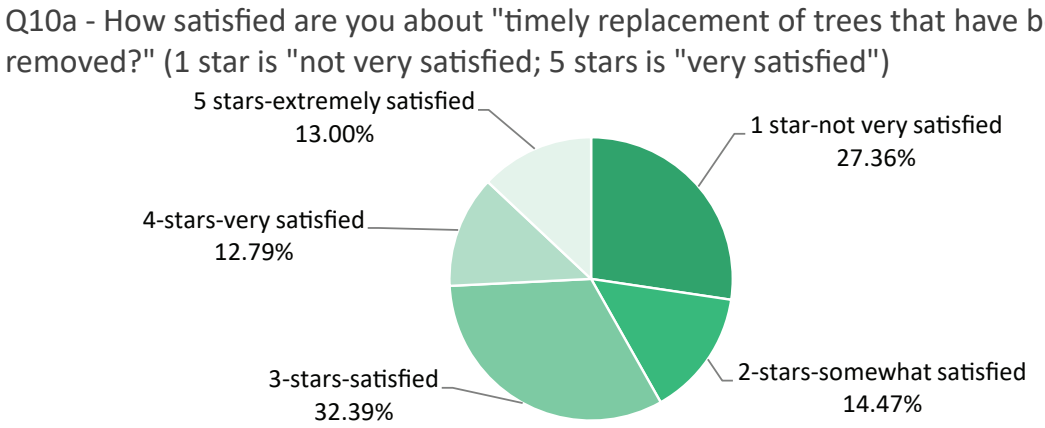


Figure 97. Timely replacement of trees that have been removed.

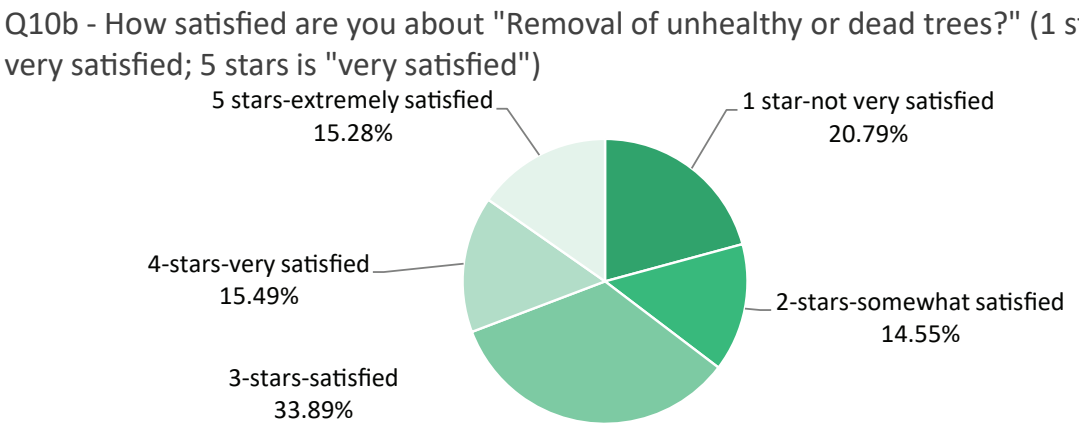


Figure 98. Removal of unhealthy or dead trees.

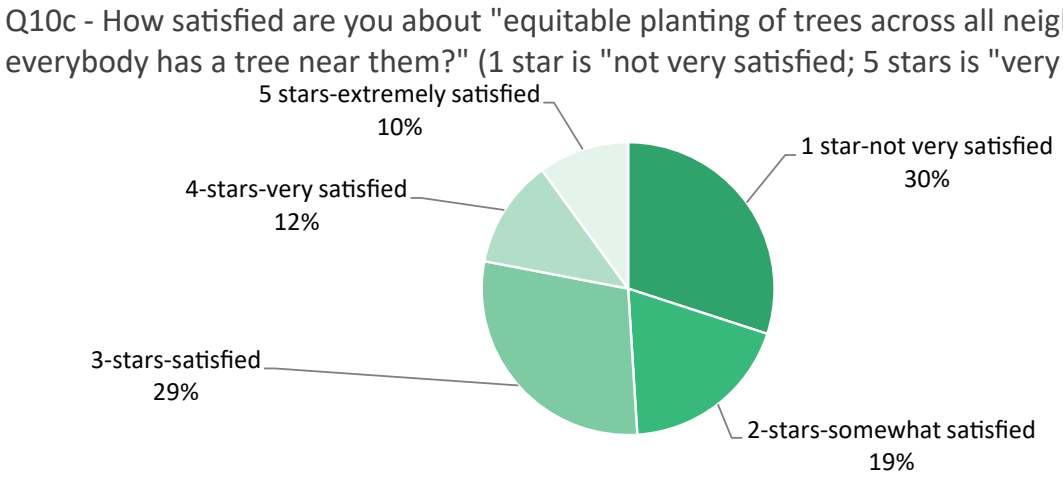


Figure 99. Equitable planting of trees across all neighborhoods "so everybody has a tree near them".

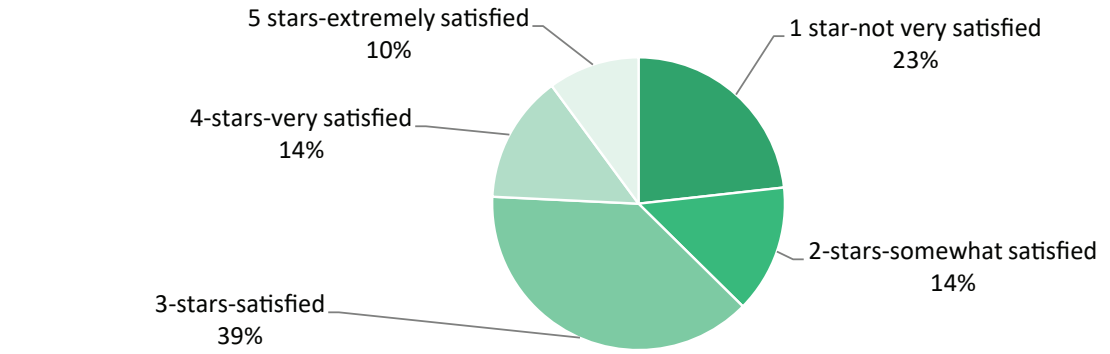


Figure 100. Satisfaction with the City's responsiveness to requests to prune, remove, replace, or plant trees.

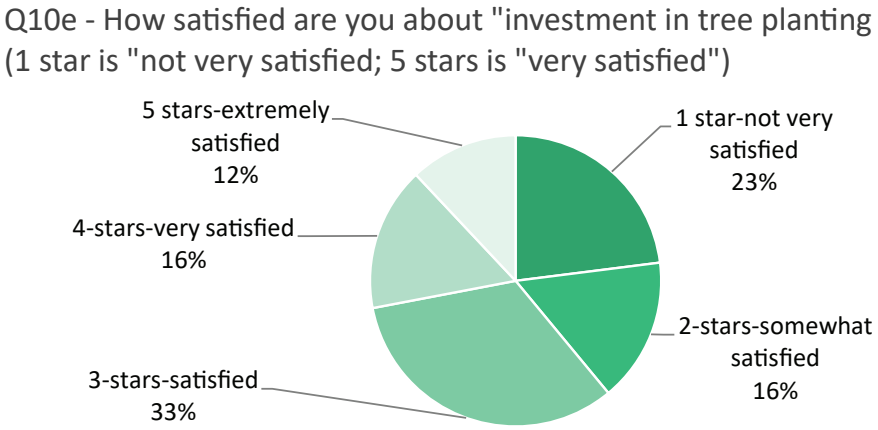


Figure 101. Satisfaction with the City's investment in tree planting and caring.

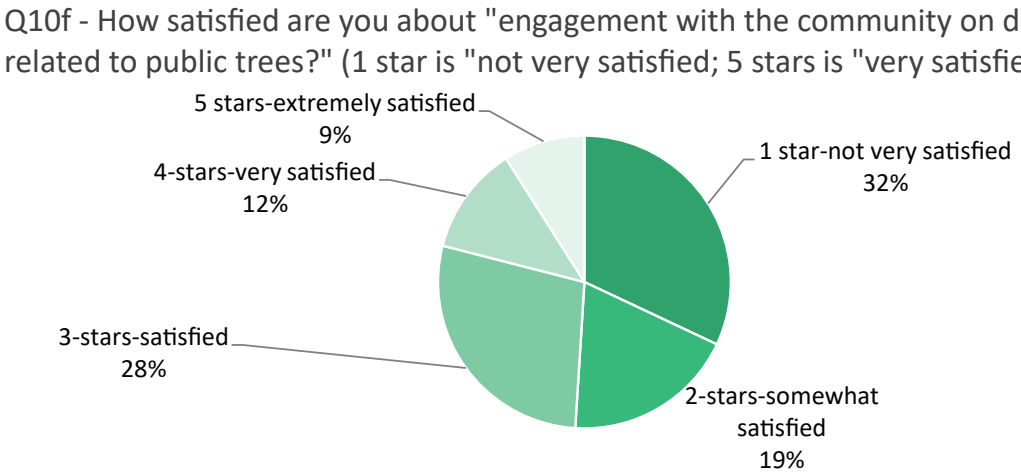


Figure 102. Level of satisfaction with the City's engagement with the community on decisions related to public trees.

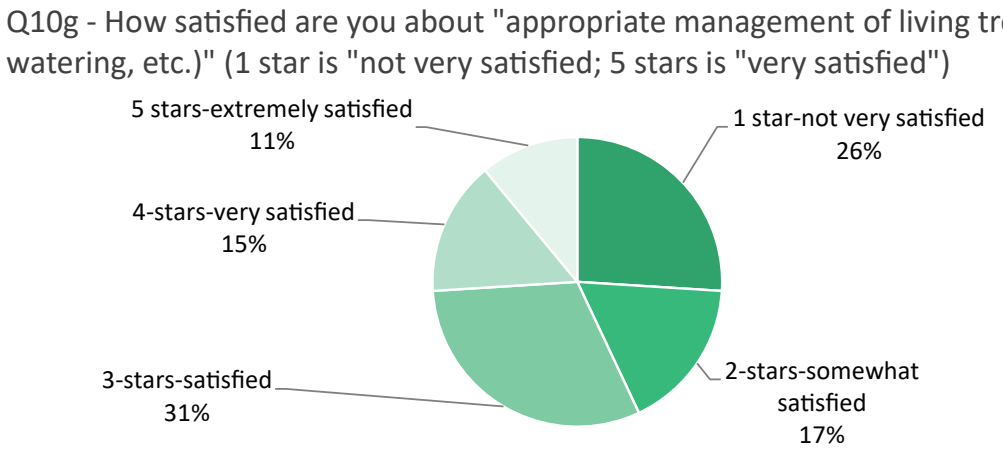


Figure 103. Level of satisfaction with the City's management of living trees.

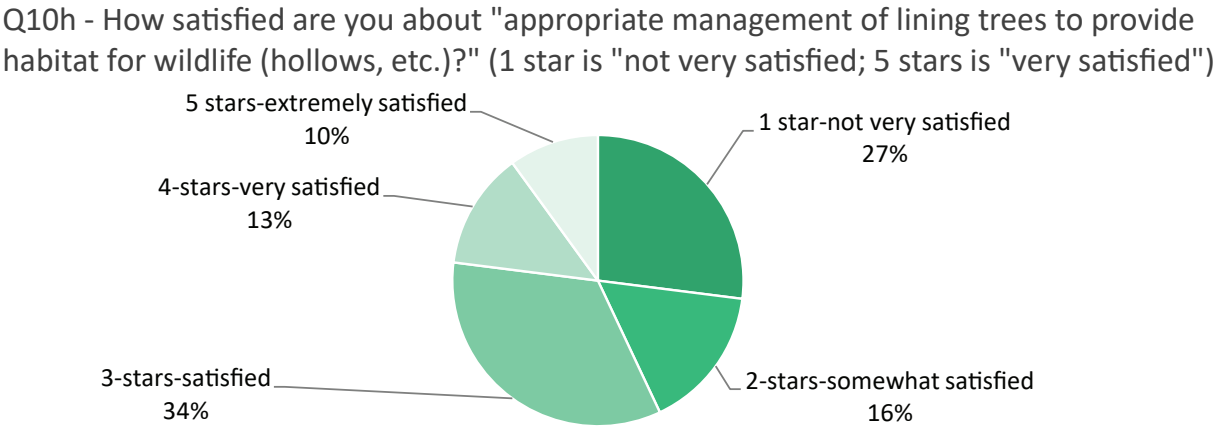


Figure 104. Level of satisfaction with the City's management of trees to provide habitat for wildlife.

Considering the satisfaction of participants based on where they live in the city is one way to understand patterns of variation in perceptions of urban forest management. In Figure 105, this map shows where survey participants were less satisfied with management of public trees (based on zip code). Areas in darker green on this map have larger percentages of survey residents or business owners who marked that they were "not very satisfied with public tree management".

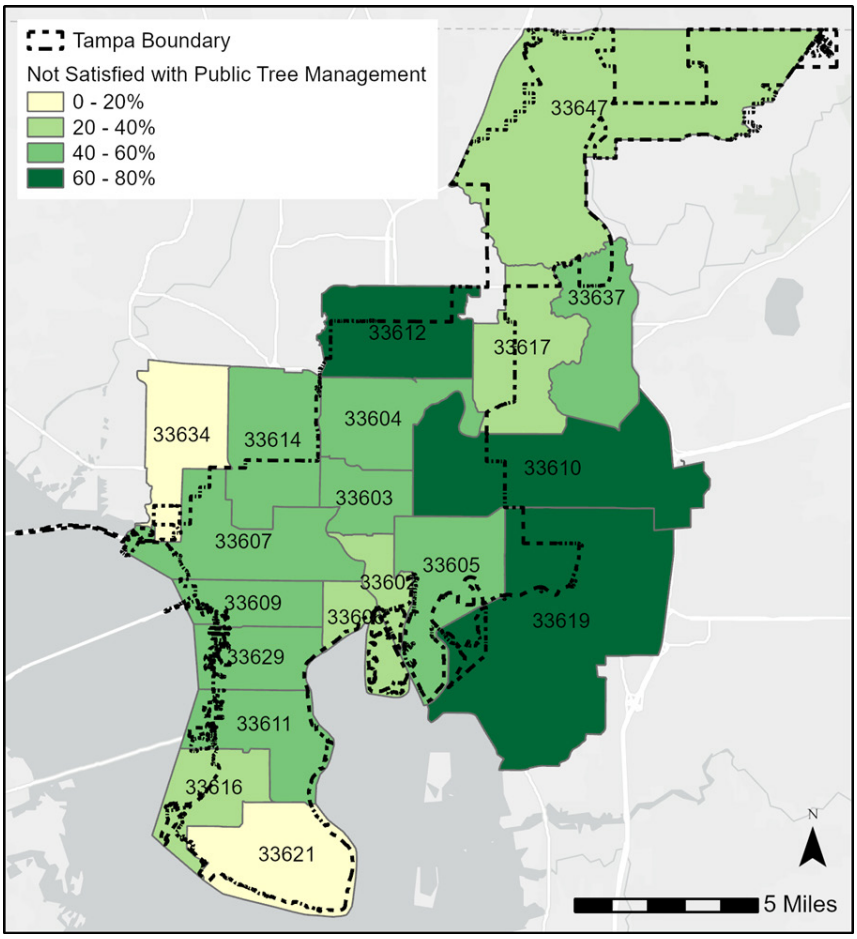


Figure 105. Map shows percentage all responses for Survey Q10_25 "How satisfied are you about management of public trees in your city or neighborhood?", where participants rated their satisfaction with management of public trees as 1 or 2 stars out of five stars, or "not very satisfied."

One interesting finding from the survey is that of those who participated, the overwhelming majority agreed that taxpayers should be willing to pay a small additional tax – such as a penny tax – to support augmentation and replacement of the urban forest, through planting of more public trees. Much more research is needed to better understand public opinions on "willingness to pay," for tree planting by the City, but this suggests participants assign value to tree planting.

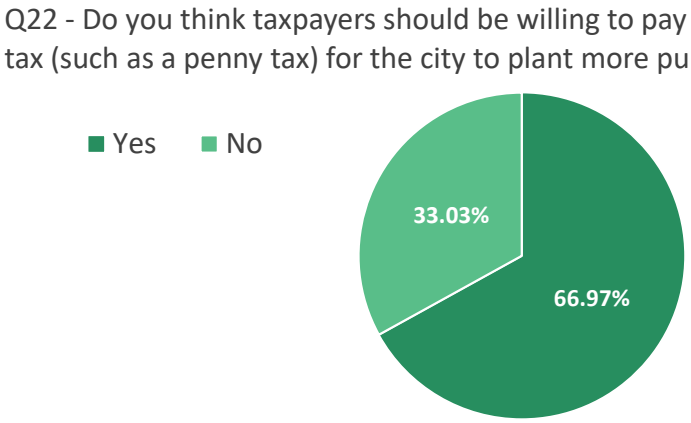


Figure 106. 67% of survey respondents think taxpayers should be willing to pay a small additional tax for the City to plant more trees.

Differing opinions on development and need for tree management regulations

When discussing the history of tree planting in Tampa, the view of one developer is that less regulation in the past, not more regulation, may have actually contributed to today's urban forest canopy. However, they also mentioned that having some rules in place is probably a good thing, today. They explained,

> *"Burgert brothers [historic] photos…show Davis Island as a sandbar, Hyde Park as like a Palmetto thicket, and by Plant High School, scrub pines and palmettos and that's about it. So, from the 1920s they dissolve and got developed… But what's interesting is all of that development was done without any landscape ordinance…right, no tree requirements etc. However, even in the absence of any requirement, homeowners and developers, builders knew that it's beneficial to plant trees…So, all these grand oaks…this urban canopy, the award-winning canopy, just happened on its own. Why are we having all these rules and regulations and fees and replacements, when history has shown that this urban canopy has developed voluntarily?...So you know, that being said, though, there probably is good [reason] to have the rules in place."* —Developer, City of Tampa

An opposing view was often expressed by residents who are experiencing rapid tree loss in their neighborhoods due to new housing and/or business development:

> *"Listen, if places aren't careful, all I gotta say is Houston. Okay? When you're not paying attention, Houston right? That is, I mean, how sad is it that that the only reason that city floods is because there's, there's no dirt? It's a concrete jungle. The only trees that grow are the trees that have holes cut out for them where people put them in their yards and they don't even realize that those helped to strengthen that underground infrastructure Yeah, I mean without the trees I'm afraid half my lawn would have slid into the street you know?"* —Central Tampa resident

Resident Views and Experiences with Tree Removal Permitting and Policies

Views of study participants on the City's tree permitting and protections range from those who are very knowledgeable about the local tree ordinances that guide the process for application to remove trees, to those who are unclear about when and how permits are needed to safely or legally remove trees, particularly Grand trees. However, of those who are aware of the local tree ordinance are typically frustrated with the ways state regulations currently impact the City's ability to successfully protect trees in situations that they would have done so prior to 2019. Open-ended survey responses on "when do you need a permit to remove a tree?" indicate that there is widespread knowledge of the significance of Grand trees within the City ordinances and that size and diameter are important factors.

Table 33. What do survey participants think about the City's tree permitting and protections?

Resident experiences with City of Tampa's tree permitting and protections
• Conflicting ideas about what size and other criteria are for permitted removal
• Many participants aware of state regulations that undermine the local ordinance, but lack specifics on details
• Storytelling and first-hand experiences about abuses of tree ordinance regulations, covert removal of trees
• Perception that developers pay into tree fund but unclear where those funds are spent or invested in tree planting; also that costs are minimal for them
• City website as main sources for info on arborists and process—many participants on survey and interview unclear as to process and follow-up

Figure 107. Word cloud of open-ended responses to the question on survey about when a permit is needed from the City to remove a tree.

One aim of the survey was to better understand public opinions on the role of the City in governing tree removal permits. With that in mind, there was a "scenario" questions that asked participants: "The next several questions are about the scenario below. Tell us what you think should be the City's response to this situation: A proposed condominium development is planned for a neighborhood in the City of Tampa that is experiencing a big increase in home sale prices. The planned construction would involve tearing down two 1200 square foot homes that have 5 large grand oaks around them and replacing those with a new 6 living unit development with a parking area. All of the trees would need to be removed. Would you be in favor of this development and request for tree removal to be approved by the City?"

This was a yes or no response question, and 12.4% of participants said, "yes," the City should approve this request, while 71.1% said, "no, deny the request," and 16% selected "other." There was a follow-up question about who to contact and the top responses were "the City" or "City council." Related to that scenario, respondents were also asked, "if the grand oaks removal is approved, what requirements are there for the developer to replace the value of the trees or plant new trees?" There were three options in response: "the trees cut down would have to be replaced," selected by 57% of people, "there are no requirements currently," selected by 10% of people and 33% said "I don't know."

Finally, the survey assessed familiarity with the City's Urban Forest Management Plan and 72% of respondents said they were not aware of the Urban Forest Management Plan, while 23% were aware of it. This indicates the need for greater outreach and education with residents and key stakeholders about the Plan and the specific components for community and institutional feedback and guidance in the Plan.

Infrastructural Inequities in Tree Cover and Maintenance

The discussion of social equity earlier in this report has highlighted a need for attention to equitable tree canopy coverage and maintenance across neighborhoods. As some participants have stated, in interviews and survey responses, trees that pose risks to people and their property due to inadequate maintenance over time are a hazard. With consistent occurrences of damage to homes and unaddressed concerns for safety building over time, residents in neighborhoods with poorer urban forest management may begin to prefer tree removal, resist tree planting, or even advocate for better canopy management. Two realities may exist side by side, with different infrastructural inequities: inadequate canopy resulting in higher heat vulnerability, and dense yet poorly maintained canopy resulting in maintenance insecurity. As is the case in many other cities, there are often intersecting inequities, where low-income neighborhoods, neighborhoods predominantly home to minority residents, and either less tree canopy coverage, or less well-maintained tree canopy, or both, intersect to form overlapping insecurities and increased risk. Interview data provides narrative evidence that where tree canopy coverage is high in neighborhoods with predominantly minority residents, there is also likely to be inequitable maintenance of the existing canopy.

Residents of Tampa have flagged these issues as injustices, particularly in our interviews with residents in under-resourced areas of the City. This suggests that ways to increase equity in the urban forest may be to focus on where:

- Neighborhoods become urban heat islands through susceptibility to rapid development or through poorly managed existing canopy;
- Where low-income residents have little access to maintenance support for safe canopy management;
- Where historic redlining legacies have exacerbated wealth inequalities; and
- Where People of Color (documented as African American/Black, Asian, Hispanic/Latine, more than one race and ethnicity, and Other in our survey, based on census categories) and lower-income residents face disproportionate risk and cost burdens whether the tree canopy is sparse or dense in their neighborhood.

Lack of adequate management infrastructure can be addressed by designing interventions with neighborhood and community engagement at the early stages for increasing equity in urban forest management. Improving equity in the tree canopy then, is more than tree planting. It will require a broad and multi-step plan for increasing environmental justice in urban forest management.

Urban Forest Management Plan Performance Criteria

General Awareness of the Urban Forest as a Community Resource

The survey and interview findings revealed that the vast majority of community members who participated in the study viewed having a lot of trees in the City as "extremely" and "very" important, preferred more trees in both the City and in their neighborhood, and voiced support for additional tree planting and more funding for tree pruning programs. Participants of the survey also expressed strong agreement with and knowledge of the many of the scientifically supported environmental, social and economic services provided by trees. Therefore, a "good" rating is assigned to the general awareness of the urban forest as a community resource indicator, an increase since the criteria was last rated in 2011.

Neighborhood Cooperation

The key objective of this performance criteria is for citizens at the neighborhood level to understand and participate in urban forest management at a broad level. The survey revealed a long list of neighborhood associations reported by individual respondents as their association. In addition, several neighborhood associations reached out to project researchers to find out more about the study and tree ordinances and enforcement. Although the survey and interview results did not provide evidence that a "majority" of neighborhood associations formed partnerships (i.e., the rating of "good"), there was strong evidence for a limited number of active neighborhood groups. Study team participation in neighborhood meetings suggests that greater outreach to neighborhood associations by the City to raise awareness of the UFMP and current efforts to address canopy change may be positively received in the future. Therefore, a rating of "moderate" is assigned to this community framework performance criteria in 2021, an increase since the criteria was rated in 2011.

Table 34. Performance criteria related to citizens' awareness and cooperation.

Criteria	Community Framework – Performance Indicators				Key Objective
	Low	Moderate	Good	Optimal	
General awareness of the urban forest as a community resource	Urban forest seen as a community problem.	Urban forest seen as important to the community. (11)	**Urban forest acknowledged as providing environmental, social, and economical services.**	Urban forest recognized as vital to the community's environmental, social, and economic well-being.	The general public understands the importance of the urban forest to the community.
Neighborhood cooperation	Majority of neighborhoods are unfamiliar with Urban Forest Management Plan. (11)	**Isolated or limited number of active neighborhood groups.**	Majority of neighborhood associations form partnerships with city government.	All neighborhood associations form partnerships with city government.	At the neighborhood level, citizens understand and cooperate in urban forest management.

The presence of "Christmas" or "baton rouge" lichen (*Cryptothecia rubrocincta*) on the trunks of trees is an indicator of good air quality.

Conclusions

This report presented the results of the fourth tree canopy and urban forest assessment required by the City of Tampa tree ordinance (Ord. No. 2006-74, § 9, 3-23-06). In addition to the continued monitoring of approximately 200 permanent field plots, mapping of tree canopy and quantification of tree canopy change, the study also included a survey and in-person interviews focused on Tampa residents' opinions and priorities related to trees, a mapping of urban heat and an analysis of environmental equity. The contents of this report were comprehensive and extensive but like previous assessments the results can inform decisions related to the City's trees and urban forest for years to come.

This report presented the scientific results of the tree canopy and urban forest assessment. The authors of this study deliberately avoided the inclusion of opinions about policy and management efforts. Occasionally, when supported by the research results, management related options may have been mentioned. However, all decisions about the management of Tampa's trees and urban forest need to be made by City Council, the Mayor's Office and City staff based on the interests of residents and business and guided by the City of Tampa Urban Forest Management Plan.

Appendices

Appendix A: Ecological Assessment Species Level Results

Table 35. List of all tree species found in Tampa's urban forest.

For each species percentage of tree population, percentage of all leaf area, importance value, and native/invasive status is given.

a Percent of the leaf area of all trees in Tampa

b Importance Value (IV) = percent of the entire Tampa tree population + percent of leaf area

c Native, exotic (non-native), and invasive status (FISC 2019) of tree species d Wind resistance is based on research suggesting tree species resistance to wind damage (Duryea et al. 2007).

d Wind resistance is based on research suggesting tree species resistance to wind damage (Duryea et al. 2007). H = high resistance, MH = moderate high resistance, ML = moderate low resistance, L = low, UNK = unknown.

Species	*Scientific Name*	% Population	% Leaf Area[a]	IV[b]	N, E, I[c]	Wind Resistance[d]
American elm	*Ulmus americana*	0.9	2.1	3.1	N	ML
American holly	*Ilex opaca*	0.2	0.0	0.2	N	H
American sycamore	*Platanus occidentalis*	0.1	1.0	1.1	N	ML
Areca palm	*Dypsis lutescens*	0.3	0.1	0.4	E	H
Baldcypress	*Taxodium distichum*	0.6	3.5	4.1	N	H
Benjamin fig	*Ficus benjamina*	0.2	0.1	0.3	E	L
Bird of paradise tree	*Strelitzia nicolai*	0.0	0.0	0.0	E	UNK
Bitter cassava	*Manihot esculenta*	0.0	0.0	0.0	E	UNK
Black cherry	*Prunus serotina*	0.1	0.2	0.2	N	ML
Black locust	*Robinia pseudoacacia*	0.1	0.0	0.1	N	UNK
Black mangrove	*Avicennia germinans*	7.8	0.5	8.3	N	UNK
Black tupelo	*Nyssa sylvatica*	1.4	1.1	2.5	N	MH
Brazilian peppertree	*Schinus terebinthifolia*	6.3	3.9	10.2	E, I	UNK
Buttonbush	*Cephalanthus occidentalis*	2.6	0.5	3.1	N	UNK
Button mangrove	*Conocarpus erectus*	0.0	0.0	0.0	N	H
Cabbage palmetto	*Sabal palmetto*	4.4	2.0	6.5	N	H
Camphor tree	*Cinnamomum camphora*	0.1	1.5	1.6	E, I	ML
Canary island date palm	*Phoenix canariensis*	0.0	0.1	0.1	E	H
Carolina ash	*Fraxinus caroliniana*	1.9	2.6	4.5	N	MH
Carolina laurelcherry	*Prunus caroliniana*	0.8	0.3	1.1	N	L
Carrotwood	*Cupaniopsis anacardioides*	0.5	0.4	0.8	E, I	UNK
Chapman oak	*Quercus chapmanii*	0.1	0.4	0.5	N	UNK

Species	*Scientific Name*	% Population	% Leaf Area[a]	IV[b]	N, E, I[c]	Wind Resistance[d]
Chinaberry	*Melia azedarach*	0.0	0.0	0.1	E, I	UNK
Chinese elm	*Ulmus parvifolia*	0.1	0.2	0.3	E	L
Chinese fan palm	*Livistona chinensis*	0.0	0.0	0.1	E, I	H
Coastal plain willow	*Salix caroliniana*	1.7	0.7	2.4	N	ML
Common crapemyrtle	*Lagerstroemia indica*	0.6	0.2	0.8	E	H
Dahoon	*Ilex cassine*	2.0	1.6	3.6	N	H
Earpod tree	*Enterolobium cyclocarpum*	0.0	1.1	1.1	E	ML
Eastern baccharis	*Baccharis halimifolia*	0.6	0.1	0.6	N	UNK
Eastern red cedar	*Juniperus virginiana*	0.2	0.8	0.9	N	L
European black elderberry	*Sambucus nigra*	0.1	0.0	0.1	N	UNK
Fetterbush lyonia	*Lyonia lucida*	0.6	0.1	0.7	N	UNK
Fiddle leaf fig	*Ficus lyrata*	0.1	0.0	0.1	E	UNK
Florida royal palm	*Roystonea regia*	0.3	0.3	0.6	N	MH
Florida strangler fig	*Ficus aurea*	0.1	0.5	0.6	N	ML
Florida swampprivet	*Forestiera segregata*	0.6	0.1	0.7	N	UNK
Fragrant dracaena	*Dracaena fragrans*	0.2	0.0	0.2	E	UNK
Georgia oak	*Quercus georgiana*	0.5	0.9	1.4	N	UNK
Glorybower spp.	*Clerodendrum* spp.	0.0	0.0	0.0	E	UNK
Glossy privet	*Ligustrum lucidum*	0.0	0.0	0.1	E, I	UNK
Green ash	*Fraxinus pennsylvanica*	0.1	0.1	0.2	N	ML
Guiana chestnut	*Pachira aquatica*	0.0	0.0	0.1	E	UNK
Horseradishtree	*Moringa oleifera*	0.0	0.0	0.1	E	UNK
Indian albizia	*Albizia lebbekoides*	0.0	0.0	0.0	E, I	UNK
Inkberry	*Ilex glabra*	0.1	0.1	0.2	N	H
Japanese privet	*Ligustrum japonicum*	0.7	0.4	1.1	E	UNK
Key Lime	*Citrus aurantifolia*	0.0	0.0	0.0	E	ML
King palm	*Archontophoenix cunninghamiana*	0.1	0.2	0.3	E	UNK
Lacey oak	*Quercus laceyi*	0.0	0.5	0.6	N	UNK
Laurel oak	*Quercus laurifolia*	5.4	15.7	21.1	N	L
Live oak	*Quercus virginiana*	2.8	19.1	21.9	N	H
Loblolly pine	*Pinus taeda*	0.1	0.1	0.2	N	ML
Longleaf pine	*Pinus palustris*	0.8	2.0	2.8	N	ML
Loquat tree	*Eriobotrya japonica*	0.1	0.0	0.1	E	ML
Lyonia tree	*Lyonia ferruginea*	0.6	0.2	0.8	N	UNK
Mango	*Mangifera indica*	0.1	0.2	0.3	E	ML
Mangrove	*Rhizophora mangle*	2.3	0.4	2.7	N	UNK
Manilla palm	*Adonidia merrilli*	0.1	0.0	0.1	E	UNK
Mexican fan palm	*Washingtonia robusta*	0.2	0.1	0.3	E, I	L
Mountain ebony	*Bauhinia variegata*	0.0	0.0	0.1	E, I	ML
Norfolk island pine	*Araucaria heterophylla*	0.0	0.0	0.0	E	L
Oriental planetree	*Platanus orientalis*	0.0	0.1	0.1	E	UNK
Paper mulberry	*Broussonetia papyrifera*	0.2	0.5	0.7	E, I	UNK
Parsley hawthorn	*Crataegus marshallii*	0.1	0.0	0.1	N	UNK
Pecan	*Carya illinoinensis*	0.0	0.0	0.1	E	L

Species	*Scientific Name*	% Population	% Leaf Area[a]	IV[b]	N, E, I[c]	Wind Resistance[d]
Peregrina	*Jatropha integerrima*	0.0	0.0	0.0	E	UNK
Pink Poui	*Tabebuia rosea*	0.0	0.0	0.0	E	ML
Plumeria spp.	*Plumeria* spp.	0.1	0.0	0.1	E	UNK
Pond cypress	*Taxodium distichum* v. *imbricarium*	10.6	13.0	23.6	N	H
Ponytail palm	*Beaucarnea recurvata*	0.0	0.0	0.0	N	UNK
Pygmy date palm	*Phoenix roebelenii*	0.4	0.0	0.4	E	H
Queen palm	*Syagrus romanzoffiana*	0.6	0.4	1.1	E, I	L
Red Beach Hibiscus	*Taliparititi tiliaceum* v. *rubra*	0.0	0.1	0.1	E, I	UNK
Red maple	*Acer rubrum*	1.4	1.8	3.2	N	ML
Redbay	*Persea borbonia*	0.2	0.4	0.6	N	ML
Rubber plant	*Ficus elastica*	0.0	0.0	0.1	E	ML
Sand live oak	*Quercus geminata*	0.1	1.9	2.0	N	H
Sand pine	*Pinus clausa*	0.2	0.4	0.6	N	L
Scarletbush	*Hamelia patens*	0.0	0.0	0.1	N	UNK
Schefflera	*Schefflera actinophylla*	0.1	0.0	0.1	E, I	UNK
Sea grape	*Coccoloba uvifera*	0.2	0.3	0.5	N	MH
Senegal date palm	*Phoenix reclinata*	0.2	0.1	0.3	E, I	H
Shining sumac	*Rhus copallina*	0.0	0.0	0.0	N	UNK
Slash pine	*Pinus elliottii*	0.8	0.9	1.7	N	ML
Small-leaf arrowwood	*Viburnum obovatum*	0.1	0.0	0.1	N	UNK
Sonoran oak	*Quercus viminea*	0.0	0.4	0.5	E	UNK
Sour orange	*Citrus aurantium*	0.0	0.0	0.1	E	ML
Southern bayberry	*Morella cerifera*	4.3	0.7	5.0	N	ML
Southern magnolia	*Magnolia grandiflora*	0.1	0.1	0.2	N	H
Sparkleberry	*Vaccinium arboreum*	0.1	0.0	0.1	N	H
Stiff dogwood	*Cornus foemina*	0.4	0.1	0.5	N	H
Strangler fig	*Ficus thonningii*	0.0	0.0	0.0	E	UNK
Strelitzia spp.	*Strelitzia* spp.	0.3	0.0	0.4	E	UNK
Sugarberry	*Celtis laevigata*	0.1	0.2	0.3	N	ML
Surinam cherry	*Eugenia uniflora*	0.0	0.0	0.0	E, I	H
Swamp bay	*Persea palustris*	1.0	0.3	1.3	N	ML
Swamp tupelo	*Nyssa sylvatica* v. *biflora*	2.9	3.3	6.2	N	MH
Sweet viburnum	*Viburnum odoratissimum*	0.6	0.1	0.7	E	UNK
Sweetbay	*Magnolia virginiana*	0.1	0.2	0.4	N	MH
Sweetgum	*Liquidambar styraciflua*	1.0	2.0	3.0	N	MH
Texas mulberry	*Morus celtidifolia*	0.0	0.0	0.1	E	UNK
Traveler's tree	*Ravenala madagascariensis*	0.2	0.0	0.2	E	UNK
Turkey oak	*Quercus laevis*	0.0	0.2	0.3	N	H
Virginia pine	*Pinus virginiana*	0.1	0.0	0.1	E	UNK
Virginia sweetspire	*Itea virginica*	0.0	0.0	0.0	N	UNK
Water oak	*Quercus nigra*	1.3	2.7	4.0	N	L
Weeping bottlebrush	*Callistemon viminalis*	0.1	0.7	0.8	E, I	UNK
White lead tree	*Leucaena leucocephala*	0.5	0.4	0.8	E, I	UNK
White mangrove	*Laguncularia racemosa*	21.1	1.8	22.9	N	UNK

Species	*Scientific Name*	% Population	% Leaf Area[a]	IV[b]	N, E, I[c]	Wind Resistance[d]
Wild banyantree	*Ficus citrifolia*	0.0	0.0	0.1	N	UNK
Yaupon	*Ilex vomitoria*	0.1	0.0	0.1	N	H
Yew podocarpus	*Podocarpus macrophyllus*	0.1	0.0	0.1	E	H
Yucca spp.	*Yucca* spp.	0.1	0.0	0.1	E	UNK

Appendix B: Potential and Current Pest Impacts

Insect and disease infestations pose a threat to urban tree survival and health and the associated value of the entire urban forest. Potential pest risks differ between cities depending on the tree hosts, climate, and other factors. The i-Tree Eco model calculates potential pest impact by examining 36 significant pests and the pest range maps (Forest Health Technology Enterprise Team 2014) for the contiguous United States to determine pest proximity to Hillsborough County. Based on this and the specific host trees present in the research area, 16 pest species showed up as potential threats. Below is a description of four pests present in the county and their potential impacts on Tampa's urban forest (Figure 109), as well as a table showing all 16 of the pests identified by i-Tree Eco and their potential impacts (Table 36).

The i-Tree Eco model (v6) does not currently report any information on pest or diseases affecting palms. While palms only represent 7% of the total tree population, they provide numerous ecosystem services and contribute an estimated $186 million in structural value to the urban forest. Some known disease and pest issues of palms currently found in Tampa were added to the i-Tree generated potential pest list. The addition of palm diseases allows for a more thorough understanding of pest and disease impacts to Tampa's urban forest.

Dutch elm disease (DED)

Dutch elm disease (DED) is a fungal pathogen (Ophiostoma novo-ulmi) that has decimated the native elm population in the United States since its reported appearance in the 1930s, resulting in a substantial loss of street trees across the country (Northeastern Area State and Private Forestry 1998). Other elm species (Ulmus spp.) such as winged elm (U. alata) are susceptible, although the level of susceptibility differs between individual trees. Based on i-Tree estimates, Tampa could potentially lose 1% percent of its trees to DED, worth $23 million in structural value.

Fusiform rust (FR)

Fusiform rust (FR) is a fungal disease (Cronartium quercuum f. sp. Fusiforme) in the southern United States that affects most Florida pine species (Pinus spp.) but is especially damaging to slash pine (P. elliottii) and loblolly pine (P. taeda). It does not transfer directly from pine to pine, but instead must undergo a lifecycle stage on nearby oak leaves before moving to the next pine (Powers et al. 1981). It could potentially impact 1% percent of Tampa's trees at a loss of $22.3 million in structural value.

Laurel wilt (LWD)

Laurel wilt (LWD) is caused by the fungus (Raffaelea lauricola) and is spread by the redbay ambrosia beetle (Xyleborus glabratus). It affects trees in the laurel family (Lauraceae), including camphor (Cinnamomum camphora), swamp bay (Persea palustris), red bay (Persea borbonia), and avocado (Persea americana). Based on i-Tree Eco estimations, this pest threatens 1.3% percent of Tampa's tree population, which represents a potential loss of $29 million in structural value.

Southern pine beetle (SPB)

The southern pine beetle (SPB, Dendroctonus frontalis) attacks most pine species, but loblolly (P. taeda), pond (P. serotina), spruce (P. glabra), and sand pines (P. clausa) are especially susceptible (Clarke & Nowak 2009). This pest threatens 2% percent of Tampa's tree population, amounting to a loss of $46.7 million in structural value.

Fusarium wilt (FW)

Fusarium wilt is caused by the fungus Fusarium oxysporum. This fungal disease creates vascular wilt in palms by obstructing the xylem (water-conducting) tissue, resulting in leaf desiccation and eventual tree death (Elliot 2017; Elliot 2016). Two different FW diseases, which have pathogen subspecies that are very host specific, currently effect palms in the Tampa area. Fusarium oxysporum f. sp. canariensis has a primary host of Canary Island date palm (Phoenix canariensis) while Fusarium oxysporum f. sp. palmarum is host specific to both queen palms (Syagrus romanzoffiana) and Mexican fan palms (Washingtonia robusta). Experimental data suggests other Phoenix species such as edible date palm (Phoenix dactylifera), Senegal date palm (Phoenix reclinata), and wild date palm (Phoenix sylvestris), may be susceptible to Fusarium oxysporum f. sp. canariensis but actual field cases are extremely rare. Currently there is no known cure for this lethal disease but disinfecting pruning tools between palms has been shown to be an effective prevention measure for spreading the disease. While the two FW diseases only threaten less than 0.9% of the total tree population, the host species represents $45.9 million in structural value to Tampa's urban forest.

Lethal Bronzing Disease (LB)

Lethal bronzing disease is a fatal, systemic bacterial disease caused by a phytoplasma (bacteria with no cell wall, Candidatus Phytoplasma aculeata). This disease was previously called Texas Phoenix palm decline, but its name has since been changed since the disease infects multiple palm species (Bahder and Helmick 2022). The phytoplasma is trans-

mitted into the phloem tissue of palms by the piercing and sucking parts of insects however the exact species of insect vectoring the LB is currently unknown. Preventative treatment of healthy susceptible palms is possible with antibiotic injections every three to four months.

This bacterial disease mainly affects Phoenix species such as Canary Island date palm, edible date palm, wild date palm and Senegal date palm. Cabbage palm, Florida's state tree, has also been identified as a primary host for LB. The disease was first identified in the Tampa area in 2006 and was the confirmed cause of decline in cabbage palms throughout the area in 2008 (Harrison and Elliott 2016). Canary Island date palm, Senegal date palm, and cabbage palm represent 4.7% of the total tree population and 67% percent of all the palm species in the City of Tampa which corresponds to a structural value of $102.9 million.

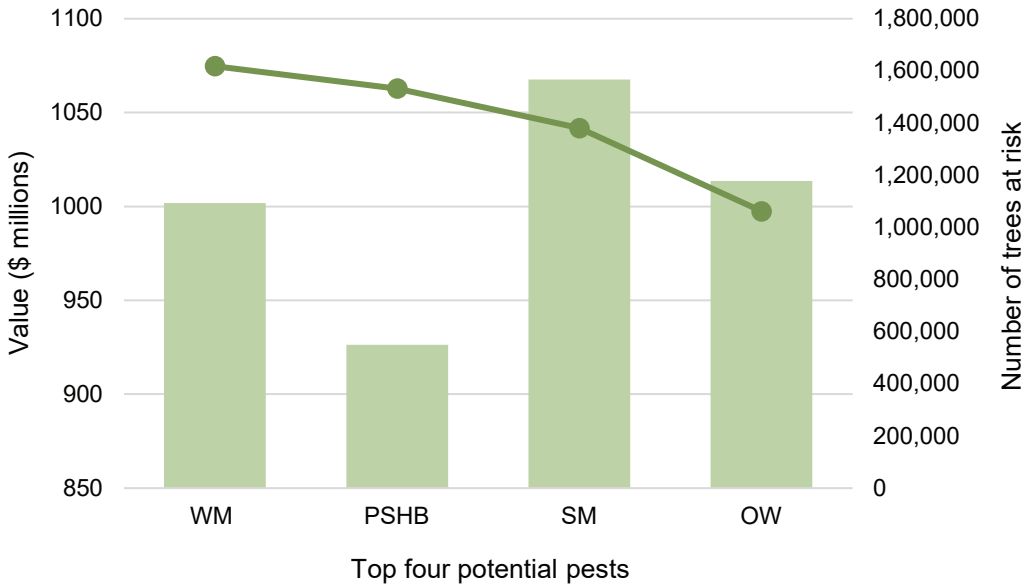


Figure 108. Number of trees at risk (points) and associated structural value (bars) for most threatening pests in Hillsborough County. WM = winter moth, PSHB = Polyphagous Shot Hole Borer,S = spongey moth, OW = oak wilt.

Table 36. Potential pest risks and their associated values in Tampa's urban forest.

Code	Scientific Name	Common Name	Trees at Risk (#)*	Value ($ millions)**
AL	*Phyllocnistis populiella*	Aspen Leafminer	176,793	5,557,118
ALB	*Anoplophora glabripennis*	Asian Longhorned Beetle	439,362	42,826,365
DA	*Discula destructiva*	Dogwood Anthracnose	43,887	1,163,284
DED	*Ophiostoma novo-ulmi*	Dutch Elm Disease	96,519	23,004,725
EAB	*Agrilus planipennis*	Emerald Ash Borer	205,580	16,659,417
FR	*Cronartium quercuum* f. sp. *Fusiforme*	Fusiform Rust	97k021	22,346,974
LAT	*Choristoneura conflictana*	Large Aspen Tortrix	176,793	5,557,118
LWD	*Raffaelea lauricola*	Laurel Wilt	140,281	29,061,428
OW	*Ceratocystis fagacearum*	Oak Wilt	1,061,532	1,013,587,410
PSB	*Tomicus piniperda*	Pine Shoot Beetle	208,320	46,725,396
PSHB	*Euwallacea* nov. sp.	Polyphagous Shot Hole Borer	1,532,090	926,316,908
SM	*Lymantria dispar*	Spongey Moth	1,380,627	1,067,575,560
SOD	*Phytophthora ramorum*	Sudden oak death	13,505	26,064,859
SPB	*Dendroctonus frontalis*	Southern Pine Beetle	208,320	46,725,396
SW	*Sirex noctilio*	Sirex Wood Wasp	208,320	46,725,396
WM	*Operophtera brumata*	Winter Moth	1,617,899	1,001,764,598
Total			**3,227,599**	**1,348,840,749**

* The number of trees at risk reflects only the known host species that are likely to experience mortality.

** Value is based on the structural value of susceptible trees.

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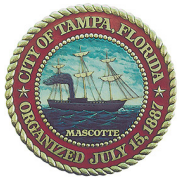

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