Evaluating the Effectiveness of Advancing Urban Forest Equity via the City of Los Angeles' Tree Ambassador/Promotor Forestal Program

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1. Executive Summary

1.1. Purpose

The Tree Ambassador - *Promotor Forestal* program is a dual-language program that pays and trains members of disinvested, low-canopy, and heat vulnerable communities in the City of Los Angeles (LA) to support tree planting and care ("*Tree ambassador program,*" n.d., para. 1). The program pilot was run in 2021 by City Plants, a nonprofit organization founded by the City of Los Angeles that oversees public-private tree planting partnerships in LA (de Guzman, 2022, p. 4). The Tree Ambassador (TA) program seeks to amplify voices of community leaders and compensate them directly for their community engagement work (Ding, 2022, para. 20). The pilot cohort started with 14 TAs and ran from September 2021 to April 2022 (Ding, 2022, para. 18). TAs canvassed local residents, held free tree adoption events, and hosted tree planting events and tree care workshops (de Guzman, 2022, p. 10). Community outreach efforts were centered around nine neighborhoods: Boyle Heights, San Fernando, Shadow Hills, Canoga Park, Sun Valley, North Hollywood, Pico Union, Westlake, and South LA (de Guzman et al., 2022, Table 1).

TAs were initially given several goals centered around raising community awareness about climate change and how trees could mitigate urban heat, listening to community needs, and strengthening community bonds. TAs were also tasked with getting 30 applications for both street trees and yard trees from community members and businesses (de Guzman, 2022, p. 5).

In total, 1,929 trees were planted or distributed, and about 1,244 residents were canvassed (de Guzman, 2022, p. 3). The TAs encountered many challenges: they found that some residents in disinvested communities did not prioritize urban greening among the multitude of issues they already faced; others distrusted the ability of government agencies to follow through on mature tree maintenance. TAs also faced physical, infrastructural, and digital barriers to interacting with neighbors (de Guzman, 2022, p. 7). Furthermore, it was difficult for TAs to secure street tree applications, which require the adjacent property owner or tenant to sign a "Commitment to Water" form, with only 3% of total trees planted being of this type (de Guzman, 2022, p. 3). Other challenges identified in an End-of-Project Evaluation Report included difficulty in administering the bilingual aspect of the program, inadequately paced training sessions that were too infrequent or came too late, and a lack of cohesion among partner organizations (de Guzman, 2022, pp. 17-18, 26).

Our UCLA team partnered with City Plants to research methods for increasing urban forest equity in the City of Los Angeles by evaluating the Tree Ambassador program. Achieving urban forest equity involves addressing policies and programs that prevent people, especially those in marginalized communities, from accessing trees and green urban areas (City Plants, 2021, p. 5). As the program administers its second round in 2023, with the benefit of lessons learned from the first round, this project is positioned to provide additional research and evaluation of program impacts, as well as identify further areas of improvement.

1.2. Methods

We used several methods to evaluate the effectiveness of the TA program's pilot round:

1. We surveyed multiple audiences about their opinions on trees in their neighborhoods and the role of community in tree stewardship, emailing those who had interacted with City Plants and TA programming in the past, as well as using intercept surveys for community members and business owners at large in areas targeted by the TA program;
2. We performed tree health analyses on all street trees planted in the pilot round through soil moisture measurements and tree health exams in order to evaluate how well residents were upholding their agreements to water trees planted in the public right-of-way;
3. We used geographic information systems (GIS) to conduct a spatial analysis of trees planted through the TA program in relation to heat-burdened, low-canopy, and low-income areas; and
4. We interviewed LA City officials and other leaders to understand what city codes and policies were currently in place to protect and promote urban greening as well as their general sentiments on the topic, and identified case studies where exceptions to standard codes and policies had been made to accommodate trees.

1.3. Findings

Low-income, heat burdened, and disadvantaged communities in the City of LA stand the most to gain from urban forests yet often have the lowest amount of tree canopy coverage. Due to the increasing risk of climate change and associated heat-related health risks that disproportionately affect these communities, it is crucial that urban forest inequity is addressed. However, the City of LA faces many challenges in doing so, from a drought-prone climate to a lack of funding. We evaluated the Tree Ambassador Pilot Program and its community-based model of tree stewardship to find how successful it was in increasing urban forest equity, using our findings to make recommendations for the program going forward.

Our intercept surveys of residents in heat-impacted communities found that most residents recognized the benefits of having trees in their neighborhoods and desired more support and fewer restrictions from the City throughout the tree planting process. Our email surveys found that City Plants and TA program tree recipients thought the TA program was efficient. Most residents felt they did not have difficulty in maintaining their trees after planting, and opinions on the importance of their roles in community tree stewardship and whether they would give up street space to plant trees ranged from neutral to agreement. Residents also had neutral opinions about the work the City did in making their communities livable.

Our tree health and soil moisture assessments found that all street trees planted by the TA pilot were alive after being planted four to 18 months prior, with 73% showing adequate soil moisture readings (above 10% soil moisture) and over half rated as "healthy." All trees had stakes, and most did not have basal sprouts. The average soil moisture of most trees decreased from the initial to final visit, except for those in one of the four geographic groupings. Comparing soil moisture measurements with crown vigor ratings yielded mixed results, with adequately watered trees receiving ratings of both "healthy" and "unhealthy." Tree health ratings also varied throughout data collection, with some trees becoming healthier or unhealthier during the course of the study. Recent precipitation in the area did not seem to have a large effect on increasing the trees' soil moisture readings. For the most part, as temperature increased, the soil moisture of trees decreased.

Through spatial analysis of trees distributed and planted through the Tree Ambassador Program, we found that the community-based nature of the program was effective and that trees were indeed planted close to TA home zip codes: out of a total of 1,455 trees analyzed, 598 (41%) of TA trees fell within 0.2 miles of a TA's zip code, with all having an average overall distance of 0.76 miles between a TA's zip code of residence and a TA tree. We also compared TA tree locations to shapefiles of SB535 Disadvantaged Communities (DACs) and the Los Angeles Urban Forest Equity Collective's (UFEC) Priority Zones, finding that 43% (630 trees) were planted in DACs, but only 7% (106 trees) were planted in UFEC Priority zones. Trees were also planted in areas that had higher CalEnviroScreen 4.0 (CES 4) scores. Finally, we compared TA tree distribution to tree canopy coverage percentage and rate of excess heat-related ER visits per zip code. While finding whether trees were planted in more heat-burdened areas was inconclusive, we did find that the TA program was moderately successful in getting trees planted in low-canopy areas, though areas with the least canopy still had little planting.

Our interviews with City officials and local leaders revealed many challenges preventing the advancement of urban forest equity in Los Angeles. Interviewees noted that, while more funding opportunities were emerging due to changes in public perception towards trees, having the responsibility of street tree maintenance rest in the hands of residents was not an effective method of ensuring trees were properly maintained. Some themes that emerged included legal restrictions preventing trees from being planted in certain urban spaces, as well as advertising the non-shade benefits of trees (like ecosystem services, biodiversity, and public health) that may resonate with certain communities.

1.4. Implications

Our findings suggest that the pilot round of the Tree Ambassador program was largely successful. Though results generally support the effectiveness of the TA program in advancing urban forest equity, there is still room for improvement. We found that not all street trees planted through the program were healthy or watered adequately. We also found that residents called for improvements in City maintenance of urban trees, as well as better communication between City Plants' various programs and program recipients. Additionally, the program could increase its impact by more strategically targeting tree planting in disadvantaged communities and in priority zones as defined by the Urban Forestry Equity

Collective.

The results of the surveys imply that residents generally value street trees in their communities and appreciate City Plants' free tree programs. They also show that residents may even be willing to give up street space to plant more trees and would be willing to water street trees in the public right-of-way. However, respondents also called for the City to become more proactive with tree and sidewalk maintenance. There were also suggestions for City Plants to provide a greater variety of fruit trees, education about tree benefits, and more communication about free tree events.

The tree health assessments and soil moisture measurements show that the TA program was successful in terms of street tree survival and resident watering, as all street trees were alive. A majority of the street trees indicated adequate soil moisture readings over the data collection period, and a moderate amount were healthy, though we note that this was not the case for all trees. Over the study period, the amount of trees with "unknown" crown vigor ratings decreased while "healthy" ratings increased, likely because many of the "unknown" trees were deciduous and had not yet leafed out during initial visits. A correlation between soil moisture and crown vigor was unclear, as there were examples of trees with low soil moisture having both healthy and unhealthy crowns. Overall, a multitude of factors likely influenced our findings: an extremely wet and cool winter and spring in 2023, many residents watering as agreed to in "Commitment to Water" forms, and optimal tree selection for the location. Though we could not parse out the degree to which winter precipitation affected soil moisture, we found that its influence did not last for more than a few weeks and that trees still needed continued supplemental watering even after significant precipitation. We also observed a warming trend that may have caused the general decrease in soil moisture between initial and final tree visits. Thus, we suspect that soil moisture and tree health will further decline during the hot, dry months of the year.

The GIS analysis indicates that the TA program is somewhat successful in getting trees planted in areas that experience higher urban heat, higher pollution and inequity burdens, and lower urban canopy cover, but that there is room for improvement. However, tree adoptions and plantings near and within various TA home zip codes indicate the success and importance of the Tree Ambassador program's model of place-based, community-led stewardship in meeting the goal of having TAs bring resources and greater benefits to their own communities.

The results of the interviews with city officials and leaders suggest that a redelegation of street tree maintenance responsibility should be seriously considered, as the current structure that requires residents to take responsibility is not the most reliable for street tree health. Interviews also indicated that, aside from shade, trees should be promoted as critical infrastructure, as they provide a host of other ecological and public health benefits. This would further justify the idea of redelegating street tree maintenance within tree stewardship programs to the City. And, in cases where it is either physically or legally impossible to plant a tree, alternatives such as shade structures should be investigated. In addition, it was also suggested that siloed departments that deal with maintaining the public right-of-way would benefit from coordinating together in order to maximize their ability to expand the urban forest canopy through sidewalk modifications.

Though we found the pilot round of the Tree Ambassador program to be largely successful in advancing urban forest equity, there are ways in which it can be improved. The TA program could increase its effectiveness by ensuring that more trees get planted in designated disadvantaged communities and UFEC priority planting zones. Checking in and offering support to residents showing signs of struggling to uphold their commitment to watering could further improve outcomes. Additionally, City Plants can consider program modifications to further appeal to community members, including options for more fruit trees and increased education on the benefits of trees. Finally, City Plants can help facilitate communication and partnerships between City departments that want to increase urban greening and departments that have the power to make that happen.

2 - Introduction

2. Introduction

Los Angeles (LA) is a city in Southern California characterized by a diverse culture and topography. It is also one of the most densely populated cities in the world, and though its population saw a 3.09% decrease from 2020, it still holds almost 10% of California's total 2023 population (Johnson et al., 2023; World Population Review, 2023). Despite being located in a chaparral biome, LA has an extensive urban forest. The *First Steps Toward an Urban Forest Management Plan for Los Angeles* report defines an urban forest as "the naturally occurring and planted trees in cities which are managed to provide the inhabitants with a continuing level of economic, social, environmental and ecological benefits today and into the future" and includes trees, understory plants, and shrubs along streets, parks, open spaces, medians, and private property (Dudek for City Plants, 2018, pp. 10-11). Trees provide a host of human health benefits that include reduced heat-related mortality, reduced anxiety and stress, enhanced memory retention, and increased self esteem (de Guzman et al., 2022, para. 1; Hall et al., 2018). Trees also provide many environmental benefits, including aesthetic pleasure, temperature regulation, and improved air quality (Hall et al., 2018, p. 45).

Like many cities across the United States, LA's urban forest is unevenly distributed, with significantly fewer green spaces and less tree canopy cover in low-income and minority communities (Nardone et al., 2021). This uneven distribution makes these communities uniquely at risk during extreme heat waves, rendering outdoor laborers and individuals with chronic medical conditions more vulnerable to heat related illness and death (Hall et al., 2018). Despite the public health risks amidst climate change, the City of Los Angeles faces many challenges in overcoming urban forest inequity. Given the ability of trees to reduce said vulnerabilities, a comprehensive approach to increasing tree equity across Los Angeles is necessary and requires innovative social, economic, political, and infrastructural innovations. Community engagement and empowerment play a key role in advancing urban forest equity (de Guzman et al., 2022).

Our team is partnering with City Plants, a nonprofit organization founded by the City of Los Angeles tasked with overseeing public-private tree planting partnerships in LA, to research methods for increasing urban forest equity in the City. Achieving urban forest equity involves addressing policies and programs that prevent people, especially those in marginalized communities, from accessing trees and green urban areas (CAPA Strategies, 2021, p. 5). In 2021, City Plants launched the Tree Ambassador - *Promotor Forestal* program, hiring community organizers living in disinvested, low-canopy, and heat vulnerable neighborhoods to encourage neighborhood-level tree stewardship and raise awareness about heat mitigation through nature-based solutions (de Guzman et al., 2022). Our project evaluated the program through the lens of advancing urban forest equity. We did so by conducting four primary activities:

1. Identifying key barriers Tree Ambassadors/*Promotores* encounter among LA residents, businesses, and other stakeholders as they organize their communities to be more climate resilient,

2. Performing tree health analyses through soil moisture readings and tree health exams,
3. Conducting a spatial assessment of trees planted by the pilot program and how closely they align with heat-burdened, low-canopy, and disadvantaged areas that City Plants wants to target, and
4. Interviewing LA city officials and other leaders to understand what city codes and policies are currently in place to protect and promote urban greening, as well as their attitudes on the subject.

We conducted surveys and interviews to help identify residents' attitudes towards community-based tree stewardship, used sensors and field equipment to analyze tree health and stewardship levels in select neighborhoods, and used GIS (geospatial information systems) to visualize where trees were planted in relation to disinvested, heat-burdened, and pollution-burdened communities. Lastly, we held interviews with City of LA officials and other local leaders to understand the current challenges of closing LA's urban forest equity gap.

3 - Background

3. Background

3.1. Trees and Green Space in Urban Areas

3.1.1. Benefits of Trees

Trees can provide communities with a variety of benefits, including heat mitigation, air quality improvement, urban walkability, mental wellness, aesthetic beauty, and crime reduction (Kuo & Sullivan, 2001; Shickman, 2021). Trees can reduce stress and anxiety, as well as improve self-esteem, cognitive abilities, life satisfaction, and happiness (Frumkin et al., 2017; Hall and Knuth, 2019*a,b*). Cardiovascular health can also improve when exposed to trees (Giacinto et al., 2021). One LA study even found that access to both tree canopy and green spaces correlated with higher life expectancies (Connolly et al., 2023, para. 41).

Additionally, trees can provide many useful ecosystem services such as carbon sequestration and oxygen production, both of which are achieved through photosynthesis. In fact, a mature tree can absorb more than 48 pounds of carbon dioxide (CO_2) from Earth's atmosphere in just one year (Arbor Day Foundation, n.d.). This ability to absorb carbon is especially important in the context of climate change. Trees also aid in reducing high temperatures by creating shade and inhibiting the heating of air and land, which will be further discussed (Fan et al., 2018). Other benefits include habitat provision, erosion control, stormwater absorption, and flood risk reduction (Shickman, 2021). The US Forest Service reports that in California alone, street trees have a value of $1 billion: $10.32 million in carbon storage, $18.15 million in air pollution removal, $41.5 million in rainfall diversion, and $101.15 million in heating and cooling related energy savings (McPherson et al., 2016).

3.1.2. Disservices of Trees

Though trees have many benefits, they can also have disadvantages. Historically, funding for citywide urban forest management activities has been limited or cyclically irregular due to the perceived costs of planting, watering, and maintaining trees according to best management practices. Each street tree in LA County has an average planting cost of $550, an establishment cost of $1,080, and a trimming cost of $165. And when a tree's life ends, removal can cost approximately $1,700 per tree (Kunsch & Parks, 2021). The shared maintenance structure of publicly managed trees in the City of LA, which relies on residents to sign "Commitment to Water" forms and fill in as proxy for a city strapped with inadequate funding, has resulted in irregular and sporadic maintenance that can impact public perception on the overall value of the urban forest.

Additionally, trees may also cause negative health effects like allergies and create tripping hazards by disrupting concrete (Sudipto et al., 2012). Dropped stems, leaves, seeds, and flowers can be seen as an eyesore and result in additional maintenance costs. Trees may further attract unwanted animals and insects that use them for food or shelter (Sudipto et al., 2012).

3.1.3. Resident Attitudes Towards Trees in Cities

Many studies have been conducted in large cities to gauge resident attitudes towards tree planting initiatives, community tree stewardship, and trees in the context of climate change. An Alabama study focusing on resident views of urban tree programs found that younger, more affluent individuals with full-time jobs who were also *aware* of tree programs were more likely to donate their time and money towards tree stewardship (Zhang et al., 2007).

Communities can also view trees negatively. Studies have shown that some community members fear that the implementation of tree planting programs in their neighborhoods will cause them to become more vulnerable to crimes such as robbery, assault, and intimidation (Jorgensen & Anthopoulou, 2007). The urban green space paradox also comes into play: when trees and other greening measures are implemented in a neighborhood, the area can become more attractive to wealthier residents, whose subsequent movement into these neighborhoods pushes lower-income, long-time residents out as rents increase. Consequently, one Harlem study found that some residents opposed the creation of parks because they saw it as a "strategy for real estate development and gentrification" (Wolch et al., 2014). This gentrification can also cause a shift in community demographics that makes residents feel disconnected from community planning efforts like tree stewardship programs (Riedman et al., 2022). Certain socio-ethnic groups may also perceive green spaces as unwelcoming due to a history of segregation (Wolch et al., 2014).

One study in the City of Detroit focused specifically on identifying the underlying causes of resident street tree planting resistance. It found that some residents declined free street trees due to concerns about maintenance and being excluded from deciding which species would be planted (Carmichael & McDonough, 2019). Those who accepted free trees did so because they believed there was a lack of trees and were able to plant their preferred species, or thought the new trees would be better than the species planted previously. It was also found that residents would be more likely to accept a tree if they received assistance in caring for it and were assured it would be removed once it died (Carmichael & McDonough, 2019). Notably, the city's history may have influenced its residents' views: by 1980, Detroit had lost 500,000 trees (and millions of dollars) due to neglect, urban expansion, and the Dutch Elm Disease (American Forests, 2012). Thus, trees may have been reminiscent of hardship and government failure to adequately fund urban forest management and support residents (Carmichael & McDonough, 2019).

3.2. The Los Angeles Urban Forest

Forests in Southern California (CA) are shaped by the region's Mediterranean climate, which is characterized by mild temperatures and relatively low total precipitation that falls primarily during late autumn and winter. In such climates, pre-urbanization landscapes would have been "grasslands and woodlands that include[ed] short trees with broad canopies" (Gillespie et al., 2012, p. 234).

Across Southern California, there are almost 39 million trees, with tree canopy covering 13.8% of the region's total land area. With an urban population of 10,583,707 in 2010, there were 3.7 trees per person in the region (McPherson et al., 2017, p. 47, Table 2). The majority of these trees are young or maturing, with only 10-20% categorized as mature (McPherson et al., 2017, p. 48, Figure 3). Currently, 11.9 million trees in the region are at risk of dying from infestation by the Invasive Shot Hole Borer, a beetle that can "transmit pathogenic fungi . . . that block water and nutrients" from being transported throughout the tree (McPherson et al., 2017, p. 44).

Historically, LA's vegetation was mostly coastal sage scrub and chaparral shrublands. Consequently, LA did not have large forested areas, except "high elevation conifer forests, riparian corridors, or oak woodlands with adequate, deep soil moisture" (Pincetl et al., 2013, p. 481). Low rainfall in the region limits soil moisture, thus restricting the extent of natural forests.

Today, LA's urban forest is further limited by modern development. As a large metropolitan area, much of LA's natural landscape has been urbanized, and land use may be a driver of tree species composition (Miller & Winer, 1984). A 2017 study found that in LA neighborhoods with mostly single family homes, recent development trends that favor larger home sizes have reduced tree canopy by 14-55% between 2000 and 2009 (Lee et al., 2017, p. 228). Despite this, Gillespie et al. (2012) documented increased urban tree density in LA since the early 1900s, presented in Figure 3-1. Figure 3-1 also shows that there is denser tree canopy on private property than on public property (Gillespie et al., 2012). About 90% of LA's trees are on private land and open space (Dudek for City Plants, 2018, p. 34).

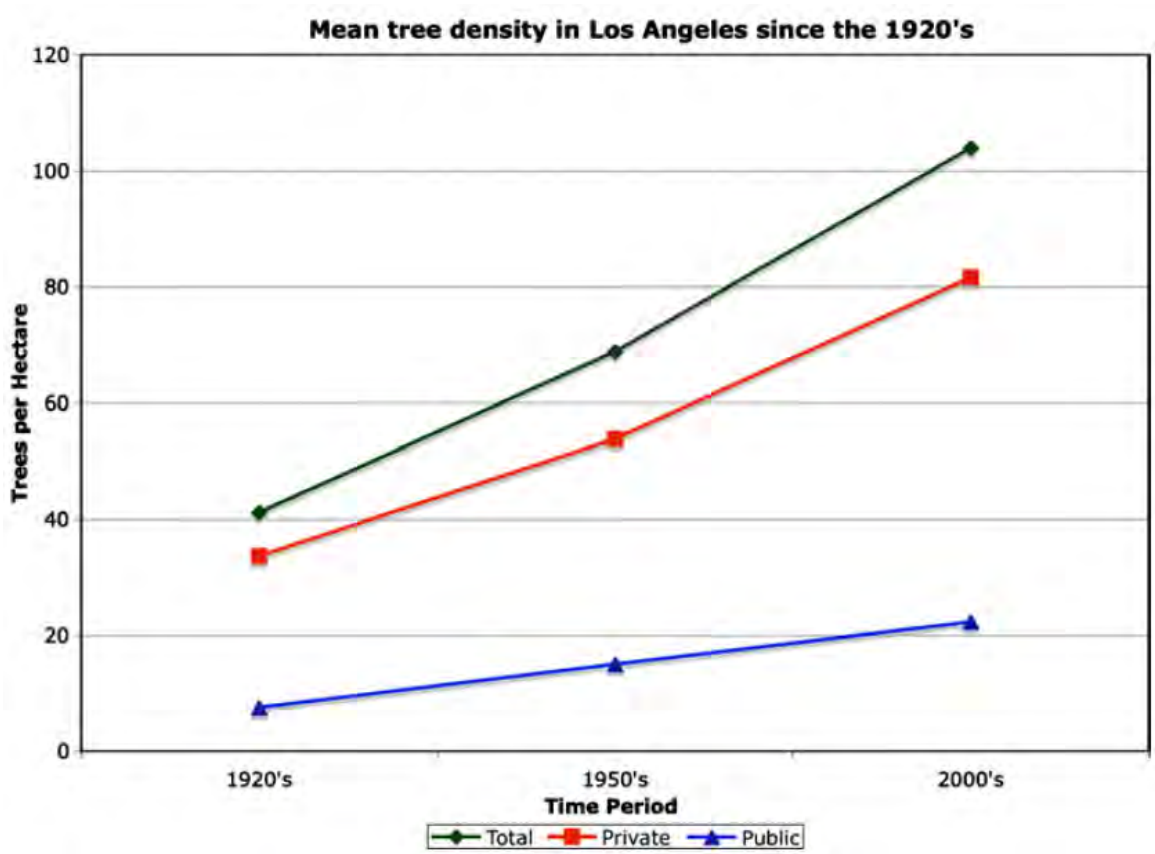


Figure 3-1. Mean tree density in Los Angeles since the 1920s. (Gillespie et al., 2012)

3.2.1. Heat Mitigation by Urban Forests in Los Angeles

With increased concretization and urbanization, heat mitigation is critical in cities as heat exposure negatively impacts the health of urban residents. Extreme heat is one of the deadliest consequences of climate change in the United States, as heat waves kill more people than floods, hurricanes, tornados, or any weather hazard combined. Exposure to excessive heat can cause "heat stroke and heat exhaustion as well as . . . heart attacks" and exacerbate pre-existing conditions, including breathing, heart, and kidney illnesses (Gregory and Azarijafari, 2021; Kalkstein et al., 2022). Between 2016-2010, 85 Angelenos died from heat or heat-related illness in LA County, up from 35 from 2011-2015 (Centers for Disease Control and Prevention, n.d.). Moreover, according to a 2021 *Los Angeles Times* investigation, extreme heat causes more deaths than official records show in California, due to comorbidity in health factors and inadequate data tracking systems statewide. According to the *Times* analysis, between 2010-2019, extreme heat caused 3,900 heat-related deaths in California, more than six-times the official count (Phillips et al., 2021).

Shade and evapotranspiration (moisture release from trees) provided by urban forests can greatly cool urban areas, with one LA study finding that blocks with over 30% tree coverage were up to "5°[F] cooler than areas with less than 1%" coverage (Pincetl et al., 2013). This effect can occur through decreases in air temperature and changes in moisture content, which affect urban air masses (volumes of air with similar physical properties throughout) (Kalkstein et al., 2022, p. 912). Specifically, urban landscape interventions, like expanding tree cover and replacing dark-colored surfaces with reflective ones, can result in cooler air masses, thus reducing heat exposure and related deaths. In fact, projections show that about one in four lives lost to extreme heat in LA could be saved through these interventions (Kalkstein et al., 2022, pp. 911, 918). However, not all these interventions are equally effective: tree shade is much more helpful in mitigating heat, as light-colored surfaces can reflect heat back at people and cause them to feel hotter (Dunlap, 2023).

3.2.2. Impacts of Heat, Drought, and Climate Change on LA's Urban Forest

Extreme heat—where temperatures exceed 90 °F for at least two consecutive days, often coupled with high humidity (United States Department of Homeland Security, 2022)—is a major stressor for urban trees. Processes vital to plant function are temperature-dependent: the efficiency of photosynthesis, for example, drops rapidly at temperatures of ~95-104°F. Consequently, activities like respiration and adenosine triphosphate production are inhibited (Teskey et al., 2014). These disturbances damage leaf cells, causing foliage to wilt, discolor, or die (Tabassum et al., 2021). If heat is extreme and persistent, overall tree growth may also be reduced (Teskey et al., 2014).

Drought—prolonged, restricted access to water—restricts nutrient transport within trees. Depending on the species and duration of drought, this can lead to starvation, tissue damage, and death (Hammond et al., 2019; Sevanto et al., 2013). These effects limit tree growth in the long-term and increase the likelihood of disease and pest invasion (Belvins & Flocke, 2022).

Los Angeles is, and will continue to be, significantly impacted by climate change. Average maximum temperatures are expected to increase 4-5°F by 2050 and up to 5-8°F by the end of the 21st century, resulting in a continuous warming trend (Hall et al., 2018). Already, the Los Angeles International Airport experiences 15 days of extreme heat per year. If CO_2 emissions continue at their current rate, this will increase to 50-90 extreme heat days per year (Hall et al., 2018). While the extent to which climate change will affect tree mortality is uncertain, by 2050, 20-40% of species within urban forests globally will likely be imperiled (Esperon-Rodriguez et al., 2022). Furthermore, more frequent extreme heat events will increase tree mortality and the time it takes for trees to recover between events, threatening vulnerable native and exotic species within urban forests (Gessler et al., 2020).

3.2.3. Factors Impacting the Distribution of LA's Urban Forest

Across the United States, historically redlined areas have higher poverty rates, unemployment, and industrial pollution levels than non-redlined areas (Mitchell & Franco, 2020). New Deal lending programs via the Home Owner's Loan Corporation based loans on an assumption of "increased risk," with lenders providing significant financial opportunities to white communities while denying home mortgages to certain ethnic groups (Winling & Michney, 2021). Historians have found a complex correlation between Black, Asian, and Latinx communities and discriminatory redlining at the hands of the Federal government.

Redlining can be one of many drivers of tree planting locations, and previously redlined areas today have higher amounts of impervious land cover and far less tree canopy (Hoffman et al., 2020; Nowak et al., 2022; Winling & Michney, 2021). In fact, as presented in Galvin et al. (2019), this uneven distribution of urban forests continues to affect today's residents:

> Five census block groups, one in Pacific Palisades, one in Los Feliz, two in Brentwood, and one in Shadow Hills, contain 18% of the City's total tree canopy. Less than 1% of the City's population resides in these areas making it clear that much of the City's tree canopy is not where the people are. (p. 6)

As a result of discriminatory planning policies, low tree canopy and limited access to green space have measurable impacts on public health, as median rates of emergency department visits due to asthma were two to four times higher in previously redlined census tracts (Nardone et al., 2018).

Other factors also contribute to the uneven distribution of tree canopy in LA, including space available to plant trees, permeable surfaces, microclimate, individual human actions, and government policies (F. Escobedo, personal communication, February 22, 2023). Regarding inadequate planting space, neighborhoods could hypothetically be physically restructured to allow more space for trees. However, even if such interventions are implemented, financial constraints can make tree maintenance difficult, as areas with higher average income are more likely to have the resources to afford and care for plants (Clarke et al., 2013; Pincetl et al., 2013). The urban green space paradox can also exclude the very residents urban greening efforts seek to benefit (Wolch et al., 2014).

The Los Angeles Urban Forest Equity Collective (UFEC) is a group bringing researchers, practitioners, community stakeholders, and policy-makers together with the goal of dismantling the physical, political, and social barriers that perpetuate urban forest inequity. Co-founded by Rachel O'Leary and Dr. Edith de Guzman in partnership with CAPA Strategies in 2020, in its first phase of work UFEC published the *Los Angeles Urban Forest Equity Assessment* and the *Los Angeles Urban Forest Equity Streets Guidebook*. UFEC meets monthly to assess the unequal distribution of LA's urban forests and provide recommendations for increasing tree canopy in disadvantaged neighborhoods (City Plants, 2023).

3.2.4. Criticisms of Tree Planting Initiatives in Los Angeles

Though there are many benefits of urban tree planting initiatives, we must also consider their emerging critiques. Dr. Francisco Escobedo, a research social scientist for the USDA Forest Service, notes that cities are "already there" in terms of increased heat and unreliable water, and that climate change is only further intensifying these conditions (F. Escobedo, personal communication, March 10, 2023). Dr. Stephanie Pincetl, a UCLA professor who focuses on land use and environmental justice, further adds that areas where trees are needed most have poor soil quality. Disinvested communities often have narrower planting strips and higher density housing, oftentimes due to historic planning policies like redlining, meaning "the trees that can (barely) survive there are smaller trees that yield less shade" (S. Pincetl, personal communication, November 24, 2022). Dr. Pincetl also cites Saugier et al. (2001) for finding that the carbon uptake of a hypothetical forest modeled over LA's land area insufficiently offsets current carbon emissions in that same area (Pincetl et al., 2013, p. 482). Moreover, foresting this entire urban area is unrealistic in the context of local biogeography. Char Miller, a Pomona College environmental analysis professor, also points out that LA is a coastal sagebrush ecosystem and that tree planting programs are a "rejection of environmental realities in favor of [settler] cultural norms" (Miller, 2022, paras. 10, 12).

Additionally, residents may have personal reasons for not wanting trees planted on their property or in the planting strip in front of their residence. For this reason, it is important that tree planting initiatives involve residents in determining if and where they would want trees.

3.3. Management of Los Angeles' Urban Forest

Urban forest management activities in Los Angeles are broken down according to a tree's life cycle phase, including planting, establishment care, young tree pruning, mature tree pruning, and tree removal. LA's urban forest is managed by a wide array of stakeholders, including City Plants (LA's tree planting initiative), various government agencies, such as the Board of Public Works, Urban Forestry Division (UFD), Department of Recreation and Parks (RAP), LA Sanitation and Environment, Bureau of Engineering, Department of City Planning, Los Angeles Department of Water and Power (LADWP), and Department of Building and Safety, as well as several nonprofit organizations (Dudek for City Plants, 2018, p. 38). Due to inadequate funding and cycles of disinvestment in city budget processes, the City of LA, like many cities across the United States, has a shared maintenance model for street tree management in the public right-of-way. Unless nonprofit partners or government agencies secure outside grant funding for tree planting and young tree care, individual residents are largely responsible for street tree planting and establishment care, and Angelenos must secure permits from the City of Los Angeles' Urban Forestry Division within StreetsLA to prune and remove street trees, stumps, or dead standing trees. Mature tree care, including pruning, is conducted by UFD, RAP, and, in cases where trees intersect with powerlines, LADWP. Another significant challenge is that street trees planted in the parkway—the public right-of-way or planting strip between the sidewalk and curb—are often not irrigated by automatic irrigation systems and do not get the maintenance needed to survive.

While many agencies oversee tree planting and maintenance on public lands, one of the most overlooked elements is the management of trees and plants on private land, which constitutes 90% of LA's urban forest. In fact, the highest rate of loss of LA's canopy cover is caused by private property expansion and development (Dudek for City Plants, 2018, p. 50).

3.3.1. Tree Planting, Young Tree Establishment Care, and Mature Tree Maintenance

Currently, public space tree planting in the City of LA is conducted by City Plants via funding from LADWP, various nonprofit organizations, the City of LA's Urban Forestry Division, and RAP (Dudek for City Plants, 2018, p. 38). LA Sanitation and Environment secures outside state grants to fund tree planting, concrete cuts, and three to five years of establishment care through City Plants nonprofit partners in neighborhoods deemed "disadvantaged," according to California's CalEnviroScreen tool (R. O'Leary, personal communication, March 9, 2023). In 2018, the City of LA also passed Ordinance 185573, the "Tree In-Lieu Fee" (also known as the "Guarantee Tree Fee"), establishing a tree replacement fee to satisfy the City's tree planting requirements when a tree removed due to development cannot be planted "on-site." Under this ordinance, the Board of Public Works, the Department of City Planning, and the Urban Forestry Division require developers to pay a fee for every mature tree removed, and these funds are then utilized to procure, plant, and maintain replacement trees along city streets and commercial corridors (Ordinance 185573, 2018).

The responsibility of providing establishment care for newly planted public-space trees falls largely on individual residents, except in cases where nonprofit or City agencies secure grant funding to provide this central service via paid contractors, or in cases where developers pay the tree-in-lieu fee for trees removed due to development. The required establishment care period is five years for newly planted street trees and three years for newly planted park trees. For grant-funded street tree projects, this five-year establishment care period includes watering 33 times per year, with increased maintenance visits during hot summer months. For non-grant-funded street tree plantings, or when Angelenos request free street trees from the City Plants program, City Plants requires residents to sign a "Commitment to Water" form. For private property trees delivered or distributed through tree adoption events, City Plants requires residents to sign a "Pledge to Plant and Care" form. City Plants conducts a random-sample survival study every two years on trees planted and distributed through their program, while RAP requires organizations that plant trees in parks to secure grant funding to maintain them for a minimum of three years through establishment (Dudek for City Plants, 2018, pp. 38, 40). While City Plants and LA city agencies do not plant trees in public spaces unless there is funding in place to maintain them during their establishment period, decades of inconsistent funding in the City budget and heavy reliance on outside grants has resulted in a confusing system of shared maintenance responsibility, where some trees receive establishment care by paid contractors and others rely on residents to provide this critical care.

Another vital element of planting within LA is community engagement and education, and City Plants and their collaborators distribute free trees to LA residents for their homes with tree care instructions. The organization measures program impact by gathering information from residents who participate, as well as electronically verifying planting locations (Dudek for City Plants, 2018, p. 38). Funded by LADWP through their energy efficiency programs, the City Plants program plants, delivers, and distributes an average of 3,500 street trees and 18,300 residential trees per year (Dudek for City Plants, 2018, p. 37). City and nonprofit partners often leverage LADWP funding for the City Plants street tree program to secure local, state, and federal grants for concrete cuts and establishment care in disadvantaged communities.

Regular tree pruning is a vital component of tree maintenance and urban forest management, as well as an important public safety procedure. Despite this, City budget cuts have reduced the mature street tree pruning cycle to once every 17 years, far behind the five to seven year pruning cycle recommended by industry standard best management practices (R. O'Leary, personal communication, March 9, 2023). Prolonged pruning cycles and deferred maintenance may result in an increase in tree-related injuries, lawsuits, and property damage, as well as negatively impact tree health (Dudek for City Plants, 2018, p. 42). Between 2014-2018, tree-related settlements, either "trip and fall" or "dangerous condition" cases, have steadily increased in the City of Los Angeles (Dudek for City Plants, 2018, p. 45). To further complicate matters, those responsible for pruning do so by different standards and goals. The UFD prunes trees based on standards set by the International Society of Arboriculture (ISA) and the American National Standards Institute (ANSI). On the other hand, LADWP prunes to maintain minimum required electrical line clearance, while the LA Fire Department prunes for fire protection (Dudek for City Plants, 2018, p. 43).

LA's semi-arid climate also poses specific watering challenges for its urban forest. Street trees planted in commercial corridors, when funded by an outside grant or city agency, receive an establishment schedule of 33 visits per year over three to five years, which includes weekly watering in summer with less in autumn and winter (Dudek for City Plants, 2018, p. 41). The watering schedules are three times a month in October, twice a month in November through May, and four times a month in June through September (C. Basurto, personal communication, February 23, 2023). RAP, which manages park trees, will specifically plant within their irrigation footprint to ensure watering. And, as aforementioned, trees in privately owned areas are dependent on watering from residents (Dudek for City Plants, 2018, p. 97).

Tree removal is the final, integral element of tree maintenance. LA's public tree inventory accounts for approximately 8,000 both known and unaccounted-for dead street trees. RAP has logged 5,000 dead trees inventoried in parks that have yet to be removed (Davey Resource Group, Inc, 2023; Dudek for City Plants, 2018, p. 42). The challenge of removing dead trees is a major limitation to expanding the urban forest, as the presence of dead trees prevents new ones from being planted. The lack of data, funding, and staff for these activities further exacerbates the decline of the current canopy as officials are unaware of the issue's extent.

3.3.2. Systemic and Environmental Challenges to Tree Maintenance

Large cities like LA face frequent water shortages during the summer due to climate change (Hall et al., 2018). Such shortages can result in mandatory, city-wide watering restrictions, causing trees to experience additional water stress as ratepayers cut back on usage. Repeated or long-term exposure to drought eventually jeopardizes tree health and longevity, further reducing their ability to provide ecosystem services like heat mitigation (Esperon-Rodriguez et al., 2022; Kunsch & Parks, 2021).

Urban environments also experience a phenomenon called the urban heat island (UHI) effect. Urban areas are saturated with impervious surfaces, all of which eliminate the cooling capabilities natural environments provide (Gregory & Azarijafari, 2021). During summer, these surfaces retain and radiate excess heat, resulting in surrounding air temperatures being 1-7°F higher than those in nearby rural areas (Admin, 2018; US EPA, n.d.; Gregory & Azarijafari, 2021). LA experiences the most extreme UHI effect in California, which, when coupled with climate change, produces significantly higher temperatures and dangers to surrounding trees and communities (Hall et al., 2018).

Furthermore, grants for tree planting do not always include funding for maintenance or watering (de Guzman et al., 2022, p. 3). Trees planted on private property or in the public right-of-way frequently rely on watering from residents or businesses who must sign a watering commitment form for the first five years after planting. However, establishment care commitments are not always upheld, and, when paired with LA's hot weather and dry soil, newly planted trees can experience high mortality, especially considering that a majority of Angelenos rent, not own, property (Dudek for City Plants, 2018, p. 97). Research has also found that residents often believe public space tree care is the City's responsibility (de Guzman et al., 2022, p. 17). This presents a challenge to the survival of street trees after planting, as they may not be watered through their establishment period, despite commitments from individual residents who sign "Commitment to Water" forms. Currently, there is "chronically insufficient" funding allocated to support trees in LA's urban forest throughout their entire life cycle, with an estimated $70-80 million annual budget gap needed to proactively manage LA's urban forest (de Guzman et al., 2022, p. 17).

Over the past two decades, the City's perception of trees has shifted from being viewed and budgeted for as "nice to have" to being considered critical city infrastructure in light of climate change. However, this has not been reflected in increased funding for trees in the City of LA's budget (R. O'Leary, personal communication, June 3, 2023). Thus, while trees typically appreciate in value as they mature, underfunding can limit their potential to reach full maturity, thereby decreasing the value and projected benefits of LA's urban forest (R. O'Leary, personal communication, March 9, 2023).

3.4. Urban Forest Assessment Methods

Assessing the condition of tree canopy coverage of LA's urban forest requires a combination of field work, remote sensing, and ancillary data (Hermansen-Baez et al., 2019). This effort is complicated by tree-ownership, as municipal workers can only access trees located on public and city-owned plots of land. 90% of LA's urban forest is privately owned and can only be assessed remotely (Dudek for City Plants, 2018).

3.4.1. Remote Sensing Methods

In 2019, Hermansen-Baez et al. published "Urban Tree Canopy [UTC] Assessment: A Community's Path to Understanding and Managing the Urban Forest" for the US Forest Service. This paper creates a solid framework for municipal cities to adopt and customize to fit their needs. It also provides a comprehensive comparison of assessment technologies and establishes LiDAR (Laser Imaging, Detection, and Ranging) as the "gold-standard" for UTC assessments. Advanced LiDAR can not only calculate the total UTC area, but can also be used for "distinguishing vegetation from other features, identifying individual tree species, and providing detailed descriptions of tree structure, such as tree height and crown cover" (Hermansen-Baez et al., 2019, p. 6).

For urban forest assessment, LiDAR data are typically collected from a helicopter or airplane, then combined with multi-spectral, high resolution imagery and other geographic data (Hermansen-Baez et al., 2019, p. 6).

While LiDAR data can offer significant insights beyond just satellite imagery, they are extremely costly, often falling outside the budget of municipal forest management departments. And, like any other technology, the full capabilities of LiDAR sensors are also cost-dependent: while a city may have the budget for LiDAR data that detail tree canopy height, it may not have the budget for LiDAR data that identify tree species, structure, and canopy thickness (Dubayah & Drake, 2000). Furthermore, a complete assessment of urban forest health often requires additional details that fall beyond the capabilities of current remote sensing technology. Health indicators—including forest age diversity, tree health, tree stocking (trees per acre), and tree pruning cycle—are still more easily assessed on-site (Bureau of Street Services, 2015; Bowers, 2013, section on "Measure stand volume and growth"). LA's urban forest was assessed in 2019 using LiDAR data collected in 2016, accessible using the Los Angeles County Tree Viewer. The Los Angeles County Geographic Information Office expects to commission another round of LiDAR data in the coming months (E. de Guzman, personal communication, February 6, 2023).

3.4.2. Field Data Collection Methods

The extent of field data collection can vary depending on assessment needs: random sampling of urban forest populations (which include all trees within a defined geographic region) can be extrapolated to analyze wider areas, or extensive tree inventories of specific tree populations can be created by researchers sampling street by street (Hermansen-Baez et al., 2019; Nowak et al., 2011). Tree inventories provide the most accurate information over the study area, as every tree is assessed by a professional arborist. However, this can be a costly endeavor due to the time required and number of workers involved. To further complicate inventory efforts, city arborists can only assess trees on public land, so the largest swath of the urban forest on private property is inevitably left out (Dudek for City Plants, 2018). The City of Los Angeles budgeted $2 million for a street tree inventory following the publication of the *First Steps* report in 2019, slated for completion at the end of 2023.

3.4.3. Citywide Tree Inventory & Assessing the Urban Forest of Los Angeles

In late 2020, following key recommendations outlined in City Plants' *First Steps Toward an Urban Forest Management Plan* report, and reinforced by requests from StreetsLA, the Bureau of Street Services, the City Controller, LA Sanitation & Environment, the US Forest Service, the California Department of Forestry and Fire Protection (CAL FIRE), and many outside entities, the City of LA contracted Davey Resource Group to create an extensive street tree inventory (Davey Resource Group, Inc., n.d.). This was the first large-scale inventory of LA's street trees since 1996, creating a significant database of tree locations, species, sizes, and distances from other infrastructure (Bureau of Street Services, n.d.). Nearing completion, the City of LA's public tree inventory has recorded 763,044 trees in city parks and along city streets to date, providing an estimated $113,254,093.86 in annual eco benefits to the region (Davey Resource Group, Inc, 2023).

RAP completed an inventory of all City of LA park trees in 2022, reporting a total of 136,529 trees in parks, worth an estimated $32 million in annual eco benefits. The street tree inventory is currently underway and is slated to conclude in November 2023. Publicly accessible data continue to be updated in real time, and according to the most recent count, a total of 626,738 street trees have been recorded to date, worth an estimated $80 million in annual eco benefits (Davey Resource Group, Inc, 2023; R. O'Leary, personal communication, February 9, 2023). While the 2022 LA Biodiversity report indicated that the street tree inventory would include information about the health of each tree, this information is not available on the public-facing inventory website (Barton, 2022, p. 77; Bureau of Street Services, n.d.).

Lacking more recent tree health data from the inventory, the most recent data regarding LA's urban forest comes from the 2015 State of the Trees report. This assessment was conducted by randomly inspecting trees across the city and combining these findings with ancillary data. Arborists graded the city's trees on an academic scale (A through F), assessing species diversity, age diversity, stocking rate, health, and maintenance. While they found the species diversity and stocking rate to be sufficient (with respective grades of A and B+), the forests' age diversity (grade D), tree health (grade D), and maintenance (grade F) were extremely poor. The report remarked that tree health was significantly stressed due to drought conditions, bacterial pests, and lack of proper pruning. Arborists gave an overall grade of C- for the street trees' condition and noted that the urban forest was in desperate need of maintenance and funding from the city (Bureau of Street Services, 2015).

3.5. City Plants' Tree Ambassador Program

The Tree Ambassador - *Promotor Forestal* program is a dual-language program that pays and trains members of disinvested, low-canopy, heat vulnerable communities in the

City of LA to support tree planting and care (“*Tree ambassador program,*” n.d., para. 1). The program pilot was run in 2021 by City Plants (de Guzman, 2022, p. 4). Funding sources include State and City government agencies, LA nonprofits, and Ecosia, a search engine that invests profits in tree planting and conservation in biodiversity hotspots worldwide (de Guzman et al., 2022, p. 4; Ecosia, n.d.).

The program is inspired by the community health worker model, which trains trusted community members to work in public health (American Public Health Association, 2021). Likewise, the Tree Ambassador (TA) program seeks to amplify the voices of community leaders and “directly compensate” them for their community engagement work (Ding, 2022, para. 20). Ambassadors working in their own communities may know *where* trees can be planted, as well as specific hurdles to planting where they live. They are also “more approachable . . . than City Officials or nonprofit[s]” (City Plants, n.d., p. 4). By using this model, the TA program hopes to avoid volunteerism and green gentrification (de Guzman, 2022, p. 4).

The pilot cohort had 12 TAs and began in September 2021, ending in April 2022 (Ding, 2022, para. 18). TAs canvassed local residents, held free tree adoption events, and hosted tree care workshops (de Guzman, 2022, p. 10). Community outreach efforts were centered around nine neighborhoods: Boyle Heights, San Fernando, Shadow Hills, Canoga Park, Sun Valley, North Hollywood, Pico Union, Westlake, and South LA (de Guzman et al., 2022, Table 1).

TAs were initially given several goals centered around raising community awareness about climate change and how trees could mitigate urban heat, listening to community needs, and strengthening community bonds. TAs were also tasked with getting 30 applications for both street trees and yard trees from community members and businesses (de Guzman, 2022, p. 5).

In total, 1,929 trees were planted or distributed, and about 1,244 residents were canvassed (de Guzman, 2022, p. 3). Surveyed TAs felt that the program was supportive and that they gained awareness about urban greening as well as interpersonal and technical skills. Some program employers also planned to hire TAs going forward (de Guzman, 2022, pp. 20, 24, 27).

There were many challenges initially faced by the TAs. Some residents in disinvested communities did not prioritize urban greening among the multitude of issues they already faced; others distrusted the ability of the government to follow through on tree care. TAs also faced physical and digital barriers to interacting with neighbors (de Guzman, 2022, p. 7). It was furthermore difficult for TAs to secure street tree applications, with only 3% of total trees planted being of this type (de Guzman, 2022, p. 3). Challenges identified by the End-of-Project Evaluation Report included difficulty in administering the bilingual aspect of the program, trainings that were too infrequent or came too late, and a lack of cohesion among partner organizations (de Guzman, 2022, pp. 17-18, 26).

The Evaluation Report gives suggestions on how the program may improve going forward, including integrating TA feedback, building accountability by using minimum attendance requirements, increasing opportunities where TAs can express needs and concerns, creating more community-building opportunities among the Ambassadors themselves, taking into account the TA’s experience both before and after the program, and having host organizations compare and adopt optimal methods (de Guzman, 2022, pp. 28-33). As the Tree Ambassador program embarked upon its second round in 2023 with the benefit of lessons learned from the first round, this practicum project is positioned to provide additional research and evaluation of the impacts of the program and identify further areas of improvement.

4 - Research Objectives

4. Research Objectives

As the Tree Ambassador program entered its second round, City Plants partnered with our team of undergraduate students from the UCLA Institute of the Environment and Sustainability to answer the following research questions, which our team explored using a mixed-methods approach:

1. What beliefs, attitudes, and opinions do people who live or work in select disadvantaged LA neighborhoods have around community-based tree stewardship and the community's role in advancing urban forest equity?
2. What is the health of trees planted via community-based efforts through the Tree Ambassador program? Are those trees being cared for as intended by agreements signed by residents or businesses, as indicated by soil moisture readings and tree health assessments?
3. Our revised research question became: How effective was the Tree Ambassador pilot program in planting trees in high priority, low-canopy, heat vulnerable, and environmentally burdened census tracts?
4. Our revised research question became: What factors either hinder or support closing LA's urban forest equity gap, and how do Los Angeles City and county policy-makers perceive those factors?

5 - Community Surveys

5. Community Surveys

5.1. Methods

5.1.1. Research Design and Data Collection

The question we sought to address by using community surveys was, "What beliefs, attitudes, and opinions do people who live or work in select disadvantaged LA neighborhoods have around community-based tree stewardship and the community's role in advancing urban forest equity?" To address this research question, we created surveys for two main audiences:

1. Audience 1 was composed of residents of the community-at-large.
2. Audience 2 included recipients of free yard and street trees via both the City Plants program and the Tree Ambassador Pilot Program. Audience 2 was further sub-divided into six sub-audiences based on the location that the tree was planted (street vs. yard), as well as the method of tree acquisition (delivery vs adoption).
    a. Sub-audience 1: TA Pilot Program Street Tree Recipients
    b. Sub-audience 2: TA Pilot Program Yard Tree Recipients via Delivery
    c. Sub-audience 3: TA Pilot Program Yard Tree Recipients via Adoption
    d. Sub-audience 4: All City Plants Street Tree Recipients in the last 5 years
    e. Sub-audience 5: All City Plants Yard Tree Recipients via Delivery in the last 5 years
    f. Sub-audience 6: All City Plants Yard Tree Recipients via Adoption in the last 5 years

The questions for both survey audiences were composed of multiple choice, Likert scale, and open-ended answers. The surveys took an estimated five minutes to complete, and respondents were given the change to be entered into a raffle to win a $100 Amazon e-gift card as an encouraging incentive to participate. Respondents from Audience 1 and Audience 2 were included in the raffle. Four winners were chosen from four distinct groups—all Audience 1 participants, TA free tree delivery respondents (Audience 2 sub-audience 2), TA free tree adoption respondents (Audience 2 sub-audience 3), and City Plants street tree program respondents (Audience 2 sub-audience 4). Winners were determined by randomly generating an email from a list of compiled addresses in each group; the winner was notified they had won a gift card via email and asked to respond to the email in order to claim it.

Audience 1 was composed of residents who were approached outside of businesses in the same neighborhoods that tree health data had been collected. These neighborhoods were split up into four color groups and included: Green (South Park, Downtown, Pico Union/Exposition Park, Boyle Heights, Westlake), Yellow (Sunland, Tujunga), Orange (North Hollywood, Valley Village, Valley Glen, Sun Valley), and Blue (Sun Valley, Pacoima/Arleta). In total, 59 residents from Audience 1 responded to the intercept survey. The respondents of this survey were not people directly involved in the Tree Ambassador pilot program or the City Plants program more broadly but who live and work in high priority, low-canopy, heat vulnerable neighborhoods. Intercept surveys held in public spaces asked residents their opinions on trees in their neighborhood focusing on four core themes: *Relationship to Neighborhood*, *Tree Value*, *Tree Maintenance*, and *Desire for Change*. The surveys were administered on paper with questions provided in both English and Spanish, and data was manually entered into SurveyMonkey. The Audience 1 survey included 14 questions, 13 of which were taken directly from the UFEC Community Engagement survey provided by City Plants. There was an additional question that provided respondents with an opportunity to give an open-answer response to the prompt "Is there anything you would like us to know about trees in your neighborhood?", as well as the addition of the statement "I often think about trees in my community" within the first Likert scale question that asked about respondents' opinion about trees. The decision to utilize the UFEC Community Engagement survey was made to allow for easy data-comparison for our client when analyzing the opinions of various audiences across Los Angeles. We found that the questions from this survey effectively explored all four themes and reflected the goal in our research question.

Audience 2 included recipients of free yard and street trees via both the City Plants program and the Tree Ambassador Pilot Program. These surveys were sent via email and collected via SurveyMonkey. In total, 1,002 residents from Audience 2 responded to the free tree recipient surveys. We received zero responses from Sub-Audience 1, and therefore this sub-audience was excluded from analysis. The questions in Audience 2 included one Likert question with statements also found in Audience 1 that asked about residents' desire for change regarding trees in their community as well as their opinion on tree maintenance. Additionally, the final four questions from both audience surveys were the same, asking about the respondents' relationship to their neighborhood, such as their home type and how long they lived there. The remaining questions in the Audience 2 survey included a Likert scale question that asked residents' opinions on various statements pertaining to their overall program experience and the effectiveness of the free tree program, as well as a question that asked about their experience maintaining their tree. Additionally, four questions asked for information regarding the status of the acquired tree, including information on the amount of trees received, their health status, and the individual's tree maintenance practices, such as frequency of watering and mulch status. Respondents were also given the opportunity to attach a picture of their tree(s). These questions were based off a student research project conducted at the University of Toronto that proposed a municipal tree monitoring framework for program administrators (Wells, 2022). The questions asked to the six sub-audiences in Audience 2 were distributed via email and provided in English only. The questions reflect our goal of understanding tree recipients' opinions on the program by including the five following themes: *Program Experience, Acquired Tree Status*, *Tree Maintenance*, *Desire for Change*, and *Relationship to Neighborhood*. Below is a table that specifies the sub-audiences included in Audience 2:

Sub-Audience	Population Size	Sample Size	Survey Response Rate
1 - Tree Ambassador (TA) Pilot Program Street Tree Recipients	20	0	0%
2 - TA Pilot Program Yard Tree Recipients via Delivery	224	24	11%
3 - TA Pilot Program Yard Tree Recipients via Adoption	170	13	8%
4 - All City Plants (CP) Street Tree Recipients in the last 5 years	745	66	9%
5 - All CP Yard Tree Recipients via Delivery in the last 5 years	12697	716	6%
6 - All CP Yard Tree Recipients via Adoption in the last 5 years	3359	183	5%

Table 5-1. Audience 2 Sub-Audiences Surveyed by Email. This table shows the sub-audiences within Audience 2. The "Sub-Audience" column specifies the name and number of each sub-audience, while "Population size" denotes the total number of people emailed in each group. "Sample size" denotes the number of people who responded per group, and "Survey Response Rate" denotes the percentage of people in each group that responded.

5.1.2. Data Analysis

To analyze the data from both Audiences 1 and 2, an excel spreadsheet was downloaded from the SurveyMonkey website containing data from all questions. The final results in this report include five questions and their corresponding answers from both audiences.

The purpose of analyzing the first audience was to better understand residents' general opinion of trees in their neighborhoods. To do this, all questions in English and Spanish were aggregated, and each question was analyzed separately and in English. Questions with Likert scale answers were displayed as a bar graph showing tallied counts of respondents' answers to each statement. For all Likert scale questions, the answer options ranged from 1-5. 1 was "Strongly Disagree", 2 was "Disagree", 3 was "Neutral", 4 was "Agree", and 5 was "Strongly Agree". Questions with multiple-choice answers were displayed as a pie chart showing the tallied counts of each answer option. The visual data for each question and summaries describing corresponding themes are provided in Appendix A - Intercept Surveys.

The purpose of analyzing Audience 2 was to better understand previous City Plants and Tree Ambassador free tree program recipients' experiences with the program, to compare experiences with and opinions on themes surrounding neighborhood trees, and to get a snapshot of tree survival post planting via delivery or adoption.

While only a chosen sample of the survey analyses are discussed in this report, all responses from each sub-audience survey in Audience 2 will be shared with City Plants for further data analysis. The questions in the following results section are organized by the five themes previously stated. The questions are composed of four sub-audiences from Audience 2 (sub-audiences 2, 3, 5, and 6) and additionally include questions that incorporate responses from the intercept surveys of Audience 1. All questions are displayed as bar graphs. Due to the contrasting sample sizes among the groups, responses from questions in subsections 5.2.1.2-5.2.1.4 were first averaged before bar graph creation. The question in Figure 5-2 provided a multiple-choice answer presenting three options. For this question, average answers from each group were first compiled as percentages prior to graph creation. Finally, section 5.2.2 presents three figures that display word clouds showing the emerging patterns from the open-answer question from respondents in the intercept survey of Audience 1, as well as sub-audiences 2 and 3 from Audience 2.

We excluded data from the Tree Ambassador Pilot Program Street Tree survey as the population size was very small and no responses were received, although tree health assessments in the field were conducted for each street tree planted through the TA Program, as discussed in subsequent sections of this report.

5.2. Results

5.2.1. Survey Responses

5.2.1.1. Acquired Tree Status

Below are the results of questions from Audience 2 sub-audiences 2 and 3—TA program tree recipients via Delivery and Adoption, respectively. The compiled sub-audience responses below reflect questions that ask individuals about their acquired tree status. 23 individuals from the TA Delivered sub-audience and 13 individuals from the TA Adopted sub-audience responded to questions in Figures 5-1 to 5-3, with a compiled sample size of 36 individuals. 37 total individuals responded to questions in Figures 5-4 to 5-5 (24 individuals from the TA Delivered sub-audience and 13 individuals from the TA Adopted sub-audience). While the information is self-reported, the collected data are valuable information that will help us in understanding the effectiveness of these programs.

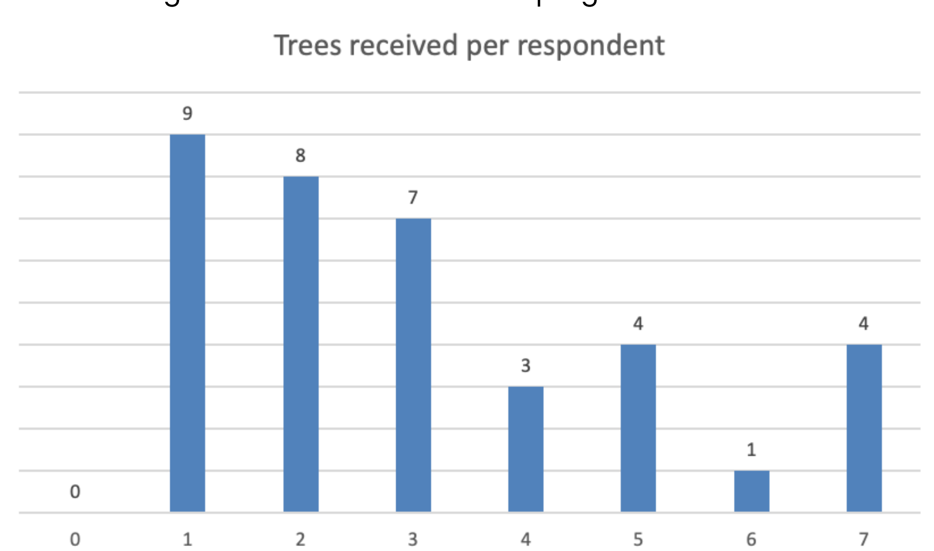


Figure 5-1. Amount of Trees Received per Respondent. Individuals from Audience 2 in sub-audiences 2 and 3 were asked to submit information about their acquired tree. Most people received one tree.

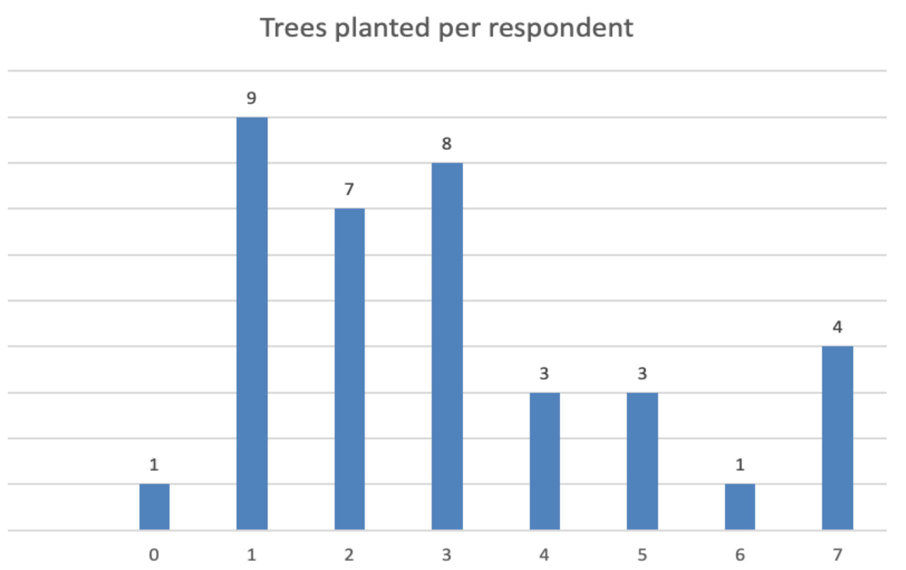


Figure 5-2. Amount of Trees Planted per Respondent. Individuals from Audience 2 in sub-audiences 2 and 3 were asked to submit information about their acquired tree. Most people planted one tree.

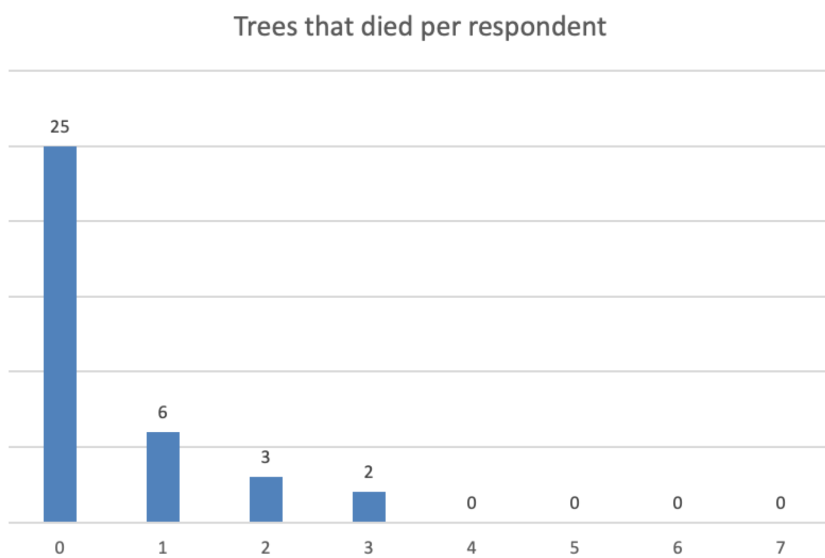


Figure 5-3. Amount of Trees that Died per Respondent. Individuals from Audience 2 in sub-audiences 2 and 3 were asked to submit information about their acquired tree. The majority of respondents did not report any tree deaths.

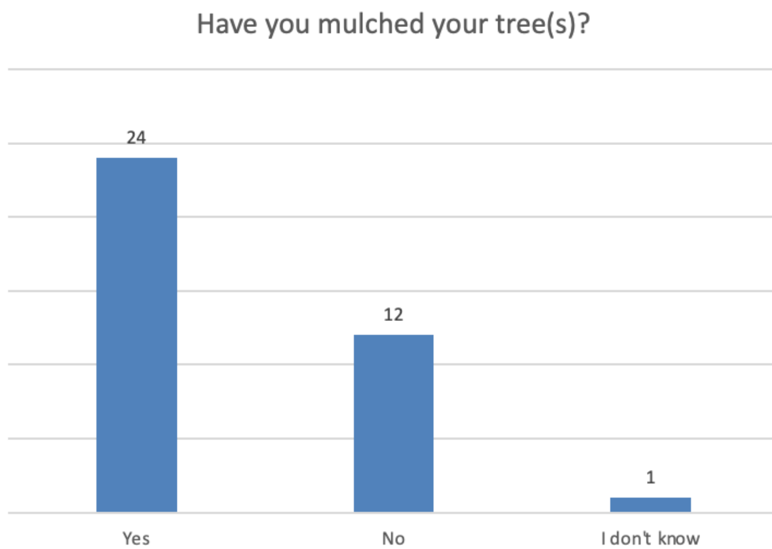


Figure 5-4. Mulch Status of Acquired Tree(s) per Respondent. Individuals from Audience 2 in sub-audiences 2 and 3 were asked to submit information about their acquired tree by answering the question "Have you mulched your tree(s)?" The majority of respondents mulched their tree.

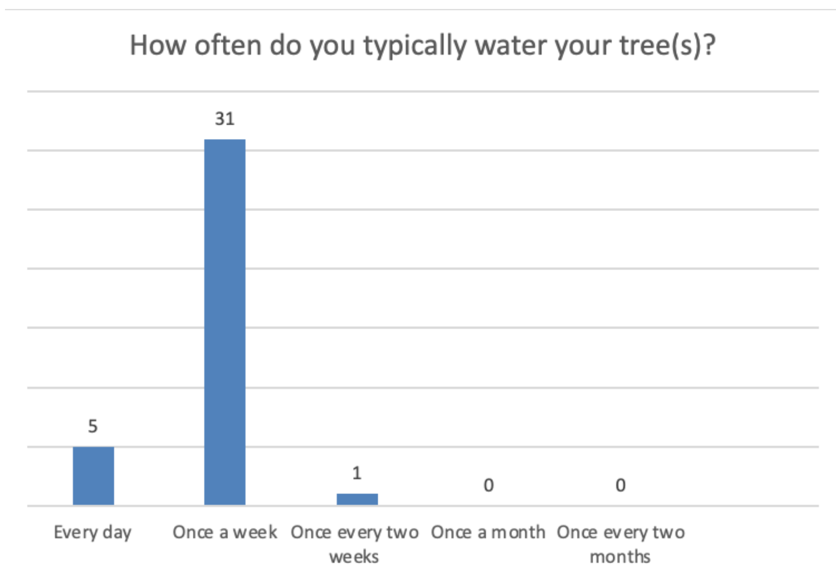


Figure 5-5. Watering Frequency of Acquired Tree(s) per Respondent. Individuals from Audience 2 in sub-audiences 2 and 3 were asked to submit information about their acquired tree by answering the question "How often do you typically water your tree(s)?" The majority of respondents water their tree(s) once a week.

Figure 5-6. Submitted Image from Respondent in Audience 2 Sub-audience 2. This image was submitted in response to the optional question that asked “Optional: Please attach a picture of your tree(s).” This image shows the tree has two stakes present, indicating a correct installation. We can estimate that the tree is alive based on its appearance.

Figure 5-7. Submitted Image from Respondent in Audience 2 Sub-audience 3. This image was submitted in response to the optional question that asked “Optional: Please attach a picture of your tree(s).” Based on its appearance, we can assume this tree is alive, though we are unable to determine the amount of stakes present or the health of the tree.

5.2.1.2. Program Experience

Below is a question that reflects the opinions of the four sub-audiences in Audience 2 who participated in a City Plants or Tree Ambassador tree program. The sample sizes of each sub-audience can be found above in Table 5-1. The answer options ranged from 1-5, with 1 being "Strongly Disagree", and 5 being "Strongly Agree".

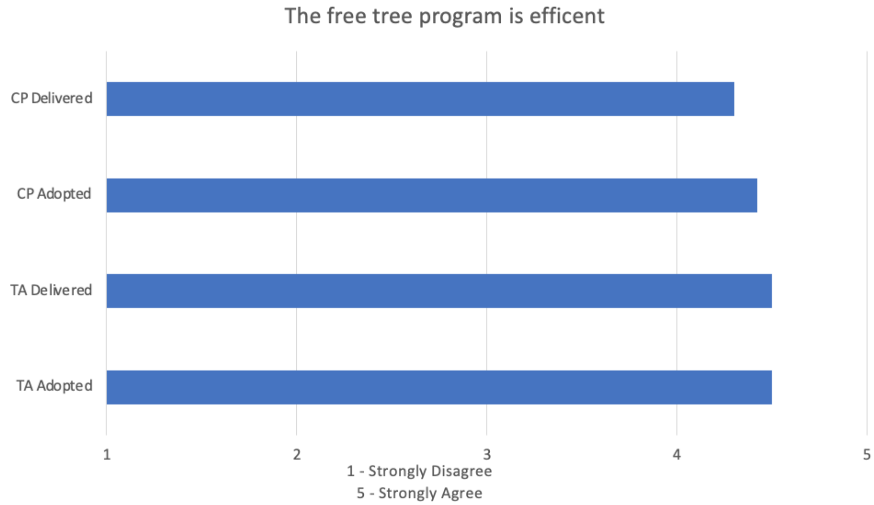


Figure 5-8. Program Efficiency. Four sub-audiences from Audience 2 were asked to evaluate their agreement with several statements about City Plants' free tree program. The respondents answered with a number ranging from 1-5, with 1 being "Strongly Disagree" to 5 being "Strongly Agree." Most people across the four groups agreed that the free tree program was efficient.

5.2.1.3. Tree Maintenance

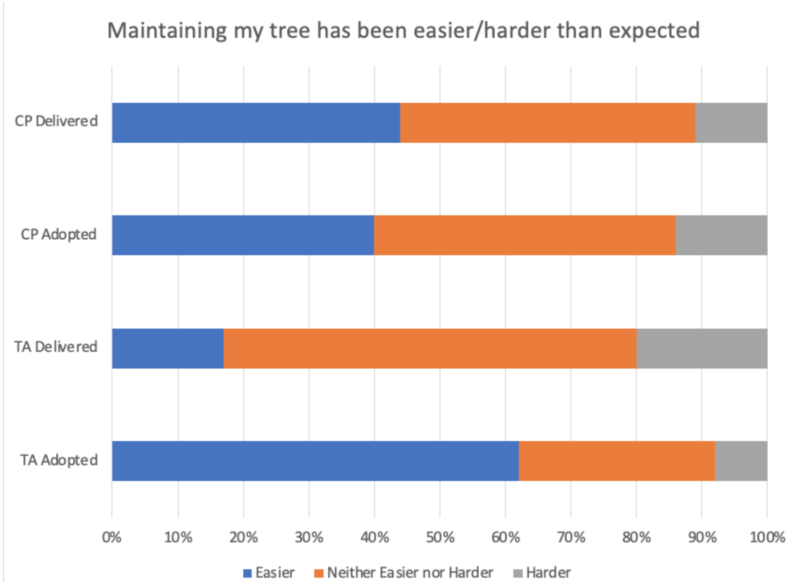


Figure 5-9. Difficulty in Maintaining Free Tree. Four sub-audiences from Audience 2 were asked to evaluate their agreement with several statements about City Plants' free tree

program. Respondents were asked to provide their experience with the maintenance of their free tree. Options included "Harder," "Easier," and "Neither Easier nor Harder." A majority of respondents believed that maintaining their free tree was either "Easier" or "Neither Easier nor Harder" to maintain than expected, with a minority expressing that maintenance was harder than expected.

5.2.1.4. Desire for Change

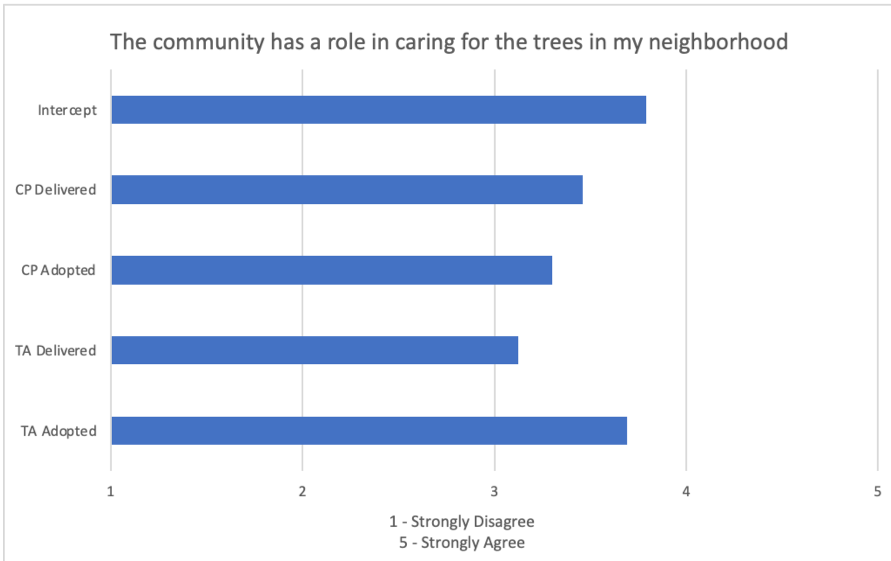


Figure 5-10. Community's Role in Maintaining Trees. Intercept survey respondents from Audience 1 and four sub-audiences from Audience 2 were asked to evaluate their agreement with several statements about the free tree program. The respondents were asked to answer with a number ranging from 1-5, with 1 being "Strongly Disagree" to 5 being "Strongly Agree." With only some variation between audiences, the average sentiment towards community involvement in neighborhood tree care fell between "Neutral" (3) and "Agree" (4).

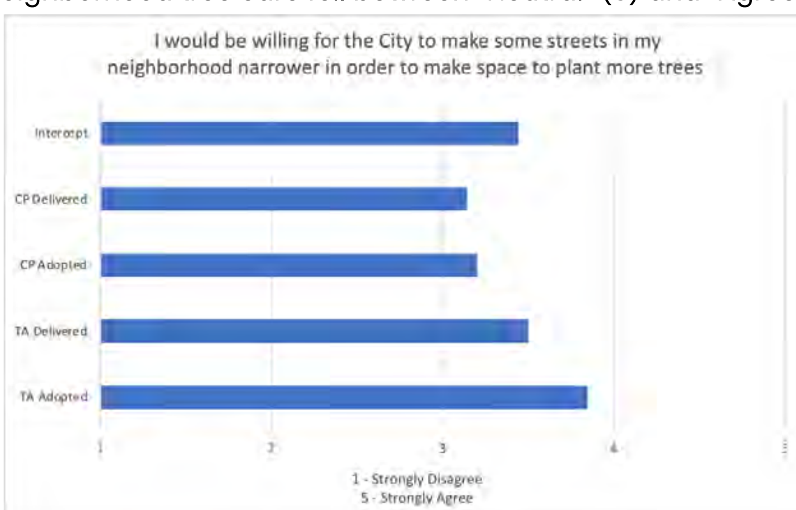


Figure 5-11. Willingness to Reduce Street Width to Accommodate Trees. Intercept survey respondents from Audience 1 and four sub-audiences from Audience 2 were asked about

their willingness to reallocate neighborhood space to make room for more trees and to answer with a number ranging from 1-5, with 1 being "Strongly Disagree" to 5 being "Strongly Agree." On average, there is some willingness towards modifying street width for more trees in the neighborhood, with the mean for all audiences falling between "Neutral" (3) and "Agree" (4).

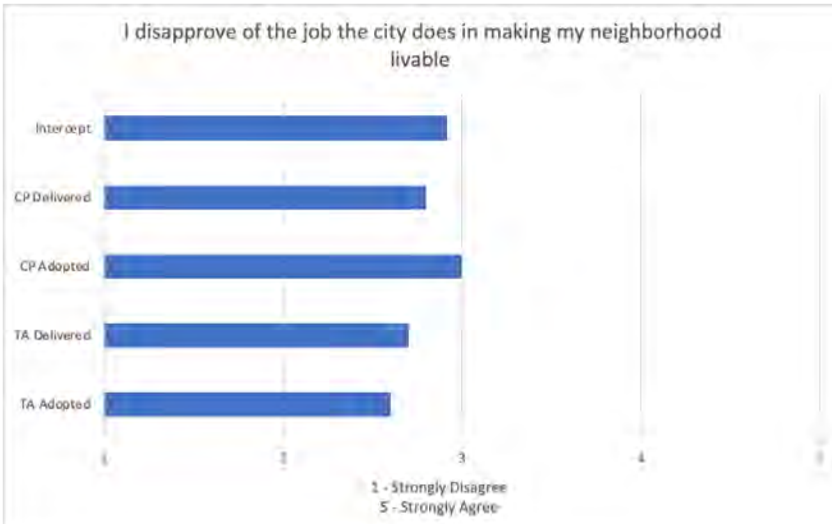


Figure 5-12. Attitudes Towards the City's Job in Making the Neighborhood Livable. Intercept survey respondents from Audience 1 and four sub-audiences from Audience 2 respondents were asked about their disposition toward local government and to answer with a number ranging from 1-5, with 1 being "Strongly Disagree" to 5 being "Strongly Agree." Average responses in all five groups about disapproving of the job the City does in making residents' neighborhoods livable ranged from "Somewhat disagree" (2) to "Neutral" (3).

5.2.2. Open-Answer Questions: Emerging Themes

The following results display common phrases and words from the open-answer question *"Is there anything you would like us to know about trees in your neighborhood?"* The findings from this question were compiled and visually displayed as a word cloud. Subsection 5.2.2.1 presents the findings from the comments left in the intercept surveys of Audience 1, while subsection 5.2.2.2 presents findings from the comments left in two online surveys tailored to the Tree Ambassador program - Audience 2 sub-audiences 2 and 3. These emerging themes allow for a comprehensive overview of residents' opinions on trees in their neighborhood and allow respondents to provide us with any additional information that they would like to share.

5.2.2.1. Intercept Surveys

Figure 5-13. Audience 1 Response to Question "Is there anything you would like us to know about trees in your neighborhood?" Phrase cloud highlighting general sentiments and areas of improvement from intercept survey respondents in Audience 1 in areas with TA presence.

5.2.2.2. Online Surveys

Figure 5-14. Tree Delivery Audience (Audience 2 Sub-Audience 2) Response to Question "Is there anything you would like us to know about trees in your neighborhood?" Phrase cloud highlights general sentiments and areas of improvement from respondents in sub-audience 2 in Audience 2 who received delivered trees through the TA program.

Figure 5-15. Tree Adoption Audience (Audience 2, Sub-audience 3) Response to Question "Is there anything you would like us to know about trees in your neighborhood?" Phrase cloud highlights general sentiments and areas of improvement from respondents in sub-audience 3 in Audience 2 who received adopted trees through the TA program.

TA Adopted Response	TA Delivered Response
Hope they are safe not to fall on powerlines or cars.	Due to the intense heat this past summer and the water use rules, my tree failed to thrive and died. I have many established fruit trees on my property that made it through the water restrictions just fine. I would really like to get another Laurel tree, however it will remain in the container under my covered patio and transplanted in the fall. It makes no sense to plant a barley rooted tree in the ground just prior or during extreme summer heat.
I would love to get emails about future tree adoptions in my area.	There is a lack of trees on my entire avenue for blocks on end. Compared to avenues over, or even 3 miles down the same avenue is completely tree lined unlike where I live. Would love to see more trees on my avenue
Please provide water bags for the trees for customers requesting them in order to conserve water and ensure trees get water on constant basis so they don't die on hot days. And more fruit tree options to be available.	Your free trees are a GREAT idea. Getting utility clearances to dig for the tree was a BIG hassle.

Figure 5-16. Comments from the Open-Answer Question: "Is there anything else you would like us to know about trees in your neighborhood?" Respondents from sub-audiences 2 and

3 within Audience 2 were invited to share their additional comments regarding trees in their neighborhood.

5.3. Discussion

Survey analysis as a whole revealed a wide mix of opinions and perspectives in regards to the City Plants' free tree program and residents' opinions on trees in their community. An important note to be made is that there was an issue in the distribution of the online surveys for delivered and adopted trees: surveys asking about the delivery process were sent to the adoption audience, while surveys asking about the adoption process were sent to the delivery audience. Despite the mix up, we determined that the survey questions were still relevant and decided to proceed with the analysis. We found no outliers in the survey response data, nor was there much deviation between the similar questions from Audiences 1 and 2. The survey results surrounding the themes *Acquired Tree Status, Program Efficiency*, and *Desire for Change* were positive and reflected the assumption that the City Plants' tree programs are efficient in fulfilling the goal of creating more equitable canopy cover. However, the Open-Answer subsection revealed that there are various ways in which the programs can improve and better reflect the needs of residents. The following discussion is structured based on the emerging five themes.

5.3.1. Acquired Tree Status

The results from the Acquired Tree Status subsection reveal that the majority of the TA tree program adopted and/or delivered between 1-3 trees per recipient, and a high majority of these acquired trees were self-reported as alive. In regards to mulching and watering, 64% were mulched and 84% of respondents self-reported that they watered their tree(s) once per week. We received three optional images out of the 37 respondents in this group of surveyed individuals. The two images presented in this report display healthy looking trees that are properly planted. These findings indicate that the TA tree delivery and adoption program was effective as we can see that most residents take good care of their acquired tree.

5.3.2. Program Experience

Figure 5-8 displays data that analyzed residents' opinions on the City Plants and Tree Ambassador program's efficiency. Most residents who received their tree via adoption or delivery believed that the program was efficient. These results show that there is a strong consensus that both TA and City Plants free tree program recipients were satisfied with the adoption and delivery processes.

5.3.3. Tree Maintenance

Figure 5-9 asked about residents' overall experience maintaining an adopted or delivered tree once planted. While the majority of respondents answered that maintaining their tree was neither easier nor harder than expected, many answered that tree maintenance was actually easier than expected, as indicated by the high percentage of blue (Fig 5-9). In fact, recipients who responded with "Easier" far outnumbered those who responded with "Harder," with the TA Delivered tree recipients being the only exception with a slight percentage difference. However, while the majority of recipients had no issues properly maintaining their trees after adoption/delivery, a variety of free response answers showed there were still some who struggled on this front. One such comment from the Adopted Trees Audience suggested to "please provide water bags to conserve water." Because proper maintenance of newly planted trees involves so many factors, it would be reasonable to consider offering more support tools.

5.3.4. Desire for Change

The questions pertaining to this theme show that residents display a connection to tree stewardship in their community, are open to trading street space for tree space, and are not fully disproving of the City's role in tree maintenance.

Results from Figure 5-10 showed responses on the community's role in caring for trees in their neighborhood. As most responses ranged from "Neutral" (3) to "Somewhat Agree" (4), we concluded that while some residents *did* find their role in maintaining trees important, there were many who felt neutral in their role. This suggests that more efforts are likely needed to foster a community attitude that tree care should be a collaborative effort between residents and the City.

Figure 5-11 displays a related question about whether residents were willing for the City to make some streets in their neighborhoods narrower in order to make space for trees. The answer distribution was similar to Figure 5-3, with responses ranging from "Neutral" (3) to "Agree" (4). This suggests that while residents may be somewhat hesitant to give up urban space, there was not complete resistance to the idea, and some are indeed willing to trade street space for tree space.

Finally, Figure 5-12 displays a question pertaining to tree maintenance, asking residents whether or not they disapproved of the job the City was doing in making their neighborhoods livable. The average of all five groups' responses fell between "Somewhat Disagree" (2) to "Neutral" (3), showing that, while residents either approved of or were not completely dissatisfied with the City's work, maintenance services still had room for improvement.

5.3.5. Open Answer Questions: Emerging Themes

The open-answer responses across intercept, online delivered, and online adopted tree surveys also included both positive and critical perspectives. Constructive criticism was provided by all groups of residents and particularly during intercept surveys, which also happened to be the audience with the least exposure to the City's tree programs. A common criticism towards street trees was the damage their roots could cause, with residents wanting the City to repair uplifted sidewalks. There was also hesitancy regarding tree maintenance due to safety concerns and a lack of resources necessary to maintain a healthy tree. Residents further called for a more equitable distribution of urban trees, more education about tree benefits, and more options to plant fruit trees, as these can help alleviate food deserts in low-income neighborhoods that lack access to healthy foods and grocery stores (Tong et al., 2020). Generally, residents pointed to specific issues they felt could be addressed by the City directly. Issues of trees being cut down but never replanted, as well as strict water-use rules that could hamper young tree establishment, are all things the City has at least some control over.

One resident also noted that those who were new to the neighborhood tended to cut down mature trees—those that have taken decades to reach a level of maturity that allows for the exponential increase of benefits like carbon sequestration, shade, and oxygen generation (Le Roux et al., 2014). While this resident discouraged this practice, the removal of mature trees is sometimes justified in instances where there is a threat to safety. More concise tree-management protocols that both preserve mature trees and plant new generations to replace the old ones could be implemented to address this issue (Le Roux et al., 2014).

Despite this constructive criticism, there was also appreciation towards City Plants' free tree programs and the benefits trees brought to communities. Some residents desired more emails about future tree adoption events, suggesting enthusiasm for the program and that more communication between City Plants programming and residents could be worthwhile. The benefits trees bring can also go beyond physical: one resident who adopted a Jacaranda tree through the free tree program actually named it, highlighting how people can build connections with their neighborhoods through trees.

5.3.6. Suggestions for Future Work

Based on this analysis of surveys from both Audiences 1 and 2, there are several suggestions for future work that City Plants can consider.

Firstly, the surveys highlight the importance of enhancing community engagement. The results revealed the *presence* of community-based tree stewardship, as most residents felt that the community had a role in caring for trees in their neighborhood. The positive outlook on this model is significant and should propel City Plants to explore ways to further engage and empower residents in tree stewardship initiatives. This can include more tree planting events, as well as fostering partnerships with local organizations to promote tree awareness and education. Additionally, expanding partnerships to schools can amplify the impact of tree planting initiatives. City Plants should actively seek partnerships within disinvested communities to share their knowledge and engage a broader range of community members in their programs.

Secondly, City Plants should consider finding ways to partner with various other City organizations that manage LA's urban forest. Many open-answer comments expressed concern with tree removal on or near residents' property with no follow-up planting, months-long response time from the City about tree implementation, and an overall lack of trees in certain residents' neighborhoods. The presence of incredibly positive comments praising the City Plants tree programs highlight the appreciation that residents have for the community-oriented tree giveaway and planting programs that City Plants offers. This aspect of City Plants makes it a unique organization, and their affiliation to the city of LA gives City Plants an opportunity to have more input on the City's urban forest compared to nonprofit organizations with no affiliation to municipal government funding or oversight. Partnerships with various other City organizations that are in charge of tree maintenance would not only improve the current state of trees around LA, but would also help further mend the gap between residents and government. City Plants' unique quasi-governmental status allows for both tangible action in improving tree canopy equity, as well as fostering empowerment and connectedness to nature within communities.

Finally, City Plants should implement an ongoing and comprehensive program evaluation framework. While the majority of responses in Audience 2 found the adoption and delivery process to be efficient, there is still room for improvement in City Plants' goal to improve canopy cover equity. One way to implement this framework would be for City Plants to include regular tree check-up visits as a responsibility of Tree Ambassadors or City Plants volunteers in order to better understand the efficacy of their programs. Possible strategies to implement this would be to include a section on tree acquirement forms that asks whether residents would be willing to have members of City Plants come check on their tree. In order to continue to foster a sense of community, these check-ups should also include opportunities to receive additional help with tree maintenance and education resources. Throughout this project, City Plants saw an unprecedented amount of responses with the six online surveys that were sent out for Audience 2, indicating that program participants are willing to share their experience and opinions. Thus, another way to implement this framework would be to conduct follow-up surveys asking residents who receive a tree from City Plants how their maintenance experience is going, as well as providing them an opportunity to request help. Regular evaluation will provide valuable insight for program improvement and demonstrate the impact of City Plants' efforts in closing LA's tree canopy gap.

6 - Tree Health Assessments

6. Tree Health Assessments

6.1. Methods

6.1.1. Tree Health Data Collection Route

GIS was used to create a map displaying street trees planted through the Tree Ambassador (TA) pilot round for tree health data collection outings. We categorized trees into various color groupings (Green, Yellow, Blue, and Orange) based on their proximity to one another and what could feasibly be visited in one outing. We then uploaded these addresses to Google MyMaps to visually verify that trees were indeed placed in the correct groupings. Finally, we created a navigation map that provided an efficient route for data collection.

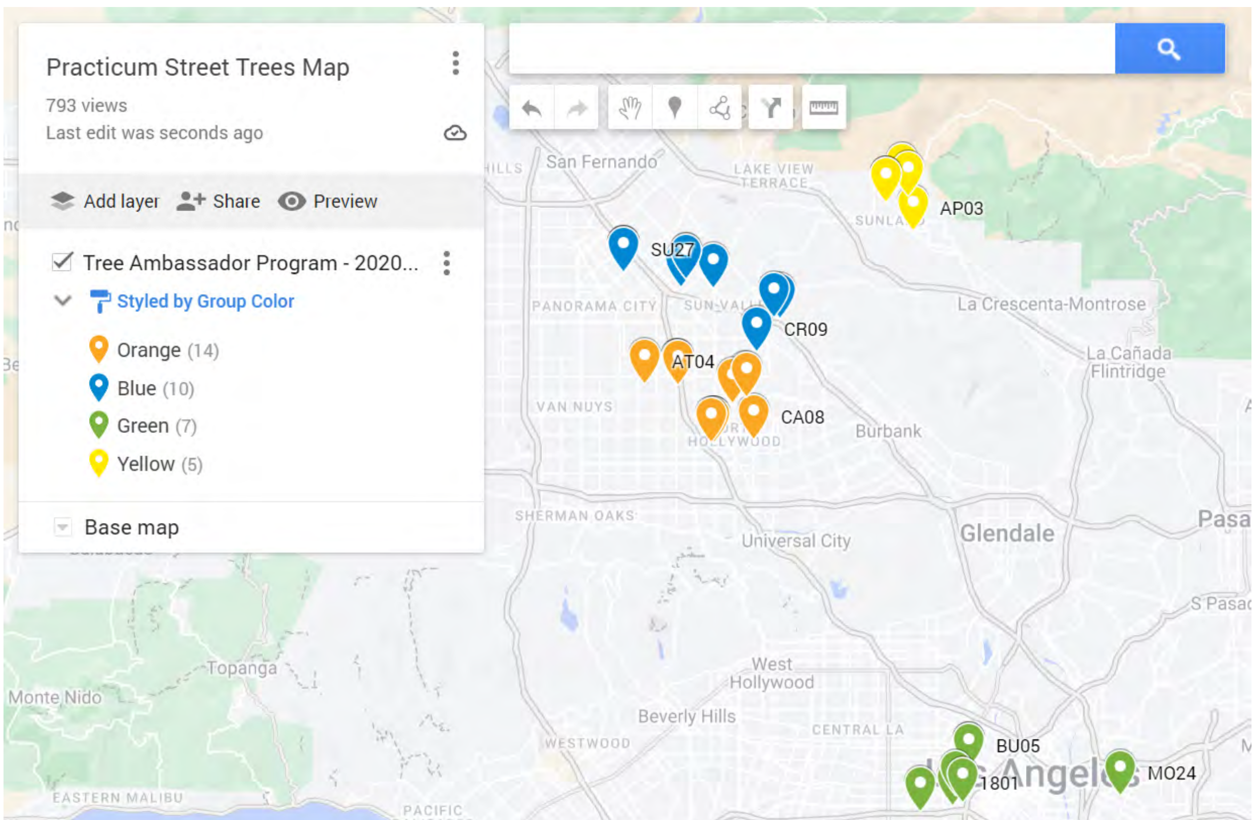


Figure 6-1. Tree Health Data Collection Route. This map shows the distribution of TA street trees across the City of LA that were assessed by the Tree Health Assessment team. Trees were grouped by location and categorized by color. This map, created using GIS, was a navigational tool for data collection outings and allowed for efficient planning and route execution. Data including address, street tree ID, color grouping, species, and other identifying information are attached to each point.

6.1.2. Data Collection

In order to determine the health of the 37 street trees planted during the Tree Ambassador program pilot, we conducted tree health assessments and collected soil moisture readings as an indicator of whether they were being taken care of as agreed upon by residents who signed "Commitment to Water" forms. Originally, we considered adding private property yard trees to our scope, but we were advised that gaining access to private yards would be too complicated to accomplish within our project timeline. Through our email surveys, residents who received yard trees were instead invited to self-report their tree's survival. These residents were also given the option to submit a photo of their private property tree. Of the 37 residents who responded, 67% reported that their private property trees were alive.

Each tree was visited four times over the course of the project. We conducted tree health assessments on first and last visits and measured soil moisture, ambient air temperature, and light value on all visits. Visits of the same number occurred on varying days, as the distance between trees made it infeasible to visit them all on a single day.

Tree health assessments consisted of evaluating trees' mortality status, basal sprout presence, stake presence, crown vigor, and diameter using industry standards following training from Dr. Lara Roman of the USDA Forest Service, who specializes in urban forestry research. Assessing mortality status and crown vigor presented a challenge, as some trees were still emerging from dormancy during the study after an especially cold and rainy winter.

Mortality status indicates whether a tree is alive, standing dead, a stump, or removed (Roman et al., 2020, p. 24). This was determined by a visual assessment of whether the tree had leaves, live buds, or green tissue beneath its bark.

Basal sprouts are buds that grow at the tree's roots from the base of the stem (Roman et al., 2020, p. 28). These sprouts can indicate if a stump or standing dead tree's root system is still alive (Roman et al., 2020, p. 28).

Determining crown vigor involves a visual examination of the tree's foliage and branches (Roman et al., 2020, p. 28). Crown vigor rating is based on a scale of 1 to 5, with 1 being the healthiest and 5 the least healthy. A rating of 1 indicates that the tree is healthy with a majority of no dead or broken branches and less than 10% foliage discoloration, defoliation, and fine twig dieback. A rating of 2 indicates the tree is slightly unhealthy, with 10-25% broken or dead branches, missing crown area, foliage discoloration, defoliation, and fine twig dieback. A rating of 3 indicates that the tree is moderately unhealthy, with 26-50% broken or dead branches, missing crown area, foliage discoloration, defoliation, and fine twig dieback. A rating of 4 indicates that the tree is severely unhealthy, with 50% or more broken or dead branches, missing crown area, foliage discoloration, defoliation, and fine twig dieback. A rating of 5 indicates that the tree is dead with no live buds, no green leaves, and no green tissue present beneath the bark (Roman et al., 2020, p. 28). The following page provides examples of trees in each crown vigor category.

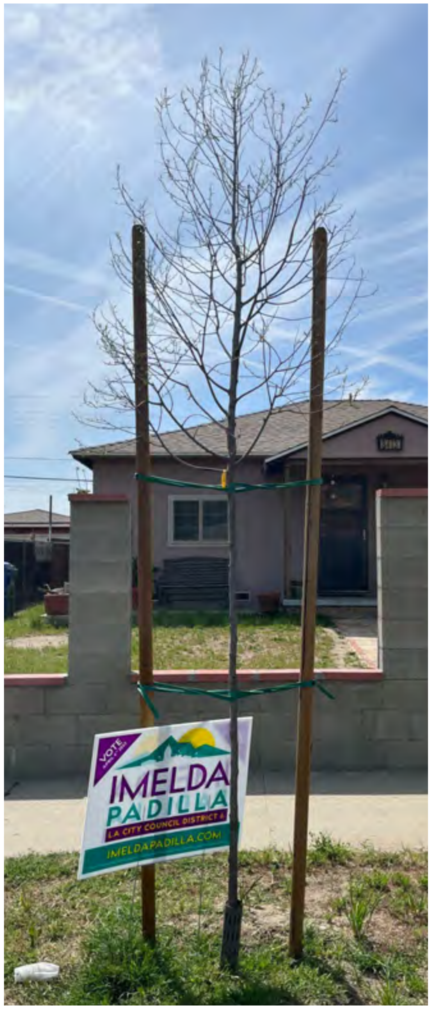
Unknown Crown Vigor WH33 (*Geijera Parviflora*). Last visit.	**Crown Vigor 1** CA08 (*Pistacia chinensis*). Last visit.	**Crown Vigor 2** IR14 (*Lagerstroemia indica*). Last visit.
		

Figure 6-2: Crown Vigor Examples of Tree Ambassador Street Trees Planted in the Pilot Program.

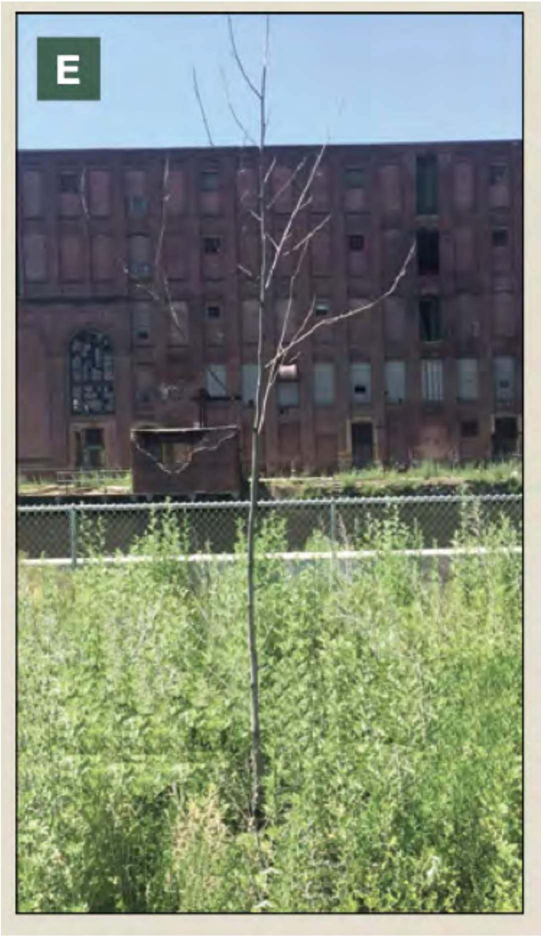
Crown Vigor 3 VA32 (*Bauhinia variegata*). First visit.	**Crown Vigor 4** 1801 (*Handroanthus heptaphyllus*). Last visit.	**Crown Vigor 5** Dead Tree in Roman et al., 2020, p. 29 (no species listed).
		

Figure 6-2 (continued): Crown Vigor Examples of Tree Ambassador Street Trees Planted in the Pilot Program.

Tree diameter is taken by first deciding the height on each tree at which to measure it. The industry-standard height—diameter at breast height (DBH)—is 4.5 feet, or 54 inches (Roman et al. 2020, p. 31). We used an extendable ruler to measure 54 inches along the trunk of each tree, starting from the ground at the base of the trunk. If the trunk was uniform in shape (approximately cylindrical, no knobs) at 54 inches, and no branches obstructed measurement at that height, diameter was taken at DBH using a digital caliper (Pittsburgh 6" Composite Digital Caliper). For each tree, two measurements were taken with the caliper—one with the caliper parallel to the street and another with the caliper perpendicular to the street—then averaged. The caliper was held perpendicular to the tree trunk for each measurement (rather than level with the ground). If the structure of the trunk did not allow for measuring diameter at 54 inches, we chose an appropriate height as close to 54 inches as possible. This was generally below the lowest branches of the canopy and where the trunk was uniform in shape.

Soil moisture was taken using two Vegetronix VG-METER-200 sensors. These sensors can record soil moisture levels (measured in percent volumetric water content (VWC%)), ambient air temperature, and light value (lux). VWC% is the volume of water in a volume of soil, represented as the percent of the total volume that is water (Datta et al., 2018). The sensors generated readings in one second. Each sensor's probe was stuck into the soil six inches away from the base tree, then switched, resulting in four soil moisture readings with two from each sensor. Initially, probes were inserted twelve inches away from the trunk. However, the distance was reduced to six inches after initial data collection visits, as berms (a soil mound surrounding the tree base that allows water to pool) around some trees meant that soil elevation at twelve inches from the trunk was higher than the soil at the base of the trunk, possibly introducing inaccuracy to the data.

Four ambient air temperature readings, as well as four lux readings at the tree's base, were also recorded at each tree per visit. Temperature readings can provide insight into heat stress that trees may experience. We later analyzed temperature at each tree with soil moisture of each tree to see if there were correlations between the two variables. Lux readings indicate how much light penetrates the tree canopy, depending on the angle of sunlight. Though we collected lux readings during each visit to each tree, we did not use these data in our analysis, as they were not meaningful in relation to our research questions. Specifically, air temperature is more meaningful to tree health, as described above regarding heat stress.

Trees were placed into groupings based on geographical location to make data collection more efficient. For organizational and logistical purposes, each grouping was assigned a color and included Green (South Park, Downtown, Pico Union/Exposition Park, Boyle Heights, Westlake), Yellow (Sunland, Tujunga), Orange (North Hollywood, Valley Village, Valley Glen, Sun Valley), and Blue (Sun Valley, Pacoima/Arleta). Despite being located in the same neighborhood (Sun Valley), some trees from this neighborhood were included in the Blue Group, while others were included in the Orange Group, because of the geographic distance between two clusters of trees present in Sun Valley. Each grouping was visited at different times and on different days of the week to approximate random visits in an attempt to observe soil moisture during varying periods of a resident's watering schedule. This relies on the assumption that residents water their street trees on a regular cycle instead of randomly. Random visitation was also intended to avoid having our presence influence a resident's watering schedule.

6.1.3. Data Analysis

We took the average of the four soil moisture percentage readings on each date of visitation for each street tree. The same was done with the four temperature recordings, resulting in one data value for both soil moisture and temperature for each date of visitation. We graphed each street tree's average soil moisture versus average temperature. We also produced graphs showing average soil moisture and temperature of groups of trees that were located in the same neighborhoods in LA, as well as graphs of average soil moisture of these same groups. Finally, we created graphs comparing average soil moisture and precipitation for groups of trees located in the same neighborhoods.

Pie charts were made to depict the change in crown vigor of all street trees between first and last visits, each "slice" showing the percentage of trees in each crown vigor category.

6.2. Results

The mortality status of all 37 street trees surveyed was "Alive" on both first and last visits. In addition, all trees were found to have stakes present on the first and last visit, though two trees had only one stake present instead of two. Our observations for all of the trees' basal spout presence can be found below in Figure 6-3. Presence of basal sprouts is an indicator that a living tree may be under stress (Roman et al., 2020, p. 28).

In the tables that follow, Street Tree ID is an identifier variable we created to distinguish individual trees. The first two characters in the ID are either the first two letters or numbers of the street on which the tree was located, and the last two characters are randomly generated numbers, from 1-36, unique to each tree. A table showing what address each street tree ID corresponds to is listed in the Appendix. We created this identifier because City Plants did not have unique identifiers for each tree, as trees were obtained by multiple partner organizations (Koreatown Youth and Community Center, TreePeople, North East Trees, and others).

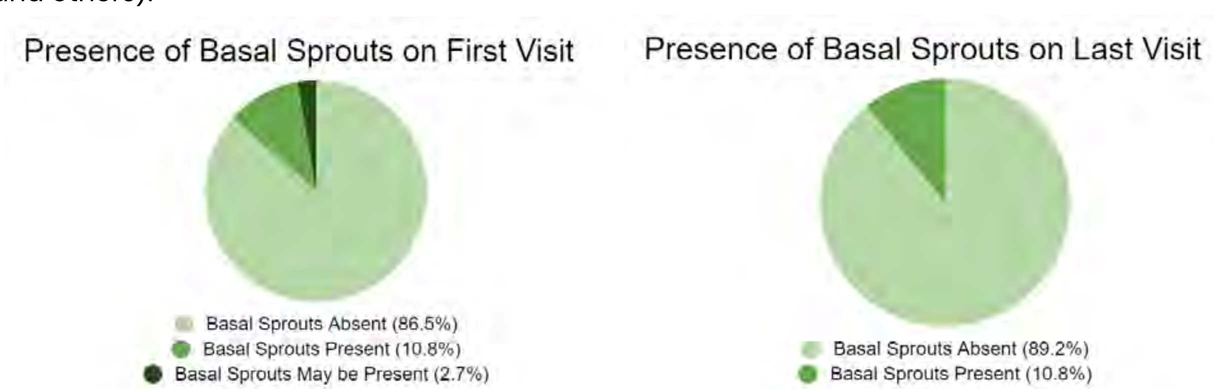


Figure 6-3. Basal Sprout Presence for All Trees On First and Last Visit.

Street Tree ID	Date Planted	Tree Species	Land Use Type	Neighborhood	Tree Grouping Color	First Visit DBH	First Visit Diameter	Last Visit DBH	Last Visit Diameter	Crown Vigor on First Visit	Crown Vigor on Last Visit	Soil Moisture on Visit 1	Soil Moisture on Visit 2	Soil Moisture on Visit 3	Soil Moisture on Visit 4
JE15	8/24/2022	Pistacia chinensis	SFH	Sun Valley	Blue	30	0.65	30	0.67	4	1	18	35	35	20
CR09	8/24/2022	Fraxinus velutina	SFH	Sun Valley	Blue	32	0.7	32	0.76	1	1	11	21	18	20
GL12	8/25/2022	Lophostemon confertus	SFH	Sun Valley	Blue	12	1.16	12	1.21	2	2	12	19	23	10
WH33	8/29/2022	Geijera parviflora	SFH	Sun Valley	Blue	54	0.97	54	0.97	Unknown	Unknown	16	16	16	13
IL13	8/29/2022	Pinus eldarica	SFH	Sun Valley	Blue	46	1.13	46	1.13	1	1	9	17	13	7
KE16	8/29/2022	Cercis canadensis	SFH	Sun Valley	Blue	48	0.7	48	0.73	Unknown	1	10	18	28	23
KE17	8/29/2022	Cercis canadensis	SFH	Sun Valley	Blue	44.25	0.59	44.25	0.61	Unknown	4	13	33	33	17
SU29	8/29/2022	Chilopsis linearis	SFH	Pacoima/Arleta	Blue	45	0.58	45	0.57	Unknown	Unknown	25	36	26	47
SU27	8/29/2022	Fraxinus velutina	SFH	Pacoima/Arleta	Blue	47	0.64	47.5	0.71	1	1	19	20	18	29
SU26	8/29/2022	Chilopsis linearis	SFH	Pacoima/Arleta	Blue	54	0.56	54	0.56	Unknown	1	24	34	33	39
1801	12/17/2022	Handroanthus heptaphyllus	MFR	Downtown	Green	56	0.79	56	0.78	4	4	21	14	14	13
1802	12/17/2022	Handroanthus heptaphyllus	MFR	Downtown	Green	54	0.72	54	0.74	1	2	30	15	24	15
BU07	12/17/2022	Wax myrtle	MFR	Pico Union	Green	53.75	1.52	53.75	1.51	1	1	28	15	27	21
VA31	12/17/2022	Lagerstroemia indica	MFR	Downtown	Green	54	0.77	54	0.78	Unknown	1	30	18	27	15
2002	11/2/2021	Cercis canadensis	MFR	Pico Union/Exposition Park	Green	47	0.79	47	0.8	1	2	40	31	36	20
MO24	8/24/2022	Bauhinia variegata	MFR	Boyle Heights	Green	55	0.57	55	0.58	4	2	30	23	11	9
BU05	11/2/2021	Lagerstroemia indica	MFR	Westlake	Green	56	0.81	56	0.86	Unknown	1	21	18	21	26
BU06	11/2/2021	Lagerstroemia indica	MFR	Westlake	Green	50	0.79	50	0.3	4	1	19	16	19	8

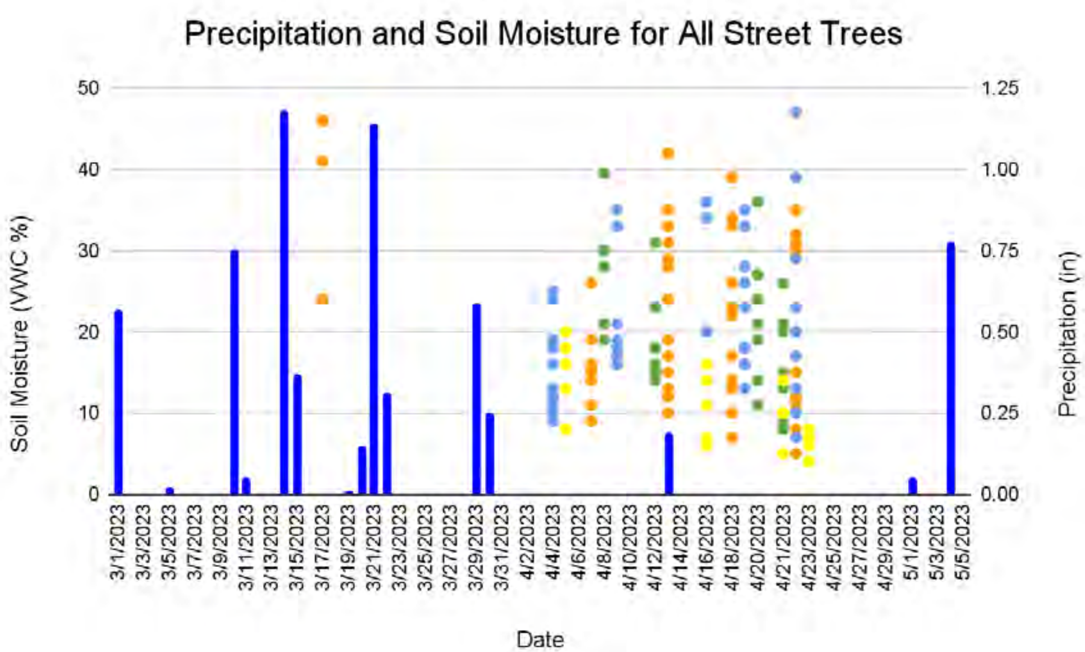
Table 6-1. General Information and Health Data for All Street Trees Planted by the Tree Ambassador Program.

Street Tree ID	Date Planted	Tree Species	Land Use Type	Neighborhood	Tree Grouping Color	First Visit DBH	First Visit Diameter	Last Visit DBH	Last Visit Diameter	Crown Vigor on First Visit	Crown Vigor on Last Visit	Soil Moisture on Visit 1	Soil Moisture on Visit 2	Soil Moisture on Visit 3	Soil Moisture on Visit 4
CA08	8/23/2022	Pistacia chinensis	SFH	North Hollywood	Orange	44	0.68	44	0.69	1	1	9	10	7	5
VA32	8/23/2022	Bauhinia variegata	SFH	Sun Valley/Valley Glen	Orange	54	0.78	54	0.79	1	4	15	13	14	13
TI30	8/23/2022	Arbutus 'Marina'	SFH	Valley Village	Orange	55	1.24	55	1.26	1	1	46	31	22	12
MO22	8/23/2022	Chilopsis linearis	SFH	Valley Village	Orange	40	0.55	40	0.52	Unknown	1	41	35	33	29
MO21	8/23/2022	Chilopsis linearis	SFH	Valley Village	Orange	41	0.76	41	0.74	Unknown	1	46	33	34	30
MO23	8/23/2022	Lophostemon confertus	SFH	Valley Village	Orange	54	1.1	54.2	1.11	2	1	24	28	22	23
KR19	8/23/2022	Pistacia chinensis	SFH	Valley Glen/North Hollywood	Orange	40	0.66	40	0.66	1	1	16	42	23	31
KR18	8/23/2022	Pistacia chinensis	SFH	Valley Glen/North Hollywood	Orange	47	0.66	47	0.67	1	1	26	33	39	32
KR20	8/23/2022	Pistacia chinensis	SFH	Valley Glen/North Hollywood	Orange	54	0.46	54	0.47	Unknown	1	11	19	17	15
FA11	8/23/2022	Pistacia chinensis	SFH	Valley Glen/North Hollywood	Orange	38	0.59	38	0.6	2	1	19	24	23	15
WH35	8/23/2022	Pistacia chinensis	MFR	Sun Valley/Valley Glen	Orange	54	0.57	54	0.58	Unknown	1	14	17	13	12
WH36	8/23/2022	Koelreuteria paniculata	MFR	Sun Valley/Valley Glen	Orange	54	0.55	54	0.55	Unknown	1	15	12	10	8
WH34	8/23/2022	Pistacia chinensis	MFR	Sun Valley/Valley Glen	Orange	44.25	0.59	44	0.58	1	1	11	15	13	11
AT04	8/23/2022	Pistacia chinensis	SFH	Sun Valley/Valley Glen	Orange	43	0.68	43	0.71	2	1	16	29	26	35
NA25	8/22/2022	Lophostemon confertus	SFH	Sunland	Yellow	54	1.22	53	1.2	2	2	16	11	10	8
NA26	8/22/2022	Lophostemon confertus	SFH	Sunland	Yellow	54	1.14	54	1.11	2	1	13	14	10	6
IR14	8/22/2022	Lagerstroemia indica	SFH	Sunland/Tujunga	Yellow	54	0.87	54	0.85	4	2	20	16	10	7
AP03	8/22/2022	Koelreuteria paniculata	SFH	Sunland/Tujunga	Yellow	54	0.52	54	0.52	2	4	8	6	5	4
EL10	8/22/2022	Pistacia chinensis	SFH	Sunland	Yellow	54	0.67	54	0.69	4	1	18	7	14	7

Table 6-1 (cont.). General Information and Health Data for All Street Trees Planted by the Tree Ambassador Program.

Key: SFH = Single Family Home, MFR = Multi-Family Residential Diameter and DBH were recorded in inches. Soil Moisture was recorded in VWC% Crown Vigor Ratings: 1 = Healthy (dark green), 2 = Slightly Unhealthy (light green), 3 = Moderately Unhealthy (yellow), 4 = Severely Unhealthy (orange), 5 = Dead Land use type refers to the property at which the tree is located. Precision varies for diameter breast height (DBH) because individual data recorders entered different levels of precision during some initial tree visits while the methodology was still being refined. The level of precision from the initial visit was replicated as closely as possible in the final visit on a tree-by-tree basis.

Figure 6-4. Percentage of Trees in each Crown Vigor Category for All Street Trees on First and Last Visit. Initial visits to each tree occurred in early April 2023, with one exception: four street trees were visited on March 17, 2023, when the team received training on tree health assessments from Dr. Lara Roman of the USDA Forest Service. Final visits occurred in late April 2023.



Legend:

- Precipitation (inches)
- Green Group (Downtown, Pico Union, Exposition Park, Boyle Heights, Westlake)
- Yellow Group (Sunland, Tujunga)
- Blue Group (Sun Valley, Pacoima, Arleta)
- Orange Group (North Hollywood, Sun Valley, Valley Village, Valley Glen)

Figure 6-5. Precipitation and Soil Moisture for All Street Trees. Precipitation data are shown as bright blue vertical bars. These data are from a National Oceanic and Atmospheric

Administration (NOAA) weather station at the Burbank Airport in Burbank, California, a city in the San Fernando Valley. These data were selected as the station is close to three of the four groups of street trees investigated in this study. Soil moisture data are individual points, color-coded based on street tree grouping. The colors used for these groupings were blue, orange, green, and yellow. Soil moisture of less than 10-18% is considered inadequate for tree health, according to a landscape architect knowledgeable about urban soils and trees (Urban, 2014). Conversely, soil moisture above 40% is considered exceptionally high (E. de Guzman, personal communication, May 2023). The precipitation and soil moisture are displayed on a per-group basis in graphs on the following pages.

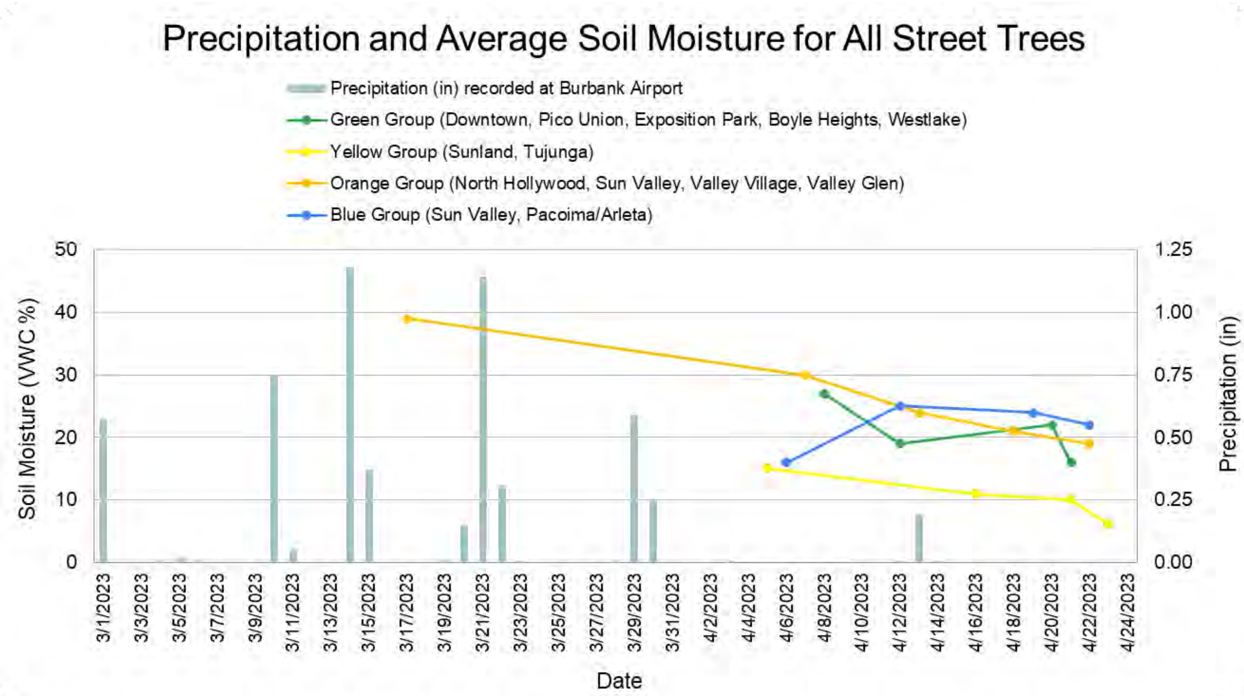


Figure 6-6. Precipitation and Average Soil Moisture for All Street Trees. This graph displays almost the same data as Figure 6-5. Here, the soil moisture values for each visit are averaged. Those per-visit averages are plotted here and connected by color-coded lines. Precipitation is shown in gray colored vertical bars. The upper bound of the x-axis marks the end of our data collection period (late April).

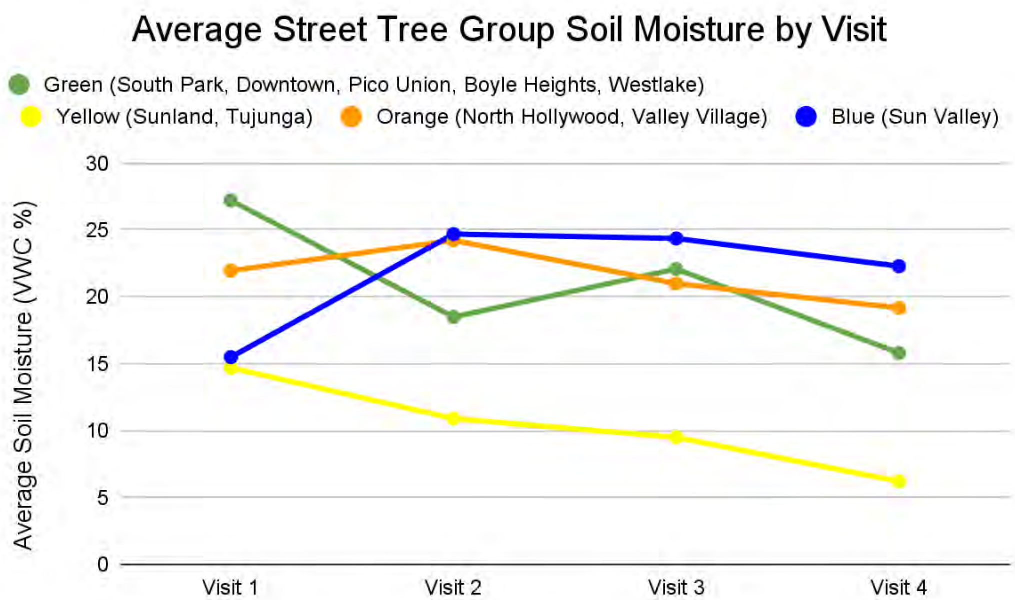


Figure 6-7. Average Soil Moisture per Street Tree Group by Visit. Note that the x-axis does *not* represent time, as visits of the same number occurred on varying days. In contrast to Figure 6-6, readings in this graph taken on March 17, 2023 are rolled into Visit 1 for the Orange group.

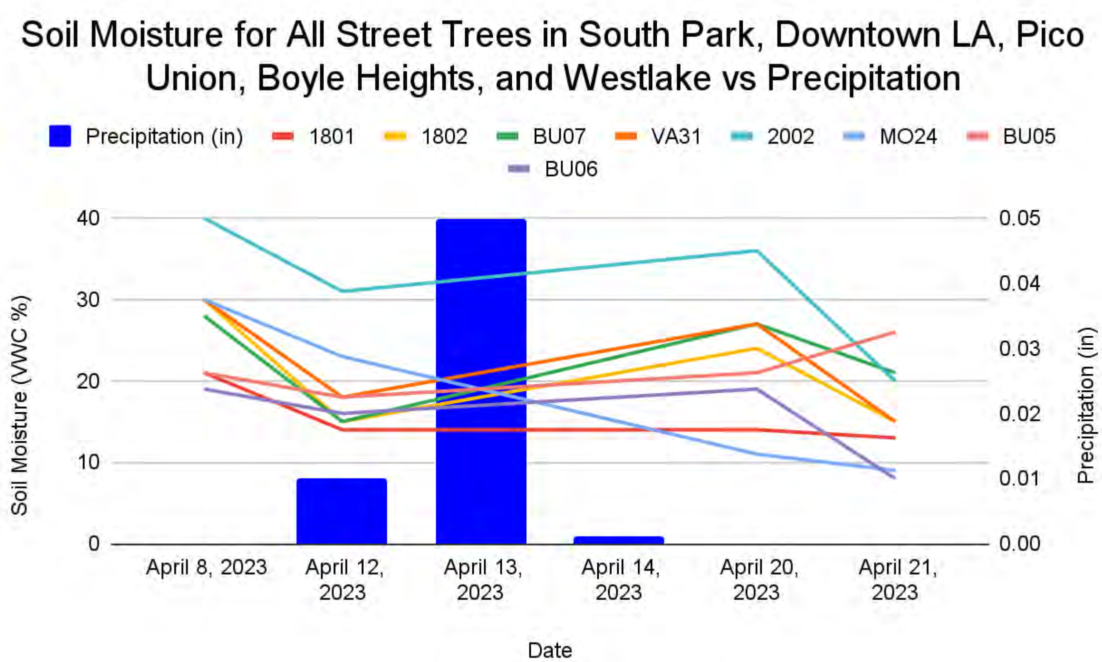


Figure 6-8. Soil Moisture of Trees Located in South Park, Downtown LA, Pico Union, Boyle Heights, and Westlake (Green Group) vs Precipitation.

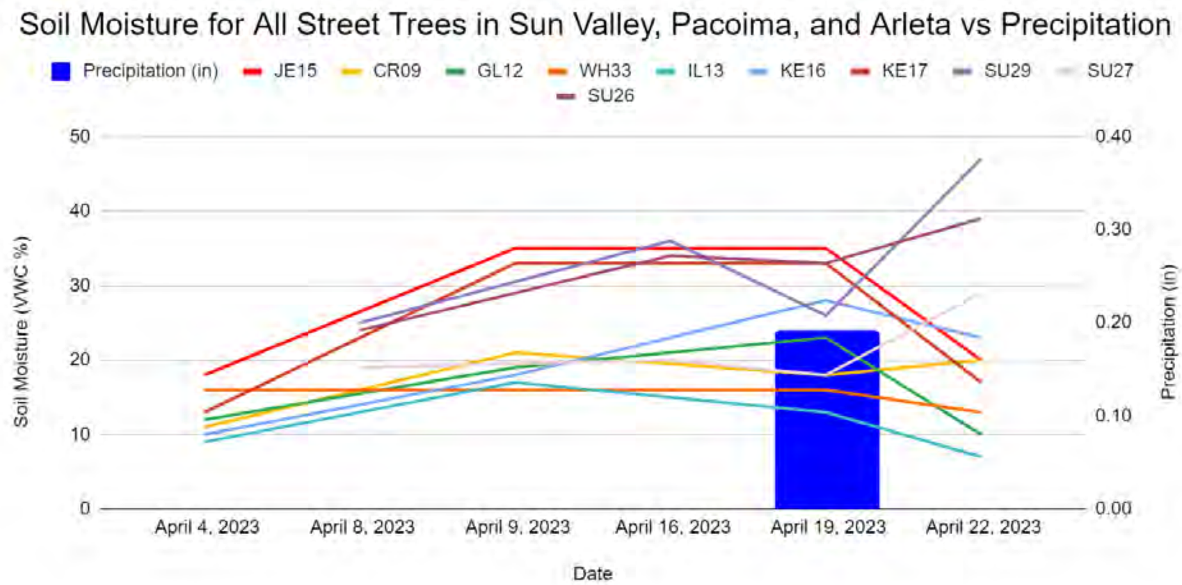


Figure 6-9. Soil Moisture of Trees Located in Sun Valley, Pacoima, and Arleta (Blue Group) vs Precipitation.

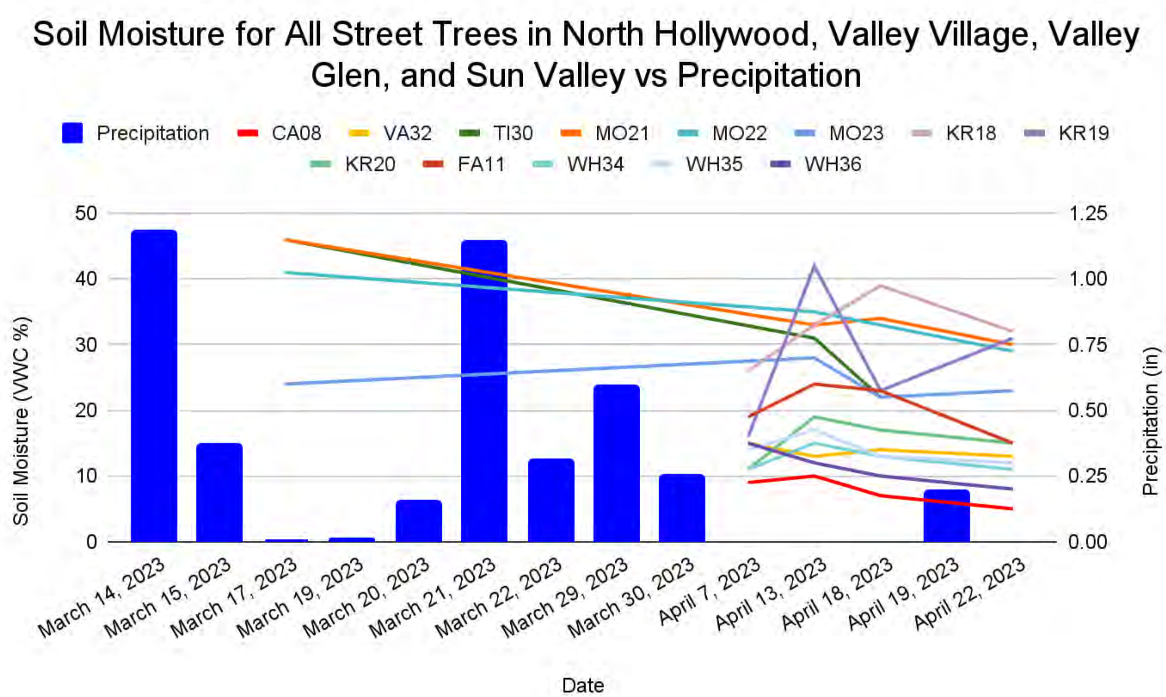


Figure 6-10. Soil Moisture of Trees Located in North Hollywood, Valley Village, Valley Glen, and Sun Valley (Orange Group) vs Precipitation. For the Orange group, precipitation data are displayed for March as well as April, as the initial soil moisture measurements for four trees in this group (TI30, MO21, MO22, MO23) were taken on March 17. All other soil moisture readings began in early April.

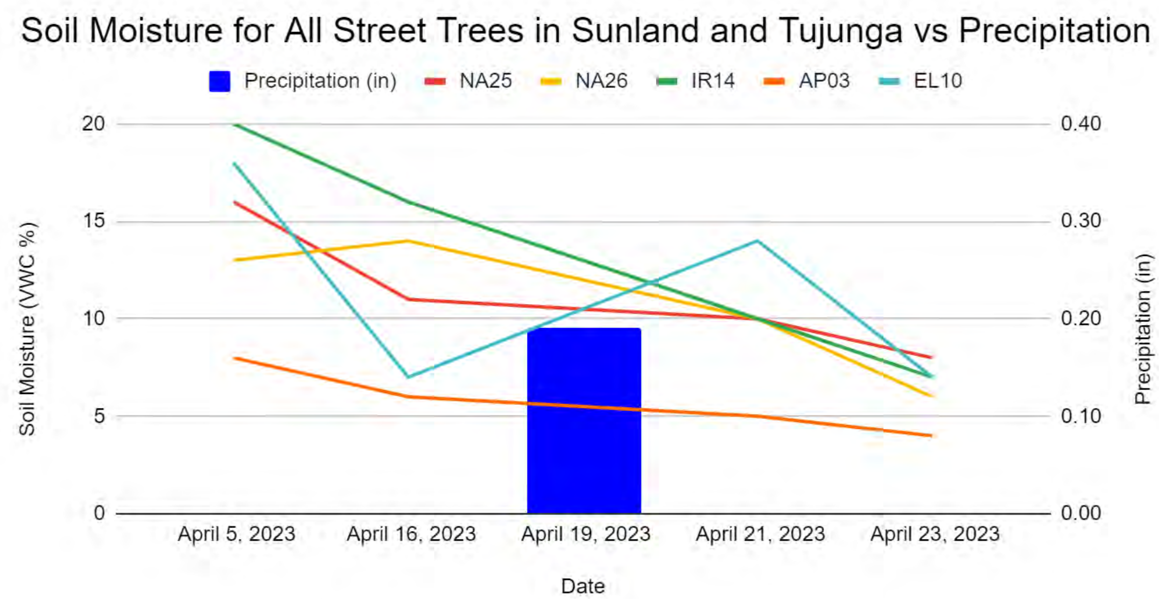


Figure 6-11. Soil Moisture of Trees Located in Sunland and Tujunga (Yellow Group) vs Precipitation.

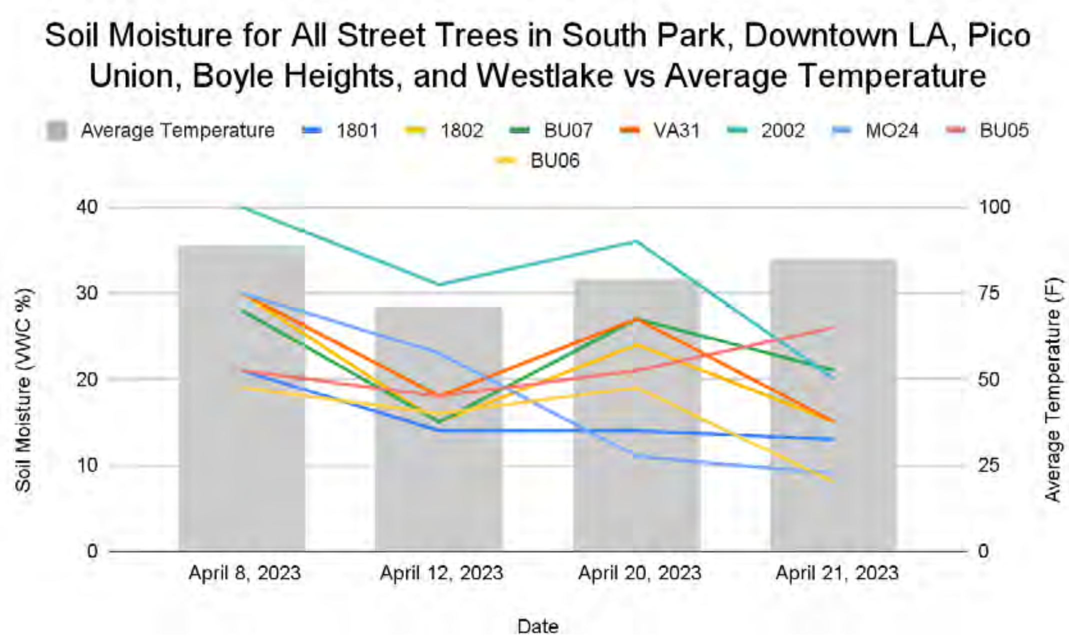


Figure 6-12. Soil Moisture of Trees Located in South Park, Downtown LA, Pico Union, Boyle Heights, and Westlake (Green Group) vs Average Temperature.

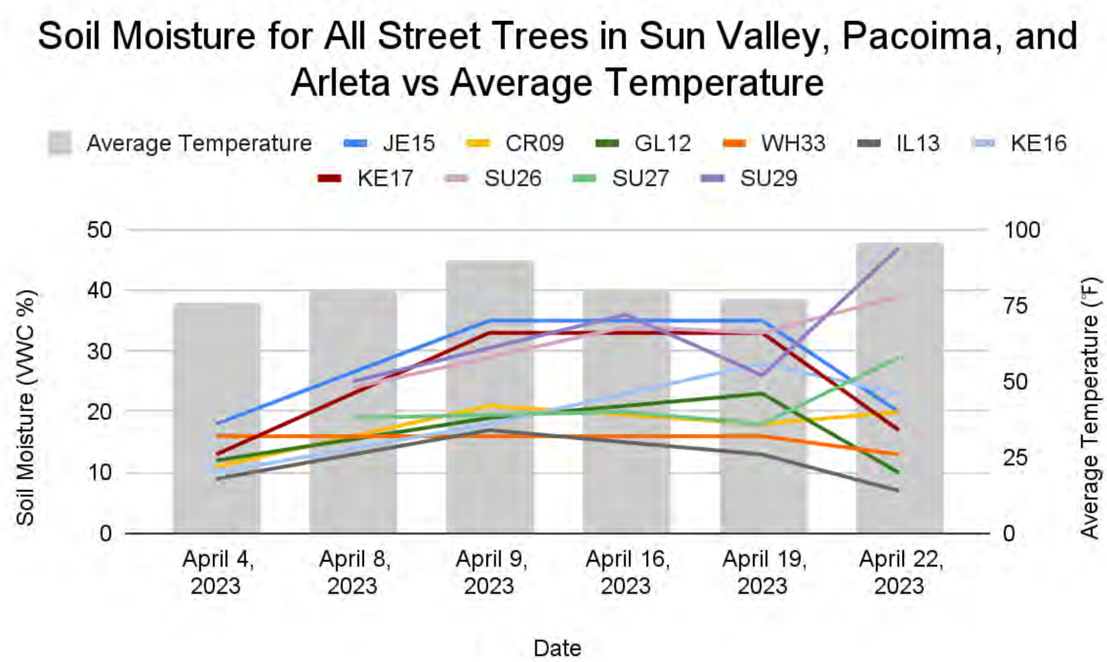


Figure 6-13. Soil Moisture of Trees Located in Sun Valley, Pacoima, and Arleta (Blue Group) vs Average Temperature.

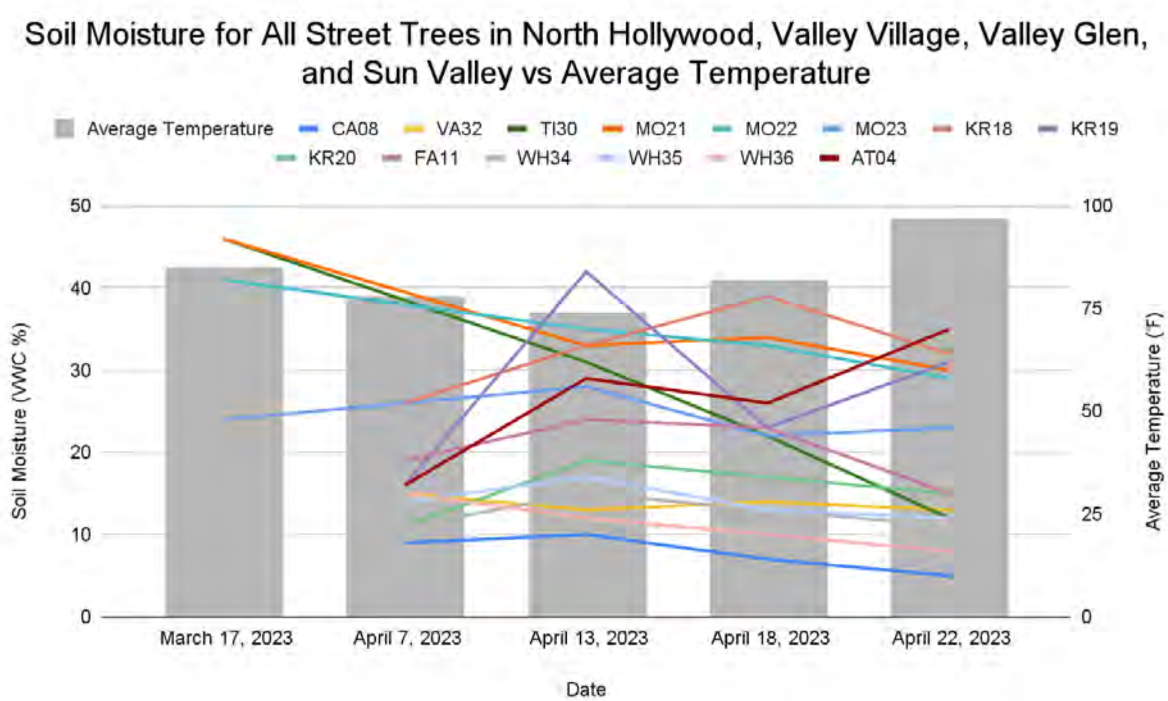


Figure 6-14. Soil Moisture of Trees Located in North Hollywood, Valley Village, Valley Glen, and Sun Valley (Orange Group) vs Average Temperature.

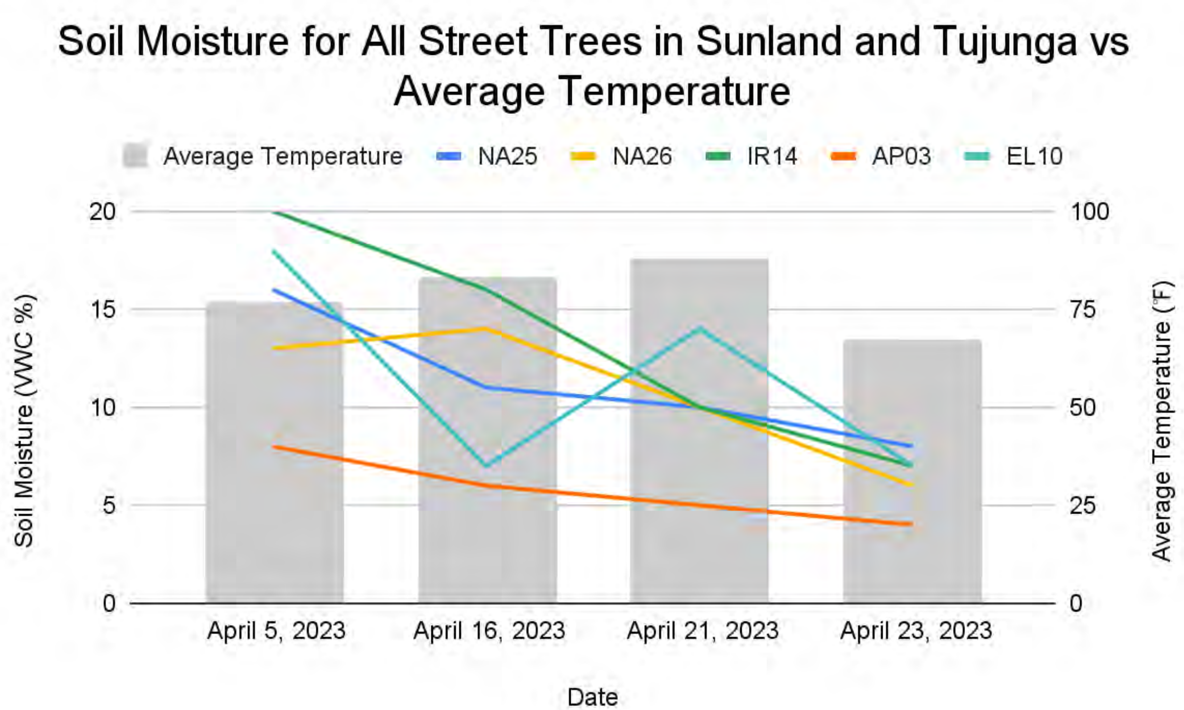


Figure 6-15. Soil Moisture of Trees Located in Sunland and Tujunga (Yellow Group) vs Average Temperature.

6.3. Discussion

6.3.1. Mortality Status and Basal Sprout Presence

All 37 street trees planted through the TA Pilot Program were alive at the time of this study, indicating that, to date, the pilot has been successful in terms of tree survival. None of the street trees were removed, cut down, or standing dead. Most of the street trees planted by the pilot did not have basal sprouts, indicating they did not exhibit this symptom of stress (Fig 6-3). Conversely, the 11% of trees that did exhibit basal sprouts were likely stressed. Stressors may have been climatic (related to precipitation or temperature), due to trash and weeds observed at the base of multiple trees, or for other reasons.

The 100% survival rate and low basal sprout presence may be due to multiple factors: a historically wet 2022-23 winter that brought significant rain prior to our study, adequate watering and maintenance by residents, proper selection of tree species for each location, and the relatively young age of the trees, all of which were planted in November and December of 2021 and August of 2022, according to records provided by City Plants. We cannot determine which factor contributed most to street tree survival. We did not study whether each tree species was suited to its planting location, nor did we analyze the age of each tree. The impacts of rain and resident watering cannot be fully separated from each other using soil moisture data alone, as those data reflect water present in the soil from any source. Nonetheless, examining our soil moisture data in comparison to precipitation and temperature yields important findings for the Tree Ambassador Pilot Program, as discussed below.

6.3.2. Soil Moisture

Though all street trees planted during the TA pilot were alive during the study period, not all were healthy. The minimum soil moisture that a tree needs to be healthy must be above its wilt point (the level of soil moisture at which it begins to wilt), which is generally 10-18% (Urban, 2014). This means that any trees that have soil moisture measurements below 10% can be considered unhealthy or insufficiently watered. As seen in Table 6-1, 27 of the 37 street trees consistently had soil moisture readings higher than 10%, indicating that a majority of residents who received street trees from the TA Pilot Program provided adequate watering.

Still, 10 of the 37 trees had soil moisture values of less than 10%. It was much more common for a tree to have a soil moisture measurement of less than 10% during our final visit than during the first visit. This may be explained by the slight warming temperature trend across some locations in the San Fernando Valley (namely, the Orange and Blue groups), though decreased precipitation was likely a stronger influence. Interestingly, trees located in Sunland and Tujunga (Yellow group) were more likely to have soil moisture below 10% than any other group (Fig 6-7). Although it rained on April 19th in Sunland and Tujunga, when we visited the trees in that area four days later, all five trees there had unhealthy (below 10%) soil moisture readings (Fig 6-11). One of these trees, AP03, consistently had less than 10% soil moisture. As an indicator of poor health, this is corroborated by its crown vigor rating—at our first visit to AP03, we gave it a rating of Slightly Unhealthy. Upon our last visit to this tree, it received a rating of Severely Unhealthy. These results indicate that AP03's resident may not be caring for their tree as agreed upon in the "Commitment to Water" form. This kind of tree-by-tree conjecture is likely too burdensome for City Plants and similar organizations to conduct for most of the trees they plant. With that in mind, we believe that the general trends we document here are more practically useful for observing patterns in soil moisture and climatological factors.

6.3.3. Soil Moisture and Precipitation

A major finding of our analysis was that precipitation does not appear to affect soil moisture for more than a few weeks, and that rain events must be significant and/or frequent in order to affect soil moisture at the 6-inch depth where soil moisture was measured. Despite (or possibly because of) five large rainfall events throughout March, most observations of soil moisture fell between 10-40% during the study period. Precipitation in March was greater than that in April (over an inch versus less than an inch). The March rain events may have led to high initial soil moisture readings, with readings decreasing as precipitation declined. For example, the average soil moistures of the Orange, Green, and Yellow groups generally decreased across visits, each final (Visit 4) average being less than the initial (Visit 1) average (Fig 6-6). The steepest consistent decrease, of about 20% soil moisture on average, occurred in the Orange group. This calculation references, as the initial value, the four trees of that group for which readings were taken in March. Excluding those four trees, the average decrease in soil moisture for the Orange group was about 11% during April.

The Yellow group saw a comparable drop in soil moisture of almost 10% on average (Fig 6-7). The difference between the initial and final average soil moistures for the Green group (about 11%) was slightly larger than for the Yellow group, though it was not a consistent decrease, as average soil moisture increased between Visits 2 and 3. Initially, it may appear that the increase between Visits 2 and 3 was due to precipitation in mid-April. However, that mid-month precipitation was trivial: only 0.05 inches (Fig 6-8). Thus, rain in April was unlikely to have affected soil moisture of trees in the Green group.

In all three of these groups, given the decreasing soil moisture trends, it is likely that many trees were not watered during April. That may be due to residents perceiving a lack of need to water their trees in the period following the March rain events. Nonetheless, the negative trends in average soil moisture over time imply that continuation of watering a few weeks after a rain event is necessary for soil moisture to remain at sufficient levels for tree health, and that small rain events such as the ones observed on April 12, 13 and 19 do not have a measurable impact on soil moisture.

The only exception to the negative soil moisture trend is found in the Blue group. From the initial to final visit, average soil moistures of this group increased by about 6%. After a jump of almost 10% between Visits 1 and 2, average soil moisture slowly decreased (Fig 6-6). Notably, there were no rain events between Visits 1 and 2. Thus, this 10% jump was most likely due to increased watering by residents. As seen in Figure 6-9, soil moisture data for individual trees are tightly clustered during Visits 1 and 2, while there is more spread in the data from Visits 3 and 4 (there is more variation among individual averages from the latter visits than among averages from the earlier visits). Almost 0.20 inches of rain fell in the area between Visits 3 and 4, which may be a cause of the larger spread. Nonetheless, this was still a small amount of rain, and the soil moisture of some trees decreased between Visits 3 and 4. Those trees may not have been sufficiently watered in that time period (whereas trees whose soil moistures increased between Visits 3 and 4 may have received a combination of rainwater and watering by residents). Overall, individual trees in the Blue group received varying amounts of water during the latter part of April, possibly from both precipitation and resident watering. This finding demonstrates that levels of both precipitation and resident watering are unlikely to be uniform within Blue group neighborhoods (Sun Valley and Pacoima/Arleta), let alone between neighborhoods in which the Tree Ambassador Pilot Program operated.

6.3.4. Soil Moisture and Temperature

We now compare trends in ambient air temperature and soil moisture. It could be expected that soil moisture would decrease with temperature, as hotter temperatures would evaporate more moisture. Graphically, this would appear as an inverse relationship.

Our results largely disagreed with this expectation. In the Green group, both temperature and soil moisture decreased between first and second visits. Between second and third visits to this group, the soil moisture of some trees increased, while temperature also increased. We only observed the expected inverse correlation between temperature and soil moisture between third and fourth visits, as soil moisture dropped for almost all trees while temperature rose (Fig 6-12).

In the Blue group, soil moisture increased with temperature in early April. It then overall leveled off while temperature decreased into mid-April. Temperature spiked to almost 100ºF near the end of the month (April 22), though its effect on soil moisture is not clear, as soil moistures varied enormously on that date, from about 7% to almost 50% (Fig 6-13).

In the Orange group, many soil moistures increased slightly while temperature decreased slightly between April 7 and 13. Many trees' soil moistures then decreased slightly as temperature rose between April 13 and 18. While this appears to cohere with the expectation of an inverse relationship between the two variables, the trends are slight, and a few individual trees do not follow the trend (notably, TI30, MO21, and MO22). Like with the Blue group, final soil moistures varied widely with the April 22 temperature spike, from about 5% to about 30%. That said, the soil moistures of many trees in this group decreased from April 18 to 22 (Fig 6-14).

In the Yellow group, temperature increased across the first three visits, then decreased by over 20℉ (from 88℉ to 67℉) by the last visit. Regardless of these trends, the soil moistures of four out of the five street trees in this group declined severely. The soil moisture of only one tree (EL10) may have been affected by changes in temperature, though these soil moisture levels generally do not vary inversely with temperature (Fig 6-15).

In summary, the soil moisture patterns across all street tree groups do not match our expectation that increasing temperatures would correspond to decreasing soil moistures, and vice versa. Moreover, there is no immediately obvious relationship between the two variables that is commonly observed across all groups. The inconsistency of the relationship between temperature and soil moisture appears to indicate that soil moisture may have been independent of or only slightly affected by local temperature across study areas. It is vital to note that temperature readings were taken at varying times of day, which impacts the sunlight levels and thus surface and air temperatures. It also means that comparisons of temperature between days may be unreliable. As such, precipitation, which was recorded as a daily total by a weather station, is a more reliable climatological indicator than field temperature readings.

Using soil moisture measurements as an indicator of program success should be done with caution. In the months leading up to data collection, Los Angeles experienced a record-breaking amount of rain, with Downtown LA receiving 8.95 inches of rain in January 2023, 5.95 inches of rain in February 2023, and 7.71 inches of rain in March 2023 (Los Angeles Almanac, n.d.*a*). A weather station in Burbank recorded similar measures of rain with 8.35 inches in January 2023, 7.86 inches in February 2023, and 5.39 inches in March 2023 (Los Angeles Almanac, n.d.*b*). These stations were selected due to their proximity to trees in the study. Without comparable data from a dry year, we cannot know the extent to which this precipitation contributed to tree health, though its influence appears to have been significant.

Soil moisture is also only a proxy for watering habits. Direct observation of residents' watering habits would provide more certainty in discussion of trends in the data. However, this kind of observation is unrealistic because 1) it could be costly in terms of human work hours or camera equipment, 2) it could be considered an invasion of privacy, and 3) knowledge of being observed might affect resident watering habits. Thus, measuring soil moisture is a necessary proxy for observing watering habits.

6.3.5. Crown Vigor

During initial data collection visits, many dormant, deciduous trees that had not yet leafed out were given an Unknown crown vigor rating. Across final visits to each tree, the number of trees originally rated Unknown declined substantially, while the percentage of trees categorized as Healthy increased (Fig 6-3). These two trends are linked. At the time of the final visit to each tree, many initially dormant trees had leafed out and were categorized as Healthy. Examples include VA31, BU05, and MO21 and MO22. Emergence of deciduous trees from dormancy was likely influenced by increases in average temperature, which was observed in three out of the four groups (Green, Blue, and Orange; Figs 6-12, 6-13, and 6-14, respectively).

However, some of the trees initially dormant (or thought to be dormant) were categorized in various poor health conditions at final visit, as in the case of KE17 (rated Severely Unhealthy). The percentage of Slightly Unhealthy and Moderately Unhealthy trees remained similar throughout the study. The percentage of Severely Unhealthy trees decreased between the initial and final visits (Fig 6-3). Some trees that had not yet leafed out remained Unknown at the final visit, such as SU29 and WH33. Nonetheless, we determined these trees to be alive by scratching their bark and observing live green wood underneath.

The crown vigor results show that some trees experienced increases in health ratings, while other trees received declines in their health ratings. For example, as seen in Table 2, tree JE15 received a crown vigor rating of Severely Unhealthy during our first visit which changed to Healthy during the last visit, signifying a major improvement in health. Alternatively, as shown in Table 2, tree IL13 received a crown vigor rating of Healthy during our first visit and later declined to Moderately Unhealthy during our final visit. Though 37.8% of all street trees planted by the TA Program received some type of unhealthy rating, more than half received a rating of Healthy during the final visit.

Comparing crown vigor with soil moisture garners mixed results. In multiple cases, a low average soil moisture reading correlated with a less-than-healthy crown vigor rating. For example, tree IL13 had only 7% soil moisture during the last visit. On this visit, we gave it a crown vigor rating of Moderately Unhealthy. It is possible that low soil moisture contributed to poor crown vigor for this specific tree. Similar correlations between low soil moisture and poor crown vigor can also be seen with other trees, including AP03, NA25, and others. This observation coheres with an April 2023 study which found a statistically significant positive correlation between higher soil moisture and "trees that were assessed to be healthy based on a 4-point evaluation of trunk, branch, and leaf health" (de Guzman et al., 2023, p. 14). Logically, it can be concluded that low soil moisture tends to correspond to poor tree health, which we measured via crown vigor.

However, it can be difficult to interpret a tree's overall health solely by comparing soil moisture to crown vigor. For example, even though a tree may not have sufficient soil moisture, its crown can be healthy. An instance of this can be seen with CA08: this tree yielded average soil moisture readings of 9%, 10%, 7%, and 5% during each of the four visits, indicating insufficient watering. Despite this, it received a crown vigor rating of Healthy on both the first and last visits. Confounding variables that are not part of this study, such as fertilizer application, may have influenced the outcome for this tree. Contradictions were also noticed between trees with soil moisture readings higher than 10%, but less-than-healthy crowns. Examples include SU26, KE17, and 1801 when comparing the last visit's crown vigor to all four average soil moisture readings for each tree. These contradictions emphasize the complexity of studying living organisms and need for holistic tree health assessments.

6.3.6. Challenges

Throughout the course of our data collection, we encountered a number of challenges. For example, both soil moisture sensors were not always reliable. One consistently produced an ambient air temperature reading of 32°F, which we did not include in our analysis. The other sensor sometimes gave soil moisture readings of 100%, which were not possible as even placing the sensor probe in a bottle of water would not produce a reading over 70%.

Though we had originally planned to visit each tree six times, we were only able to make four visits due to time and logistical constraints. And, whenever it rained, we would have to wait two days before resuming data collection to avoid artificially inflated soil moisture values, further constraining our time.

6.3.7. Suggestions for Future Work

To build on this study, we suggest surveying trees during drier and warmer conditions and over a longer period of time. The effect of resident watering habits during the warm summer may be more directly reflected in soil moisture readings than during rainy months. The lack of precipitation in the summer would also increase confidence in using soil moisture as a proxy for capturing watering behavior. Additionally, had more measurements been taken in March, a clearer picture may have emerged of the effects of that month's precipitation on soil moisture. Overall, extensions of this kind of study should cover a longer time span—ideally a full year—to capture the effects of changes in precipitation and soil moisture across each season.

Selection of climatological data is crucial for reliable comparisons. While the precipitation data we analyzed were in the form of a single cumulative value per day, our temperature readings were impacted by natural temperature variation at different times of day. To avoid this confounding factor, we recommend sourcing temperature data from a nearby NOAA weather station, which should be more reliable than field measurements. We also recommend using a single value of temperature for each day. Possible candidates include the daily maximum temperature, daily minimum temperature, or daily average temperature.

Another suggestion is to use more reliable, higher quality, and longer-lived soil moisture sensors for data collection, as one of our sensors broke after a month of usage. Since our team was under time and budgetary constraints, we were not able to replace our sensor for a functional one without drastically delaying data collection.

Our finding that soil moisture decreased substantially within a few weeks of historic rains has implications for street tree watering research and outreach. This finding highlights the need for watering when gaps between precipitation events last more than a few weeks. Residents may be unaware of this need. Consequently, we advise City Plants and similar community-based urban tree planting and stewardship programs to poll their constituents on perceived need for watering after varying lengths of time following rain events. Both recipients of trees and non-recipients should be polled to accurately determine the breadth of perceptions of watering need in a neighborhood. Additionally, City Plants and similar community-based urban tree planting and stewardship programs may boost the survival rate of trees they plant by providing tree recipients with suggested time spans to resume watering after rain events of varying intensities (measured in inches of rainfall). This information should be in an accessible format that a resident will see frequently, such as a refrigerator magnet. These magnets or other forms of reminders should be available across the city in English and Spanish, and in any other languages commonly spoken in each neighborhood the program serves.

7 - GIS Analysis of Current Tree Cover and Potential Planting Pathways

7. GIS Analysis of Current Tree Cover and Potential Planting Pathways

7.1. Methods

The original research question from the client was "What potential pathways exist to greening disadvantaged, formerly redlined, heavily concretized communities that have limited planting spaces according to city tree planting guidelines?" Over the course of the project, and with guidance from the client and advisor, we changed our focus from finding potential pathways that would increase greening to analyzing the effectiveness of the Tree Ambassador (TA) program for planting trees in select communities. The revised research question became "How effective was the Tree Ambassador Pilot Program in planting trees in high-priority, low-canopy, heat vulnerable, and environmentally burdened census tracts?" One of the TA program's goals was to plant trees in low-canopy, heat-burdened, and disadvantaged communities.

The Los Angeles Urban Forest Equity Collective (UFEC), formed in 2020, developed a decision-making matrix that identified priority census tracts in need of urban forest equity initiatives, and we utilized this research as a metric against which to evaluate the geographic focus of the TA Pilot Program. Additionally, we investigated how trees planted through the TA program fell within burdened and vulnerable census tracts as identified by CalEnviroScreen 4.0 (CES 4), disadvantaged communities (DACs) as defined by Senate Bill 535, heat vulnerable census tracts as defined by the UCLA Center for Healthy Climate Solutions, and low-canopy census tracts as defined by the Los Angeles Urban Tree Canopy LiDAR Assessment of 2016.

While pilot program TAs were not specifically chosen with these areas in mind, these measures can be used in retrospect to find how well TA tree distribution lined up with disadvantaged communities.

7.1.1. Obtaining and Cleaning Data

The following sections list datasets and layers used, as well as descriptions of the work we did to extract and clean this data. Layers we output that were used to create our thematic and interactive maps are italicized and bolded.

7.1.1.1. Tree Ambassador Program Data

City Plants supplied us with a comprehensive spreadsheet containing data on all trees planted, adopted, and distributed during the TA pilot program (**Tree Ambassador Program - 2020 - 2021 - final numbers and data tracking.xlsx**). This spreadsheet was duplicated and renamed **Tree Ambassador Spreadsheets for GIS.xlsx** for editing. Of a total 1,929 trees adopted, delivered or planted in the 2020-2021 pilot round of the TA program, 1,455 had an associated address or coordinates. The following analyses are based on trees with this available location data.

We manually added common or scientific names for trees missing this information.We also assigned trees a unique ID and georeferenced their street address, which will be expanded upon in the next two subsections.

7.1.1.1.1. Tree ID Assignment

The comprehensive spreadsheet contained data on all street trees planted and private property trees delivered and adopted through the TA Pilot Program, which included tree planting address and/or GPS coordinates, recipient name, tree species, date delivered, recipient zip code, and more. In order to organize this, we assigned a tree ID to each tree.

For trees in private residences, we assigned the first letter of the tree ID according to its distribution status (Adopted trees started with "A", delivered trees started with "D"). The next two letters refer to whether or not the tree had already been georeferenced; "YC" stands for "Yes Coordinates", meaning there were already coordinates associated with the tree, while "NC" stands for "No Coordinates", meaning the tree had no associated coordinate points and needed to be georeferenced later. The three letters were followed by a number which was arbitrarily assigned according to all the trees' addresses in alphabetical order. For example, a tree with the tree ID "ANC254" means the tree was adopted and had no associated coordinate system.

For street trees, tree IDs were assigned following a format of the first two letters of its address followed by a number which was arbitrarily assigned by address when placed in alphabetical order. Therefore, a tree on Jerome St. would be called "JE15."

7.1.1.1.2. Georeferencing Tree Addresses

Many private yard trees in this dataset were missing coordinates, so we manually added these based on tree planting addresses using the UCLA geocoder. This online tool allows an address to be input and outputs the associated coordinate points of the address. In order to verify the accuracy of these coordinates produced through the UCLA geocoder, we also geocoded coordinates for trees that already had coordinates, uploading both geocoded and provided coordinates to ArcGIS to check how close they were. We determined that the coordinate points generated by the UCLA geocoder were acceptable representations of trees for where no coordinate points previously existed, but used the original coordinates when available. We made this decision as the geocoded points were located on the street in front of the tree's address, whereas the provided coordinate points were located where the tree was planted according to the resident.

For street trees planted through the TA program, we recorded the actual coordinates of tree locations during tree health assessment outings using our smartphone's GPS. We then uploaded them alongside a layer of tree locations provided by City Plants on Google MyMaps to verify the manually-collected coordinates accurately represented their respective tree and address.

All of this information, both originally included and added through data cleaning, was included into one spreadsheet, ***TA Pilot Trees.csv***, which was then uploaded to ArcGIS and converted into the shapefile ***TA Pilot Trees.shp***. We used this layer in all of our thematic maps, as well as on our interactive map.

7.1.1.2. City Plants Adopted Trees from 2014-2020

City Plants provided us with a dataset containing data on all of City Plants' adopted trees outside of the Tree Ambassador Program (**City Plants 2014 - 2020 Adopted Trees feature layer**). This layer, which we named ***City Plants Trees***, was added to the interactive map on ArcGIS Online. We made a point cloud with the goal of showing the distribution of City Plants trees in comparison to Tree Ambassador program-specific trees (Fig 7-5).

7.1.1.3. Tree Ambassador Home Zip Codes

City Plants also provided the home zip codes of all Tree Ambassadors from the pilot round, though the data did not distinguish which TA came from which zip code. This dataset was included so that we could compare TA tree distribution to TA home zip codes and analyze the effectiveness of the "community-based" aspect of the Tree Ambassador Program.

We used the "Definition Query" tool to extract TA home zip codes from the 2020 census zip code shapefile (**tl_2022_us_zcta520.shp)**. This resulting layer was called ***TA Home Zip Codes***. We then ran the "Near" tool to calculate distance between TA trees and zip codes. We must note that the "Near" tool only calculates distance to the edge of the zip code and not the center.

7.1.1.4. Loyola Marymount University Tree Canopy Study

A dataset containing granular tree canopy data was obtained from the TreePeople/Loyola Marymount University (LMU) Tree Canopy Study (**TreeCanopy_LosAngeles_2016.gdb**). As it had little to no metadata describing layer attributes, we accessed the layers using ArcGIS Online and determined what each layer meant through visual analysis. For our analysis, we used **LandCover_Metrics_CensusBlockGroups2010.csv** as this contained tree canopy coverage (TCC) in the smallest unit of land.

As the LMU Tree Canopy Study was based on 2010 census block groups, we used GIS to overlay these with 2020 census blocks so that this data could then be spatially joined with 2020 census data. Blocks that overlapped more than one block group were joined to the one with the largest overlap. Then, we ran summary statistics on this joined data.

7.1.1.5. Urban Forest Equity Collective Designated Priority Zones

The UFEC priority zones dataset was obtained from the Urban Forest Equity Collective (UFEC) (**UFEC_Matrix_Sept_Update_gdb**). We used the ***Step3_results.shp*** layer, which contains priority census tracts for tree planting and future planning and resources as defined by UFEC. A census tracts qualifies if it is in the upper 50th percentile for at least four of eight defined sociodemographic factors (below the poverty line, formerly redlined area, no internet access, renters, non white and/or Hispanic, education below high school diploma, population density, or home language other than English).

This dataset was used to make the *SB 535 Disadvantaged and Communities and UFEC Priority Zones* map (Fig 7-2). We imported this dataset to ArcGIS and renamed the layer ***UFEC Priority Zones***. We then joined the ***TA Pilot Trees*** layer to ***UFEC Priority Zones*** via the "CT20" (2020 census tracts) field. We used the tool "Calculate Field" to find whether trees distributed by the TA program were within these priority zones.

Finally, summary statistics were generated for this new field to create the *Urban Forest Equity Collective and Disadvantaged Communities Statistics Summary* Table (Table 7-1).

7.1.1.6. 2022 CA Census Tracts, Blocks, and Block Groups

This layer, called ***Census Tracts, Blocks, and Block Groups***, was obtained from the United States Census Bureau. It contains California census tracts, blocks, and block groups.

7.1.1.7. Los Angeles City Boundary

This layer, called ***City Boundaries***, was obtained from the Los Angeles GeoHub and contains the boundary of the City of LA (**City_Boundaries.shp**). We clipped all other layers to this layer so that our maps and subsequent statistical analysis would only contain data from LA City.

7.1.1.8. CalEnviroScreen 4.0 Scores

This dataset was obtained from the California Office of Environmental Health Hazard Assessment (**SB 535 ArcGIS Geodatabase** (May 2022)). CES 4 scores show pollution burdens and vulnerabilities in CA communities by ranking communities based on pollution burden and population characteristics that may increase vulnerability (August et al., 2021).

We opened the zipped file in ArcGIS and obtained a shapefile of CES 4 scores by census tract. We called this layer ***CalEnviroScreen 4.0 Scores***.

7.1.1.9. Heat Map of LA Zip Codes

This dataset was created by the UCLA Center for Healthy Climate Solutions and the UCLA Center for Public Health & Disasters; it was retrieved from osf.io (**Heatmap_ziplevel_7.7.2022.zip**). This shapefile showcases the number and rate of excess ER visits due to heat in each zip code of LA County. We used this data to create an ***Urban Heat*** layer.

7.1.2. Making Maps

Four thematic maps, as well as one interactive map, were created, with all data clipped to the extent of LA City. The thematic maps show all trees (adopted, delivered, and street) distributed by the Tree Ambassador Pilot Program and consist of:

- A map showing the rate of excess heat-related ER visits per 100,000 people by zip code.
- A map of census tracts designated as disadvantaged communities (DACs) by Senate Bill 535 and neighborhood prioritization zones as defined by UFEC.
- A map of CalEnviroScreen 4.0 (CES 4) scores by census tract.
- A map of tree canopy percentage across LA City census tracts.

The interactive map was created on ArcGIS Online and is hosted on the Los Angeles GeoHub. The layers added to this map include ***TA Pilot Trees***, ***City Plants Trees***, ***TA Home Zip Codes***, ***CalEnviroScreen 4.0 Scores***, ***UFEC Priority Zones***, and ***Urban Heat***. Tree health and soil moisture data were also joined to the TA Pilot Trees layer so that, when interacting with a tree point on the map, one can easily bring up associated health information.

We used ArcGIS to create all maps; detailed steps can be found in the appendix.

7.1.3. Analysis

All spatial analysis and table generation was done within ArcGIS. In order to generate statistics about where trees fell within designated UFEC priority areas and DACs, we placed all trees on a map with the UFEC Priority and DACs layers and used a geoprocessing tool called "Spatial Join" to find overlap. We then created a table of summary statistics to separate these trees by type, showing both number and percent of trees in UFEC priority zones or DACs.

7.2. Results

7.2.1. Thematic Maps

Our deliverables include multiple maps of TA tree locations compared to rate of excess ER visits due to excess heat per 100,000 people, census tract CES 4 scores, tree canopy percentage, and census tracts designated as DACs and prioritized for increasing urban forest equity as determined by UFEC.

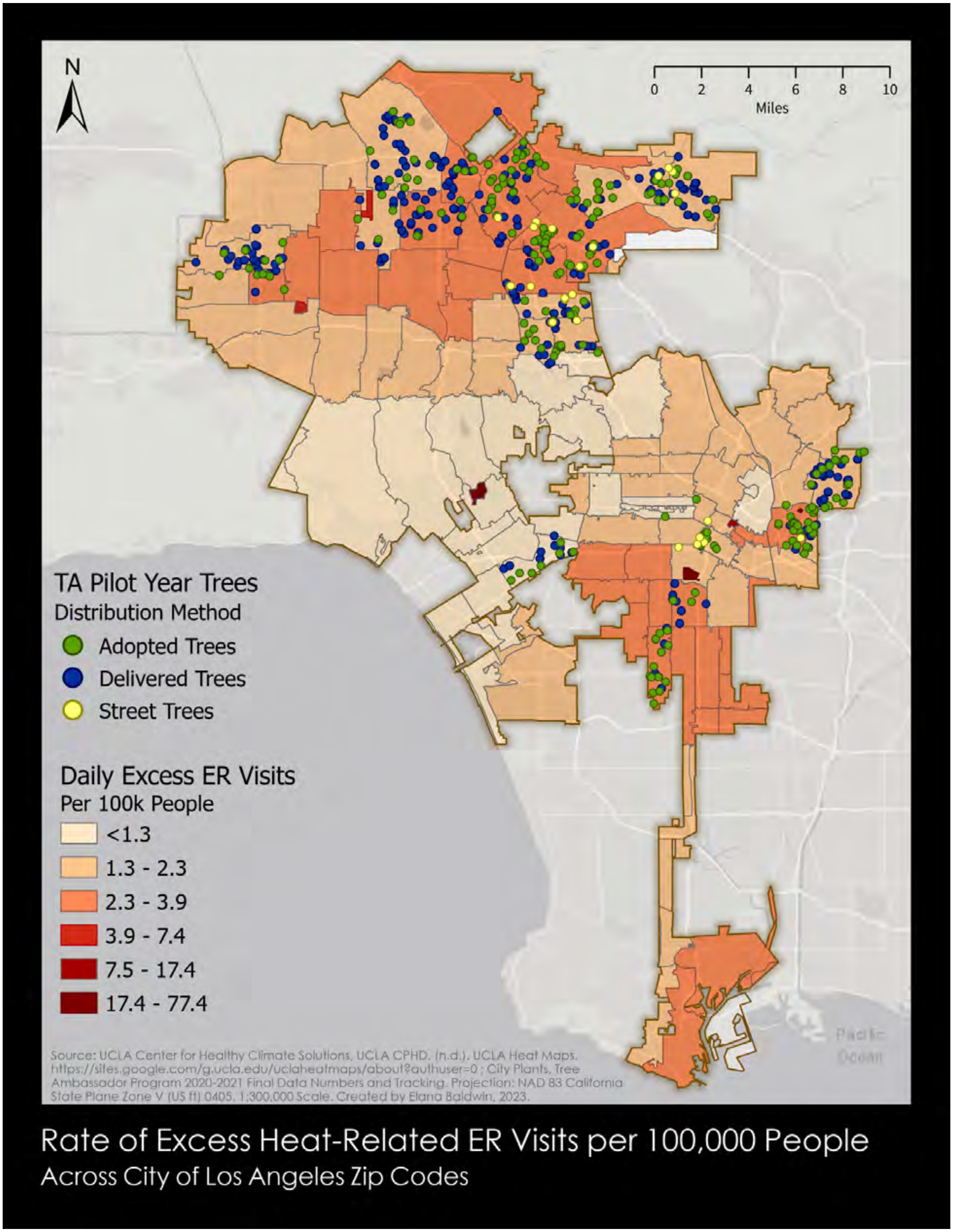


Figure 7-1. Rate of Excess Heat-Related ER Visits per 100,000 People by Zip Code. This map shows the rate (visits per 100,000 people) of excess emergency room visits due to heat in

each zip code of the City of Los Angeles (LA). Excess is defined as increased visits to the ER during extreme heat days compared to typical ER rates on non-extreme heat days (UCLA Center for Healthy Climate Solutions, n.d). This map accounts for the City's varied population densities and is thus representative of where heat burden is highest. Darker red zip codes see a higher rate of excess ER visits than lighter zip codes.

Points represent the locations of trees planted by the 2021-2022 Tree Ambassador Pilot Program. Green points represent yard trees adopted from free tree events. Blue points represent yard trees delivered directly to residents. Yellow points represent street trees. Based on this figure, trees appear to be planted in zip codes that experience a higher heat burden as demonstrated by a higher rate of heat-related ER visits.

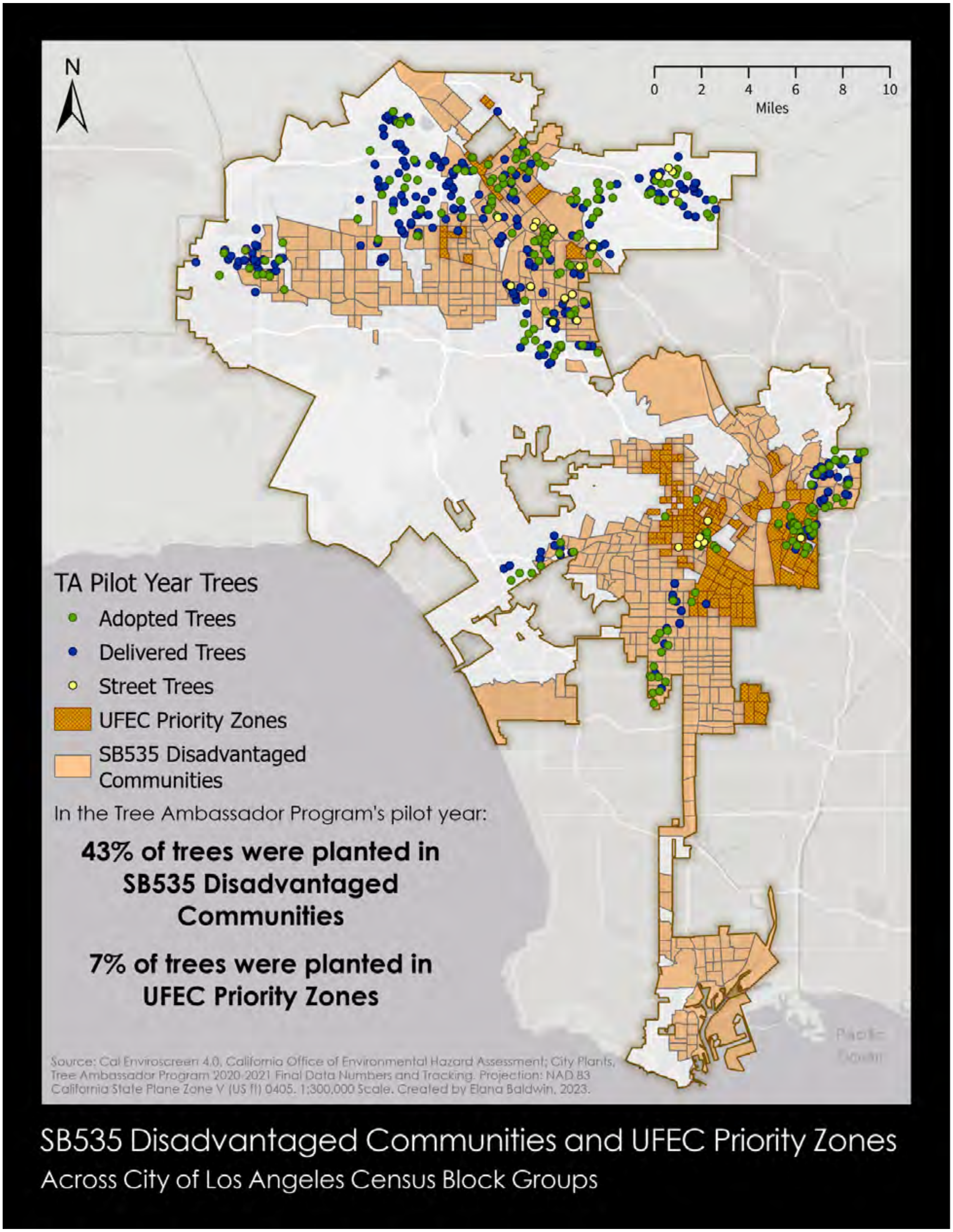


Figure 7-2. Disadvantaged Community and Priority Planting Zones for Census Tracts in the City of LA. This map depicts both disadvantaged communities (DACs) as designated by

Senate Bill 535 and priority planting zones as designated by the Urban Forest Equity Collective (UFEC).

We offer this analysis as one possible approach to evaluate the impacts that TA efforts are having, but note that the TA program does not currently use either DAC or UFEC prioritization to determine where program activities are focused and that there is thus no target to compare against. We also note that the pilot round of the TA program predated the creation of the UFEC prioritization process, and that City Plants has expressed the intent to align TA neighborhood selection with the UFEC prioritization process in future rounds of the Tree Ambassador program.

In 2012, the California Environmental Protection Agency announced DACs designations via Senate Bill 535, which aims to prioritize funding allocations to severely burdened census tracts. In May 2022, DACs were finalized and designated through the utilization of CalEnviroScreen as a tool for measurement. The designations are made based on whether the communities fall into one of these four categories (OEHHA, 2022):

1. Census tracts with the highest 25% of CalEnviroScreen 4.0 (CES 4) scores.
2. Census tracts lacking CES 4 scores due to data gaps, but receiving the highest 5% of CES 4 cumulative pollution burden scores.
3. Census tracts designated as disadvantaged in the 2017 designation.
4. Lands controlled by federally recognized Tribes.

UFEC designated prioritization zones qualify if they are in the upper 50th percentile for at least four of eight defined sociodemographic factors (below the poverty line, formerly redlined area, no internet access, renters, non white and/or Hispanic, education below high school diploma, population density, or home language other than English). Once qualified, the area is considered, within the UFEC framework, as needing increased urban canopy coverage and considered a priority census tract for future planning and resources.

DACs are denoted by orange tracts. UFEC priority planting zones are denoted by red tracts. Points represent the locations of trees planted by the 2021-2022 Tree Ambassador Pilot Program. Green points represent yard trees adopted from free tree events. Blue points represent yard trees delivered directly to residents. Yellow points represent street trees.

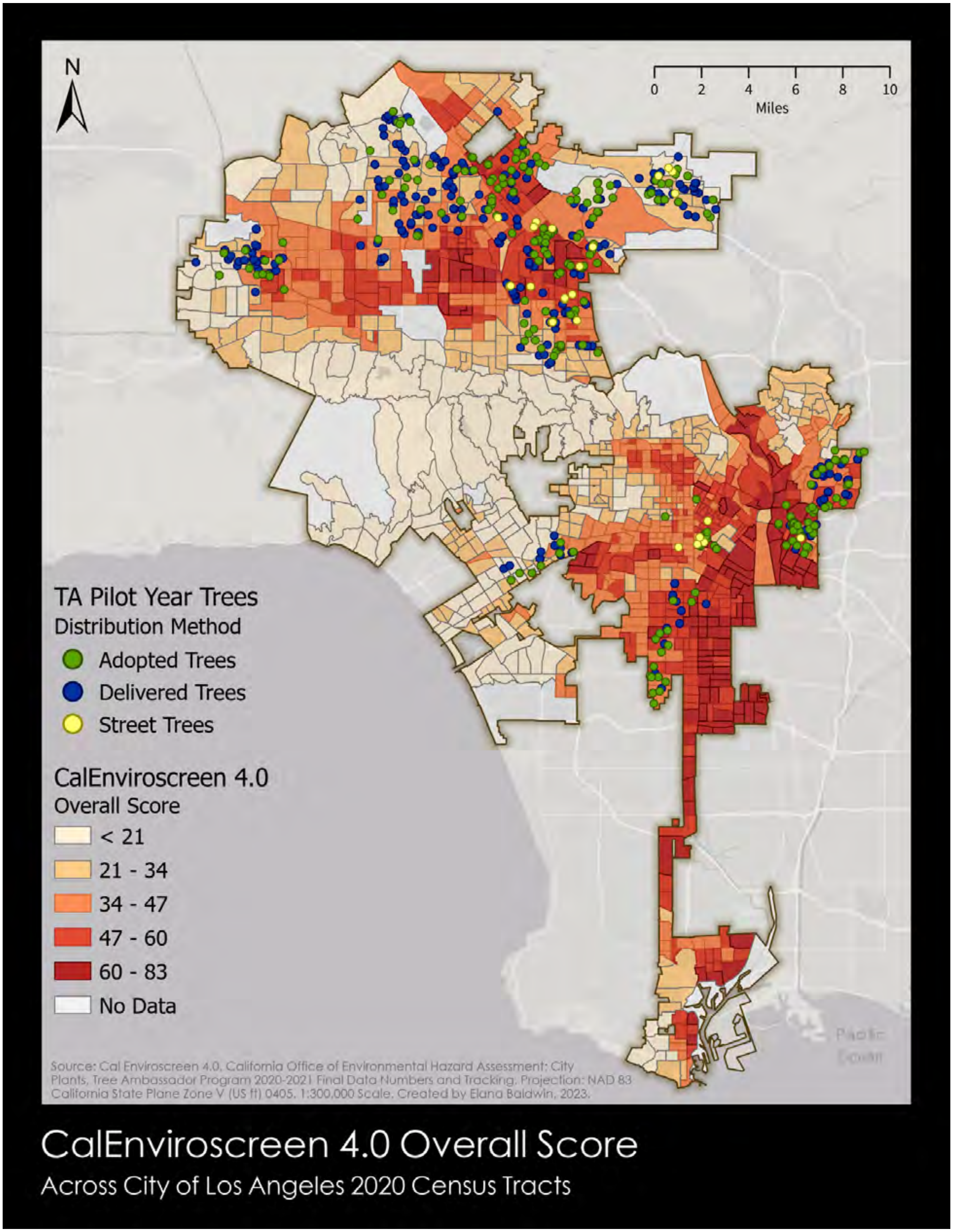


Figure 7-3. CalEnviroScreen 4.0 Score for City of LA Census Tracts. The CalEnviroScreen 4.0 (CES 4) is meant to show a "relative…evaluation of pollution burdens and vulnerabilities in

California communities" (p. 8) by ranking communities based on a score that is calculated by multiplying pollution burden (average of pollution exposures and adverse environmental effects) by population characteristics (average of sensitive populations and socioeconomic factors) (p. 13). A detailed explanation of the methodology for finding this score can be found in the CalEnviroScreen 4.0 Report (August et al., 2021).

Darker red census tracts have a higher CES 4 score and are thus more vulnerable and experience higher pollution burdens than lighter census tracts. Points represent the locations of trees planted by the 2021-2022 Tree Ambassador Pilot Program. Green points represent yard trees adopted from free tree events. Blue points represent yard trees delivered directly to residents. Yellow points represent street trees.

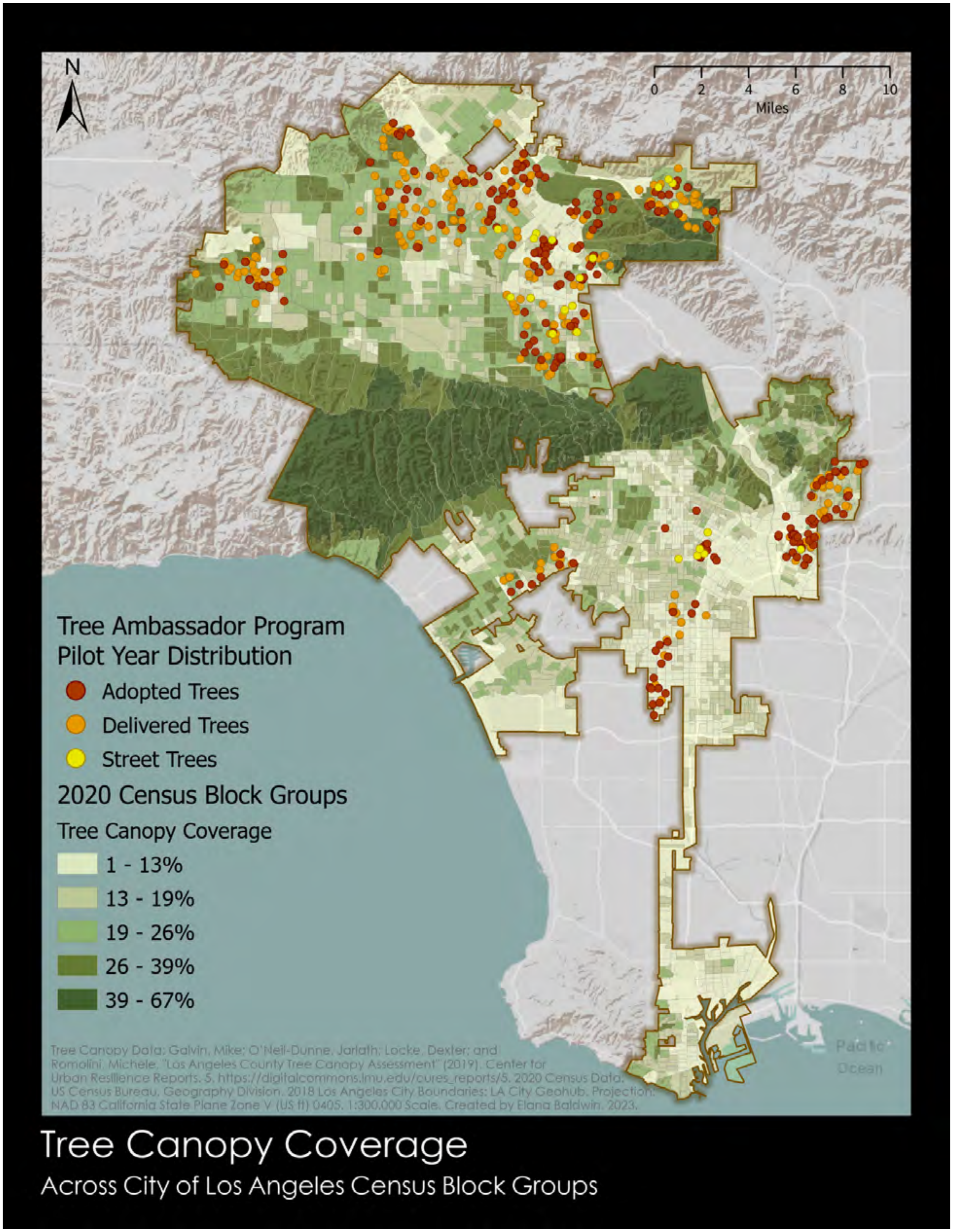


Figure 7-4. Tree Canopy Percentage across City of LA Census Tracts. This map shows the percentage of tree canopy cover (TCC) across census tracts in the City of LA according to the

Los Angeles Tree Canopy Assessment, conducted using data from 2016 (Galvin et al., 2019). Darker green census tracts have higher TCC while gray tracts have lower TCC. Points represent the locations of trees planted by the 2021-2022 Tree Ambassador Program Pilot. Green points represent yard trees adopted from free tree events. Blue points represent yard trees delivered directly to residents. Yellow points represent street trees.

7.2.2. Interactive Map

We created an interactive map comparing the locations of trees planted by City Plants program-wide from 2014-2020 versus trees distributed (adopted, delivered, and street) by the Tree Ambassador Pilot Program. The interactive map consists of the following layers: ***TA Pilot Trees***, ***City Plants Trees***, ***TA Home Zip Codes***, ***CalEnviroScreen 4.0 Scores***, ***UFEC Priority Zones***, and ***Urban Heat***.

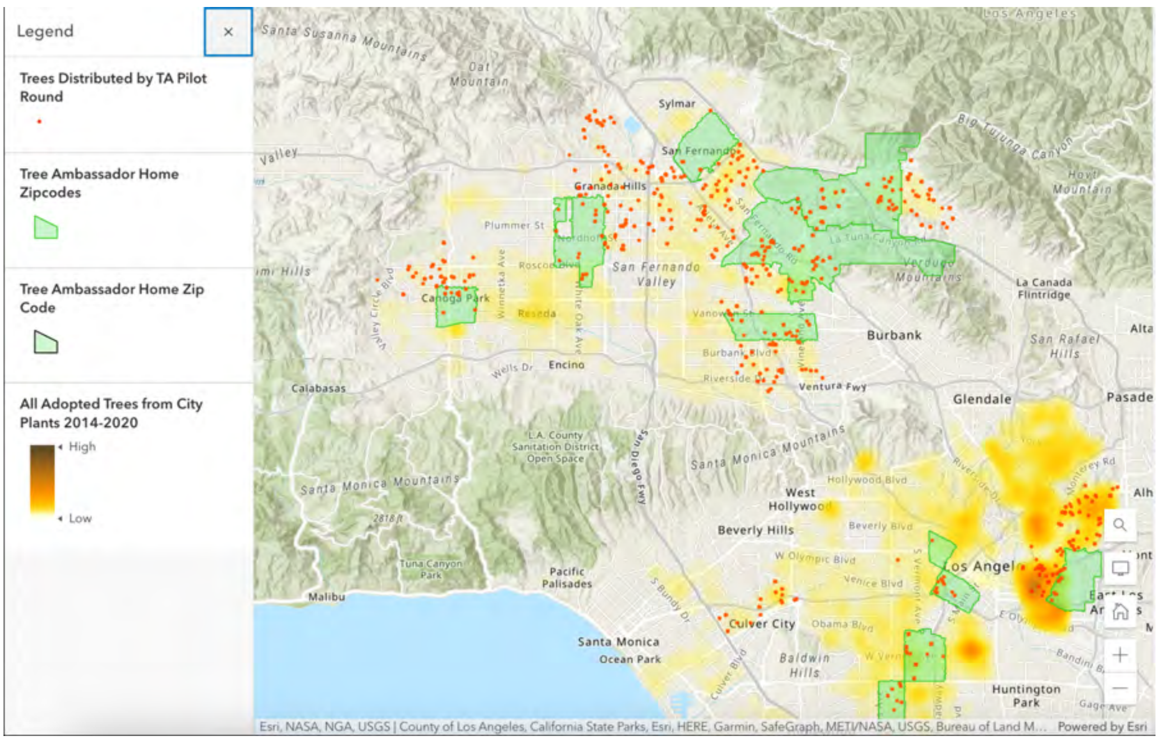


Figure 7-5. Tree Ambassador and City Plants Tree Locations Compared to Urban Heat, Priority Communities, & CalEnviroScreen 4.0 Scores. The image shows a screenshot of an interactive, web-based map depicting trees planted by both the Tree Ambassador (TA) Pilot Program, as well as trees planted by City Plants as a whole. These points are displayed alongside urban heat data, TA home zip codes (the areas where Ambassadors live), CalEnviroScreen 4.0 scores by census tract, and UFEC priority census tracts. This map compares the locations of trees planted by City Plants as a whole (depicted as a density cloud when zoomed out) vs. trees planted specifically through the TA program (red points).

"Trees distributed by TA Pilot Round" includes all adopted and delivered yard trees as well as all delivered street trees from the TA pilot round. "Adopted Trees from City Plants 2014 - 2020" includes all City Plants trees that have been adopted outside of the TA Pilot Program.

7.2.3. Statistical Analysis

Distribution Method	Total # Trees	# Trees in UFEC Census Tracts	% Trees in UFEC Census Tracts	# Trees in DAC Census Tracts	% Trees in DAC Census Tracts
Adopted	647	78	12.06%	326	50.39%
Delivered	772	21	2.72%	278	36.01%
Street	36	7	19.44%	26	72.22%
Grand Total	**1455**	**106**	**7.29%**	**630**	**43.30%**

Table 7-1. Urban Forest Equity Collective and Disadvantaged Communities Statistics Summary. This table showcases the number and percentage of Tree Ambassador distributed trees within UFEC priority and DACs census tracts.

Distribution Method	Total # Trees	Overall CalEnviroScreen 4.0 Score Avg	Pollution Burden Avg	Poverty Avg
Adopted	647	42.42	53.63	36.26
Delivered	772	36.41	50.20	30.73
Street	36	45.29	55.07	43.27
Grand Total	**1455**	**39.30**	**51.85**	**33.50**
	Overall City Avg:	25.91	52.89	26.54

Table 7-2. CalEnviroScreen 4.0 Score Statistics Summary. This table showcases average CalEnviroScreen 4.0 (CES 4) scores, including pollution and poverty burden, of where TA trees have been distributed within the City of LA vs. overall average scores for the City. CES 4 scores are calculated based on census tract (overall pollution burden multiplied by population characteristic score). Scores are on a scale of 0-100, with 100 being the highest exposure to environmental burden and risk. For analysis of TA tree distribution, scores are calculated based on the amount of trees distributed within tracts in the City of LA. Tree scores are then compared to overall scores for the City of LA.

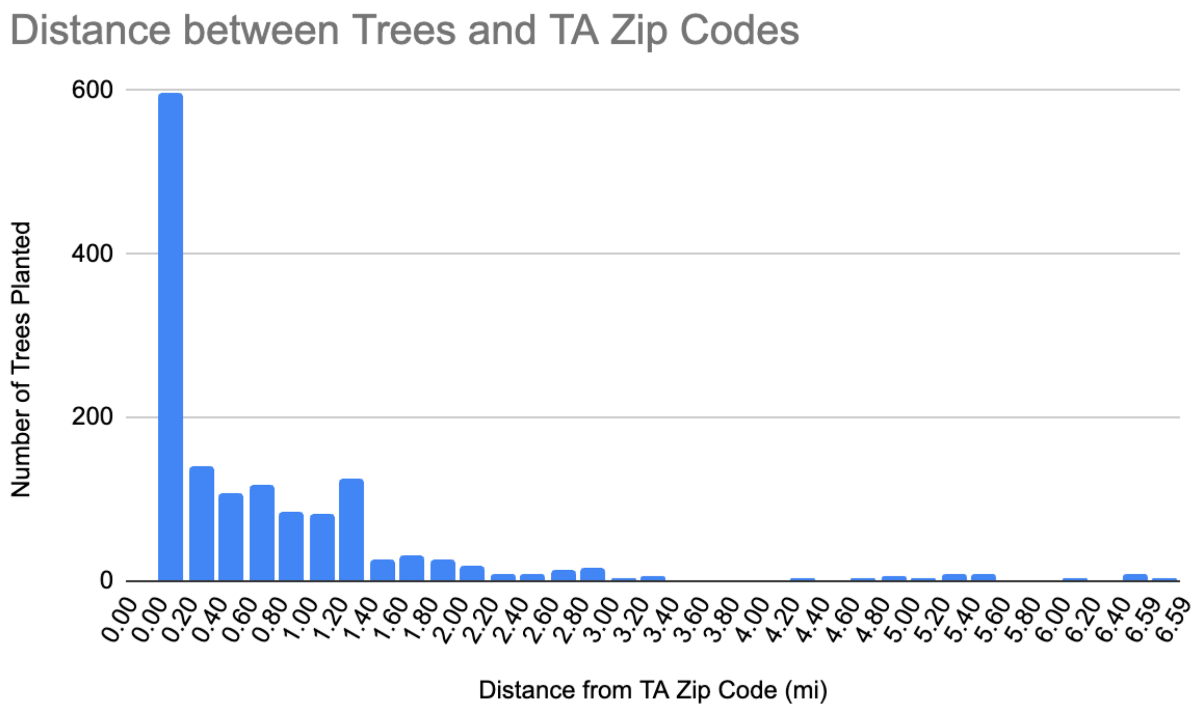


Figure 7-6. Proximity of Tree Ambassador Trees to Tree Ambassador Home Zip Codes. This graph shows the amount of all Tree Ambassador Pilot Program trees planted within a certain distance to TA home zip codes. TA home zip codes are the zip codes of the neighborhoods where Ambassadors were from, but does not distinguish which Ambassador was from which zip code. The x-axis depicts miles from home zip codes, while the y-axis shows the number of trees within that selected distance.

Distribution Method	Average Distance (mi)	Median Distance (mi)
Adopted	0.642	0.245
Delivered	0.888	0.533
Street	0.208	0.056
Grand Total	**0.762**	**0.384**

Table 7-3. Proximity of Tree Ambassador Trees to Tree Ambassador Home Zip Codes Summary Statistics. This table showcases average and median distances among TA trees with respect to TA home zip code. The average mile distance is 0.762 from TA zip codes, whereas the median is 0.384 miles.

Distribution Method	Total # Trees	Avg % Hispanic Pop	Avg % White Pop	Avg % African American Pop	Avg % Native American Pop	Avg % Other/Multi Race Pop	Avg % AAPI Pop
Adopted	647	56.04	27.78	6.15	0.17	2.21	7.65
Delivered	772	47.60	33.82	4.56	0.17	2.29	11.57
Street	36	59.58	28.61	2.42	0.06	1.56	7.77
Grand Total	**1455**	**51.65**	**31.00**	**5.22**	**0.17**	**2.23**	**9.73**
Overall City Avg:		47.64	29.09	8.25	0.16	2.69	11.67

Table 7-4. CalEnviroScreen Score Race Statistics Summary. This table showcases demographic percentages, as calculated within the CalEnviroScreen Score 4.0 Framework, with respect to distributed TA trees, vs the overall average demographic percentage for the City of LA. For the analysis of the TA tree distribution, percentages are calculated based on the amount of trees distributed within City of LA census tracts. Percentages are then compared to overall demographic values for the City of LA.

The average population from all census tracts that TA trees are located in is roughly half (or 51.65%) Hispanic, compared to the city average of 47.64%. These census tracts are on average 31% white, 9.73% Asian American Pacific Islander, 5.22% African American, 2.23% Other/Multi Race, and 0.17% Native American.

Demographic values are higher for TA-distributed trees than the city averages for Hispanic, White, and Native American populations. The most notable difference is among the Hispanic population with a difference of 4.01%. Otherwise, the African American, Other/Multi Race, and AAPI populations have lower percentages compared to the average city values. The largest difference is among the African American population with a decrease in 3.03%.

Distribution Method	Total # Trees	Avg Excess Rate	Median Excess Rate
Adopted	647	2.35	2.4
Delivered	772	2.27	2.2
Street	36	2.13	1.9
Grand Total	**1455**	**2.30**	**2.2**
Overall City Avg		2.94	1.8
Overall City without Outliers		1.98	1.8

Table 7-5. Excess ER Visits due to Heat in Zip Codes where TA trees were planted. This table showcases excess ER visits due to heat in zipcodes where TA were planted, in comparison to the overall city excess ER visit rate.

Zip Code	# Excess Visits	Rate Excess Visits
91504	4	77.4
91606	9	66.6
90290	1	17.4

Table 7-6. Outliers for Excess ER Visits due to Heat in Zip Codes where TA trees were planted.

Distribution Method	Average TCC (%)	Number of TA Trees in BGs with < 20% TCC	Percent of TA Trees in BGs with < 20% TCC
Adopted	20.60	349	53.94
Delivered	21.85	317	41.06
Street	17.95	20	55.56
Total	**21.20**	**686**	**47.15**
Overall City	19.13		62.90

Table 7-7. Tree Canopy Coverage of TA Tree Plantings by Census Block Groups. This table showcases the average Tree Canopy Coverage (TCC) relative to individual census block groups (BGs) of where TA trees were planted. These values are then compared to the overall TCC city values.

Distribution Method	Census Block Group Tree Canopy Coverage				
	< 30%	< 25%	< 20%	< 15%	< 10%
Adopted	559	498	349	160	35
Delivered	663	561	317	138	22
Street	36	32	20	9	4
Total	**1258**	**1091**	**686**	**307**	**61**

Table 7-8. Number of TA trees planted in Low TCC Census Block Groups. This table showcases the number of TA trees planted in census block groups (BGs) that have low tree canopy coverage (TCC).

Distribution Method	Census Block Group Tree Canopy Coverage				
	< 30%	< 25%	< 20%	< 15%	< 10%
Adopted	86.40%	76.97%	53.94%	24.73%	5.41%
Delivered	85.88%	72.67%	41.06%	17.88%	2.85%
Street	100.00%	88.89%	55.56%	25.00%	11.11%
Total	**86.46%**	**74.98%**	**47.15%**	**21.10%**	**4.19%**

Table 7-9. Percent of TA trees planted in Low TCC Census Block Groups. This table showcases the percentage of TA trees planted in census block groups (BGs) that have low tree canopy coverage (TCC).

7.3. Discussion

7.3.1. Program Success in Planting in Disadvantaged Neighborhoods

One of the TA Pilot Program's goals was to increase canopy coverage in disadvantaged communities. We focused on where program trees had been planted in relation to heat-burden, tree canopy coverage, and census tracts designated as DACs or UFEC priority zones.

We found that while the Tree Ambassador Pilot Program was somewhat successful in getting trees planted in heat burdened, low-canopy, disadvantaged communities, there is further room to increase the presence of trees and City Plants programming in these areas. Future rounds of the TA program could target the census tracts that fall under the metrics we used for this study.

7.3.1.1. Heat Burden

The overall average excess ER visit rate for TA tree zip codes was 2.30, which is smaller than the average City value of 2.94. The median excess rate for zip codes containing TA trees of 2.2 is larger than the city average of 1.8. Three outliers were also observed and had values well out of range, which can be seen with values for overall average excess rate (1.98) and median excess rate (1.8) (Table 7-6). These varying results suggest our research was inconclusive on whether trees were planted in more heat burdened census tracts, and that perhaps the rate of excess heat-related ER visits is not the best proxy for measuring heat burden.

7.3.1.2. Disadvantaged Communities (DACs) and UFEC Priority Zones

The TA program was moderately successful in getting trees planted in DACs and only slightly successful in getting trees planted in UFEC priority zones. Less than half (43.30%) of all TA trees were distributed within DACs census tracts, with 50.93% of these being adopted, 36.01% being delivered, and 72.22% being street trees. An even smaller portion was distributed to UFEC priority zones, with only 7.29% of total TA trees planted here. Of these, 12.06% were adopted, 2.72% were delivered, and 19.44% were street trees. Adopted trees had the highest number of trees in DACS and UFEC areas. However, street trees had the highest percentage located in UFEC and DACS census tracts (Table 7-1). While this data seems to suggest the TA program was more successful at planting trees in DACs than in UFEC priority areas, it must be noted that the number of census tracts qualifying as DACs far exceeds those designated as priority zones (Fig 7-2).

7.3.1.3. CalEnviroScreen 4.0 Scores

CES 4 scores for census tracts where trees were planted were compared to average CES 4 scores for the City of LA itself. Trees appear to be planted almost exclusively in census tracts with higher CES 4 scores (Fig 7-3). The City of LA has an overall average CES 4 Score of 25.91, whereas overall TA tree distributions have an average score of 39.30, indicating that a portion of trees are being planted in burdened areas, but areas that are significantly less burdened compared to the overall score range. Street trees and adopted trees make up the majority of this value. Pollution burden, on the other hand, has a lower score average for TA trees of 51.85 versus the City average of 52.89, a difference of 1.04. A score of 51.85 is considered moderately high, meaning that trees are located in areas with noticeably higher environmental pollution and burden. TA trees distributed in the City of LA have a poverty score of 33.50, meaning that they are located in areas with relatively low poverty burden compared to the overall score range. In comparison to the overall average for the City of LA, which is 26.54, the value is higher, indicating that the trees are distributed in areas with somewhat higher poverty rates than the City average (Table 7-2).

7.3.1.4. Tree Canopy Coverage

In regards to current tree canopy cover (TCC), the TA program was moderately successful in getting trees planted in low-canopy areas. Total average TCC percentage for block groups (BGs) containing TA pilot round trees was 21.20%, a value that is 2.07% higher than the overall City average (19.13%). Total tree count within block groups that had a TCC of less than 20% was 686, with adopted trees making up the largest piece. The total percentage of TA trees in block groups with tree canopy less than 20% was 47.15%, with the overall City average being 62.90% (Table 7-7). This analysis shows that TA trees were planted in census block groups that already had similar average tree canopy coverage to the City of LA as a whole. Almost half of all TA trees were planted in census blocks that had less than 20% canopy coverage.

1258 TA pilot trees (86.46% of all TA trees) were planted within BGs with less than 30% TCC. 1091 TA trees, or 74.98% of TA pilot trees, were planted in BGs with less than 25% TCC. 307 trees, or 21.10% of all TA trees, were planted in BGs that had less than 15% TCC. Lastly, 61 trees, equivalent to 4.19% of all distributed TA trees, were planted in BGs with less than 10% TCC (Tables 7-8, 7-9).

If we use the LA City average tree canopy coverage (around 20%) as the distinguishing value between areas with higher canopy coverage (>20%) and areas with lower canopy coverage (<20%), the TA program was moderately successful in getting trees planted in areas with lower tree canopy (Table 7-7). However, it was not very successful in getting trees planted in block groups with the lowest (<10%) amount of tree canopy (Tables 7-8, 7-9).

7.3.2. Analysis of Community Model Success

Our analysis shows that TA trees were indeed planted in proximity to TAs' home zip codes. Figure 7-6 shows that of 1,455 total trees, 602 (or 41%) were planted within 0.2 miles of a TA home zip code. 1200 were planted within 1.6 miles. Clearly, the Tree Ambassador Pilot Program was successful in getting trees planted near and within TA home neighborhoods, aligning with the program's goal for TAs to benefit their own communities. This indicates that the place-based, community-leader model and framework of the TA Pilot Program was highly successful.

7.3.3. Suggestions for Future Work

Many different organizations being involved in the TA Pilot Program meant that data collected by TAs was done so in a non-standardized format. For example, data on which TA was from which zip code was not collected, introducing a level of uncertainty to our analysis of community model success. While we assumed that trees planted closest to a TA home zip code were planted by the TA from that zip code, it is possible that this was the work of a different TA altogether. Future iterations of the program should collect this data for individual TAs, and a future study could run this analysis again with improved accuracy.

In addition to the distance between TA home zip codes and final planting location, analyzing the spatial relationship between tree adoption events and the final planting location of the adopted trees could be valuable. As tree adoption events are held at a single location, it's comparatively easy to calculate the distance between the adoption event and final tree planting location (or at least, easier than calculating the distance from an entire zip code). This information would allow for more precision in targeting low-canopy areas in the future.

Additional demographic analysis could also prove helpful in identifying where the TA program could be improved. Land parcel information, home ownership status, and income information could potentially reveal who is (and isn't) adopting trees from the program. The **TA Pilot Year** shapefile currently has land parcel zoning and home ownership status joined to each tree, but we were unable to conduct further analysis due to time constraints. In addition to land parcel zoning, the census tract of each tree is joined in the **TA Pilot Year** shapefile, so income or other census information could also be added in the future.

8 - Interviews with Local Officials on Urban Greening

8. Interviews with Local Officials on Urban Greening

8.1. Methods

The original research question from the client was "What existing codes facilitate or hinder greening, especially in neighborhoods lacking trees and planting spaces?" Over the course of the project, and with guidance from our advisor and client, we changed the focus from studying codes that promoted or discouraged urban tree canopy to instead focus on the experiences and opinions of city and county officials related to urban greening. Our revised research question became "What factors either hinder or support closing LA's urban forest equity gap, and how do Los Angeles city and county policy-makers perceive those factors?"

Our primary focus with this research question was conducting interviews with city officials about the processes in which policies are drafted towards the protection of trees in underrepresented, low-canopy neighborhoods. An additional focus was potential codes relevant to the urban forest that are currently in the process of being created or that have previously been implemented. This involved investigating responsible jurisdictions, costs, funding sources, design, and community involvement in each specific case. The deliverables include a table of the general themes expressed by the interviewees, along with direct quotes that reveal interviewee experiences and sentiments related to urban forest equity. We detail our findings along with suggestions for tree stewardship programs that include both direct practical changes within as well as areas of focus on the city level for changes beyond the Tree Ambassador program.

8.1.1. Outreach

From a group of 60+ potential interviewees, we narrowed the list to 30 organization leaders and local government representatives, including several councilmembers representing Tree Ambassador neighborhoods. We ultimately scheduled seven successful interviews. Before reaching out to contacts via email, we familiarized ourselves with their general job responsibilities, and, to the extent possible, their stance on urban forest equity, with the understanding that they may have differing values and opinions. We also became familiar with specific tree planting cases that made exceptions to standard planting procedures (such as bus bumps, remodeling of sidewalks, etc.).

8.1.2. Interviews

Throughout the outreach process, our audience expanded from city officials to a wider audience of county, state, and nonprofit representatives. We tailored the questions to each interviewee and developed a list of questions covering a wide range of discussion topics, including:

- Are tree planting cases more likely to follow a standard design, or have there been exceptions to a standard for specific cases?

    - How does existing city policy (ordinance, municipal code, etc.) aid or hinder this exemption?
    - Are these projects tied to other city-wide initiatives, such as the Mobility Plan, Resilience Plan, Vision Zero, etc.?
- Are there more examples of these exemptions and interventions?
- Do current plans exist with the purpose of promoting urban canopy cover in underrepresented areas?
- How is this program able to get funding from the city? Was this support initiated by residents?
- If you've been involved in the process of expanding city code to allow for more of these types of cases, can you tell me about the process? Is there any hesitancy when it comes to making such code or design changes (i.e. costs, pushback from community, etc.)?
- Do you see any low-hanging fruit for new city codes or standards that may allow for these tree plantings in densely developed areas with low tree canopy to become more common, or standardized in any way? In other words, are there any changes you believe could be on the horizon which would help areas with low tree canopy to support more trees?

In administering these interviews, we partnered with Krystle Yu, a UCLA Urban and Regional Planning master's student doing a related project with City Plants for the LA Urban Forest Equity Collective (UFEC). Her final report will discuss related aspects.

8.2. Results

Table 8-1. Interviewee Perspectives on Urban Forestry in Los Angeles. Prominent themes that emerged in interviews with city, county, state, and nonprofit organization leaders are compiled here. The quotes were taken directly from our interviewees and were specifically highlighted for expressing significant sentiments about the process of promoting urban forest equity.

Theme	Representative quotes
Approach to maintenance accountability	*"And so when the grant money is gone, when the trees are planted, and the establishment watering is happening, what we're not building into that, or able to follow on with is that kind of check in"* *"There's not really that sort of making sure folks are doing what they said they would do"* *"And my opinion and the opinion of CalFire is that trees in public spaces should have public maintenance. So the street trees are actually more appropriate to be planted and maintained by a municipal entity."* *"San Francisco was similar to Los Angeles where they assigned that responsibility to adjacent property owners, and they decided this is not getting the results that we want. So they put a bond measure out for the voters, they passed a $20 million a year tree maintenance program in San Francisco, and Los Angeles is looking to do something similar."*
Value of trees outside of anthropogenic needs	*"Or are there other considerations besides shade, you know, which is a big driver of why we plant trees … but there are other benefits that could be derived from those trees … it's still going to provide ecosystem benefits, and so is a substandard sort of shade opportunity, a reason to not plant at all?"* *"And in public health, we would say let's look at the whole … we're interested in getting as many trees in the ground as possible."* *"You cannot assume that everyone has the same baseline understanding, or appreciation or recognition of the place that we live in. There are very, very varied ethics that people hold, some of which are anthropocentric and ecocentric."* *"Framing … the importance of the fact that we're located within one of 36 global biodiversity hotspots … the work that we're doing here locally is not just even for our own local benefit … LA is extremely important on a global and on a planetary type of a global level as well."*

Role of private property owners in advancing urban forest equity	*"Because typically 80% or so of the land base of a municipal area is owned by numerous private property owners. So the government is not well positioned to assist private property owners that may be low income, or need technical assistance … to plant and maintain the urban forest that is on that 80% of the land base."* *"Land use regulations on private property could potentially assist in minimizing the degradation or disturbance of those ecosystems"*
Rigidity of width/distance requirements for streets and sidewalks	*"Our guidelines for where you can plant are more restrictive than others …when we say you've got to be 20 feet away from the nearest fire hydrant … can you imagine if we just changed that one requirement? How much more space that might open up? … new, potentially feasible planting locations."* *"The city has this really archaic street widening policy where … the city wants to standardize its street width … if you're a developer that knocks down a building, you have to pay to widen the street in front of your building by 5 feet … this often results in cutting down trees, because what is in between those 5 feet? It's often trees."*
Alternatives to trees for shade	*"Are there occasions where you simply could not plant a tree? Yes … the law requires that we give folks 18 inches or 24 inches … fair enough … So what do we do? We think about shade structures, we innovate, we look at all the innovation people have done, like this is an opportunity for a the county to open our minds to some of the shade structures that you know, the city of LA has piloted some at bus stops there's design students all over the world that are coming up with ways to provide shade in constrained places."*
Potential strategies to avoid infrastructure damage	*"I think there are design strategies and arboreal strategies specific to avoiding infrastructure conflicts, and … as far as I know, in LA County, we have yet to implement those, we have yet to go beyond tree selection in trying to limit infrastructure conflicts"*
Concept of combining siloed City/County departments	*"I would restructure things, so the department of transportation can actually build a curb or basic basic things that impact our streets. If you merged the Bureau of Street Services and Los Angeles Department of Transportation to a single DOT that had the ability to repave and do concrete work, then you can zoom out and say, let's have a holistic 5 or 10 year plan on how we're going to improve our streets."*
Feasibility of urban forest canopy goals	*"Last year, there was legislation adopted that now requires the state of California to increase tree canopy cover in urban areas 10% by 2035.*

	That is a very optimistic goal. Honestly, I don't know how we're going to do it.” *“The positions aren't funded. The city doesn't have a work plan that I've seen that actually will complete the goals. It's great to have goals. … but if you don’t provide the funding and make sure departments are hitting the goals … I feel like that's where the Green New Deals are.”*
Funding opportunities on the horizon	*“You know, so that's changing. I think the policies are changing, public sentiment is changing. Funding Opportunities are emerging. That's all good and new and happening now.”* *“I hope that one day, the city of Los Angeles can look at trees as infrastructure. Because that's the way that I see it, and I actually see it as some of our most important infrastructure … I would change the perception … for people to really wake up to look at our urban forest as an enormous part of our infrastructural systems here in the city.”*

8.3. Discussion

After analyzing the themes that were brought up in the interviews, we compiled a mix of perspectives and strategies related to urban tree planting and urban forest equity. Before diving into this theme analysis, it is important to preface that a portion of our interviewees had no direct influence on the city level, and instead held positions within county, state, or nonprofit organizations in or surrounding the City of LA. As such, these perspectives may not be directly representative of work currently being done in the City of LA to expand urban forest planting opportunities.

One recurring theme that was mentioned during interviews was the idea that placing the responsibility of street tree maintenance on residents can be successful in some cases, but may not guarantee that proper tree maintenance is followed long term. A representative from the Los Angeles Department of Public Health (LADPH) stated that when it comes to ensuring street tree adoption programs like the Tree Ambassador (TA) program maintain healthy trees, “what we're not building into that or able to follow on with is that kind of check in.” While the TA program significantly helps streamline the process for permitting street trees, it would undoubtedly benefit from a check-in process in which residents are incentivized to respond and follow through with their agreed watering responsibilities. It is also important to note that there have been less requests for street trees compared to adopted or delivered yard trees, possibly due to the hesitancy of committing to watering a tree along the street, rather than on one’s own property.

This begs the question: If residents do not want to water a street tree, who should? One option is to delegate street tree maintenance responsibility to city departments which currently manage related infrastructure. A representative from the California Department of Forestry and Fire Protection (CAL FIRE) stated, "my opinion and the opinion of CAL FIRE is that trees in public spaces should have public maintenance. So the street trees are actually more appropriate to be planted and maintained by a municipal entity." In addition, when referring to the street tree maintenance responsibilities in San Francisco, they added, "[San Francisco] decided this is not getting the results that we want. So they put a bond measure out for the voters, they passed a $20 million a year tree maintenance program in San Francisco," later stating that Los Angeles has plans to do something similar in the near future. This knowledgeable perspective should urge the City of LA to dive deeper into researching the relative benefits and costs of granting street tree maintenance responsibility to street-linked departments in the City (Streets LA, etc.). City Plants may want to pilot this model in select neighborhoods to determine whether alleviating watering burden on residents improves street tree health.

A surprising finding is that laws designed to protect native plants in the area may restrict growth of the City's urban forest. One ordinance that aims to directly protect the native ecosystem of the County of Los Angeles is the Oak Tree Ordinance (1988), which prohibits anyone without a permit to damage, cut, or destroy any oak tree (Los Angeles County, 1988). Similarly, the Protected Tree Species Code (2006) on the City level defines a handful of Southern California indigenous plant species. This code additionally lays out the process of permitting and replacing these trees and bushes, which are also required to be roughly the same size as the plants they are replacing (City of Los Angeles, 2006). The narrow protections for native tree species established in this ordinance and code may hamper planting *of* these species out of concern for violating these laws. When asked about any potential hindrances or pitfalls that result from any street tree-related policy, a representative from the Los Angeles County Chief Sustainability Office mentioned that they have observed residents hesitating to plant oak trees covered by the County Oak Tree Ordinance due to these rigid conditions. While the Oak Tree Ordinance and Protected Tree Species Code serve as effective mechanisms in the preservation of local ecosystems, they may inadvertently delay the expansion of the urban forest.

A few interviewees alluded to the theme of private property being at the forefront of the urban forest canopy movement. Specifically, how regulations on vegetation type on private property in residential areas can impact LA's urban forest. One such regulation is the City of LA Wildlife Ordinance (2021), which explicitly lists "preferred" and "prohibited" plants in small to large residential developments within the Wildlife District Boundary that encloses the Santa Monica Mountains. Additionally, the ordinance requires that any tree that is cut down must be replaced by two trees from the "preferred" vegetation list. One interviewee, a representative of the City of LA, agreed with this policy and stated that "land use regulations on private property could potentially assist in minimizing the degradation or disturbance of those ecosystems." The narrow focus on "preferred" tree species may prevent the planting of non-preferred species that may otherwise have been planted, if private property owners in the area had more flexibility in tree selection on their property.

Although the Wildlife Ordinance only covers a specific area within the Santa Monica Mountains, private property owners still play an important role wherever they may reside. The representative from CAL FIRE shared that about 80% of land in a municipal area is privately owned. However, this representative assumed that local government is not well positioned to assist low income private property owners through technical support in planting and maintaining the urban forest to the extent that is necessary. They concluded with, "I would say … emphasis on private property owners is appropriate." Given this insight on the importance of private property in expanding the urban forest, it is vital to maintain a relationship with low income private property owners through the technical support and guidance the Tree Ambassador Program offers.

The City of LA has strict infrastructure regulations, many of which directly affect vegetation in public spaces, such as minimum/maximum street and sidewalk width requirements. The "Local Street Standard" section of the City of Los Angeles Complete Street Design Guide stipulates that streets and sidewalks must remain at 18 feet and 12 feet wide, respectively (City of Los Angeles Department of City Planning, n.d.). A representative from LADPH shared their impression that City of LA street tree planting guidelines were more restrictive than others, claiming that, if this policy were more flexible, there would be "new, potentially feasible planting locations" in neighborhoods that may be overlooked as being too impervious.

In addition to these rigid street standards, we acknowledge that initiatives to widen streets may also be a barrier to reaching urban forest canopy goals. The representative from Streets for All recalled that "the city has this really archaic street widening policy where . . . the city wants to standardize its street width" through the default expansion of streets by 5 feet in front of newly redeveloped buildings that developers must pay for, reducing sidewalk space and thus removing opportunities for tree plantings. However, in early 2023, Councilmembers Nithya Raman, Bob Blumenfield, and former Councilmember Mike Bonin authored a motion to set up a process for city departments to discuss how to end road widening, though the motion itself does not end this practice (Linton, 2023). This motion serves as a step towards expanding the urban forest canopy by preventing the shrinking of sidewalks in the City of LA, where space may often already be too little to plant more trees.

Another factor is the minimum parking requirements throughout the region, which may correlate to a constraint on street tree planting locations. Given that 14% of Los Angeles County's unincorporated land is committed to parking, minimum parking requirements encourage reliance on personal automobile use, which contradicts the City of LA's aim to expand public transit (Chester et al., 2015). It is important to note that the County has pushed for sufficient off-street parking investment, in the form of parking lots and structures, to minimize congestion in public on-street parking, especially in coastal and recreational areas (Los Angeles County, 2019). In spite of this County level effort, the current minimum on-street parking requirements leave little to no room for new tree well infrastructure such as bulbouts. A remedy can be to replace the minimum on-street parking requirements with maximum quotas for on-street parking that accommodate for tree plantings in the public right of way. A hypothetical example would allot street space for a certain number of bulbouts per block. Coordination between the City of LA and County of LA would smooth this policy transition.

Indeed, some leaders expressed that improved collaboration among local governments would help free up sidewalk space for tree planting. The representative from

Streets for All stated that “the real big challenge for all of us is how siloed the city is when they look at a street to do improvements.” They then mentioned how rare it is for many departments (like the Bureau of Engineering, the Bureau of Street Lighting, or the Urban Forest Department) to come together to fulfill one holistic project. As a result of missed opportunities for interdepartmental collaboration, bike lanes may lack proper shade and sidewalks may have enough shade but lack sufficient space. To resolve this issue, the representative mentioned that they would “restructure things so the Department of Transportation can actually build a curb or do a curb cut or basic, basic things that impact our streets.” They expressed that if the City and County were to merge the Bureau of Street Services with the Department of Transportation, the joint department could create a holistic five or 10 year plan to improve streets more efficiently.

The interviewee also gave an example of an instance where interdepartmental collaboration did occur: the establishment of plans in Eagle Rock to increase public transit infrastructure through the specific dedication of bus-only lanes in addition to tree plantings via the Beautiful Boulevard project. While some projects like Beautiful Boulevard in Eagle Rock took off, the representative from Streets for All made it very clear that this kind of collaboration happens on a case by case basis, stating that “this was the exception, not the rule.” There is no standard procedure for these collaborations, according to this representative.

They also mentioned an example of a failed collaboration. The example was Uplift Melrose, which aimed to increase sidewalk expansions, tree plantings, outdoor dining, bike lanes, and public transit along Melrose Avenue. Despite overwhelming support for the project, plans for Uplift Melrose were cut short. The decision to cut the project came after immense pushback from departments like the Los Angeles Police Department (LAPD), which dismissed the designations of bike lanes with the notion that few people use them and that they pose a threat to bicyclists riding near oncoming traffic. In addition, there were concerns that narrower roads, pinch points, curb extensions, and raised sidewalks would reduce lane space, and thus decrease LAPD response time (Linton, 2020).

On the bright side, requirements exist to maintain and expand the urban forest canopy. One example on the City level is the tree replacement and planting in-lieu fee, which instills a fee collected by the Board of Public Works ranging from $1,945 to $2,612 for the replanting and maintenance of any replaced tree (City of Los Angeles, 2018). The City of Palo Alto can also exemplify tree canopy requirements for the City of LA. The representative from CAL FIRE noted that Palo Alto’s No Net Loss/Increase in Canopy Cover goal exemplifies a similar way to preserve urban forest canopy. According to this representative, “if an applicant for a permit can't plant the trees on their own property, there should be a mechanism for them to plant the trees elsewhere . . . so it's not to prohibit development, but it's to have development occur in conjunction with improving urban forest for the benefit of the people.” In addition, Palo Alto requires that 50% of a parking lot’s surface be shaded (City of Palo Alto, 2020). While this requirement has traditionally been fulfilled through planting trees, developers have expressed interest in fulfilling this requirement with solar panels (Humble, 2019). This shift may be significant given the unique co-benefits provided by large trees, in addition to shade (see section 3.1.1.).

Nonetheless, there is significant skepticism that the City of LA will reach its urban canopy goals. One interviewee mentioned that while "there was legislation adopted that now requires the State of California to increase tree canopy cover in urban areas 10% by 2035," this was an optimistic goal, adding, "I don't know how we're going to do it." When asked about the feasibility of these urban canopy goals, another interviewee stated that "Positions aren't funded. The City doesn't have a work plan that I've seen that actually will complete the goals. It's great to have goals . . . but if you don't provide the funding and make sure departments are hitting the goals . . . I feel like that's where the Green New Deals are." Yet another source of doubt stems from the current City Administration's lack of focus on the topic, as another interviewee stated that they are "still very uncertain given our current and new administration, whether or not that's going to be a priority moving forward or not . . . since it's not been a very large platform or talking point of our current administration." Ironically, such doubt and skepticism may impede efforts to achieve the urban canopy goals set out by the State of California and the City of LA.

In spite of these barriers to urban greening, there remains the common sentiment that change is on the horizon, with one interviewee stating, "I hope that one day, the City of Los Angeles can look at trees as infrastructure. Because that's the way that I see it, and I actually see it as some of our most important infrastructure . . . I would change the perception . . . for people to really wake up to look at our urban forest as an enormous part of our infrastructural systems here in the city." In support of this sentiment, many health care companies, like Kaiser Permanente, are investing millions of dollars to preserve parks for the human health benefits and monetary value that trees in parks provide (Matthew, 2017). Finally, it is necessary to point out State funding opportunities, as CAL FIRE has announced $117 million to help lessen the impacts of climate change for traditionally underserved communities and education (Lyle, 2023). The representative from CAL FIRE ended their interview by saying, "I think the policies are changing, public sentiment is changing. Funding opportunities are emerging. That's all good and new and happening now."

8.3.1. Urban Forest Policy and Financing Recommendations from San Francisco's Friends of the Urban Forest

Due to its longevity and similarly-aligned work, we contacted Friends of the Urban Forest (FUF), an urban tree planting nonprofit that has been in operation in San Francisco (SF) since 1981 (Friends of the Urban Forest, n.d.). We interviewed FUF representative Dr. Bunny McFadden about the various struggles and successes the organization has faced with street tree planting and maintenance.

In contrast to the City of LA, where residents must water street trees, the City of SF takes responsibility for street tree maintenance and surrounding sidewalks. This is due to Proposition E, which shifted these responsibilities from private property owners to the City of SF. This proposition allocates $19 million a year from the SF general fund for this purpose, the cost covered by a "progressive" parcel tax. Proposition E was passed in November 2016, with 78.59% of voters voting yes (Ballotpedia, n.d.). FUF was highly involved with developing this policy and a long-term urban forest plan, as well as mobilizing community organizers and other organizations in support of this proposition (B. McFadden, personal communication, May 25, 2023).

Interestingly, street tree care had been the responsibility of the City of SF until 2012 (Ballotpedia, n.d.). Dr. McFadden noted that once responsibility for street tree maintenance was handed over to private residents, tree health declined. Once tree care was given back to the city, and especially with help from a host of other collaborating organizations, tree health improved (B. McFadden, personal communication, May 25, 2023).

FUF's experiences highlight the importance of city responsibility in caring for urban trees and the manner in which urban forest health outcomes are tied to who is responsible for the care of public trees. While City Plants programming and the Tree Ambassador program follow a community-based tree stewardship model, SF's example warrants consideration of how LA might garner political support for funding that would allow the City of Los Angeles to take on more tree care responsibility.

Dr. McFadden offered insights about how LA might advance an effort like SF's Proposition E. Among these insights is the need for a policy that would work both now and in the long-term. Residents frustrated with poor maintenance may be hesitant to add even more maintenance work to the city. This feedback should be incorporated into any potential proposition for Los Angeles (B. McFadden, personal communication, May 25, 2023). Following the *First Steps Toward an Urban Forest Management Plan* report in 2018, City Plants secured grant funding to conduct *LA's Urban Forest Financing Study* in 2022, using San Francisco's Proposition E as a model and case study. This forthcoming report, currently under review before publication, has two central aims: first, identify how much funding is needed to manage the City of LA's urban forest at best management practice levels, and second, identify potential financing mechanisms to meet that budget gap. The report is slated for release in late 2023.

8.3.2. Suggestions for Future Work

Though having the opportunity to interview people with roles at different involvement levels provided an important perspective on the state of urban forest equity in the City of LA, we were only able to get a limited insight on the work that directly leads to code changes.

We recommend an empirical comparison of street tree health and resident perception of street tree health when street trees are watered by residents and when watered by the City of LA. We advise that, in select neighborhoods where City Plants and/or the TA program already operates, City Plants pilot the transfer of watering and tree care duties to relevant departments of the City of LA—these will be the experimental neighborhoods. Other neighborhoods that City Plants serves should be designated control neighborhoods, meaning that their street trees will continue to be watered by residents during the pilot. The pilot should ideally span at least two seasons to be able to observe any differences in tree health over time with seasonal temperature and precipitation variations. One of these seasons should be summer to observe tree health in the absence of rain. Observations of tree health can follow the methodology developed through our tree health assessments (section 6.1). During the pilot, residents in both experimental and control neighborhoods can be polled on their perception of the health of street trees in their communities. Those who have received street trees or private property trees from City Plants can be polled via email. To capture the opinions of other residents, we recommend conducting in-person intercept surveys with questions similar to the ones in our surveys (section 5.1). Both tree health data and resident opinion data can be collected by City Plants employees, possibly Tree Ambassadors themselves. Graphical analyses of these data will help visualize any trends and can be based on the graphs displayed in sections 5.2 and 6.2 of this report. With these graphs in hand, City Plants will be able to compare the success of piloting watering by the City of LA to that of watering by residents. Depending on pilot results, City Plants may be able to make the case for a proposition that funds partial or full transfer of these duties to relevant departments of the City of LA.

9 - Conclusion

9. Conclusion

9.1. Summary of Results

The City of Los Angeles' urban forest is unevenly distributed with significantly lower tree canopy coverage in low-income, heat burdened, disadvantaged communities. These communities are especially at risk of heat-related illness and could stand to benefit greatly from shade-providing and heat-reducing trees. As climate change renders LA hotter, achieving urban forest equity is more important than ever—yet the City of LA faces many challenges in doing so.

Our project evaluated City Plants' Tree Ambassador Pilot Program and its community-based model for tree stewardship to find methods for increasing urban forest equity and suggestions for the program going forward. We performed four major activities: in-person surveys of community members in disadvantaged neighborhoods and electronic surveys by email of City Plants and TA program tree recipients; an assessment of the health and soil moisture of street trees planted by the program; a spatial analysis of tree locations in relation to disadvantaged communities; and interviews of policy representatives along with a review of select urban greening-related policies. Through our research, we successfully answered the four questions introduced in section 4.

The results of the surveys imply that across both audiences, residents' opinions on the presence of trees in their community are mostly positive. Most residents believe that trees in their community provide a variety of benefits and that they often think about the presence of trees in their neighborhood. The answers from questions asking about the free tree program and residents' experience with maintaining their tree were also positive, showing that most people found the program to be efficient and that the maintenance of their tree has not been more difficult than they initially expected.

The tree health assessments and soil moisture measurements show that the TA program was successful in terms of street tree survival and resident watering, as all street trees were alive and a majority received adequate soil moisture over our data collection period. Large amounts of rainfall in the month prior to data collection may have contributed to the observed soil moisture levels, obscuring the impacts of supplemental watering. However, only slightly more than a half of all trees were assessed as healthy during the last visit, indicating the program has room for improvement in growing healthy street trees.

The GIS analysis indicates that the TA program is moderately successful in planting trees in areas that experience higher urban heat, higher pollution and inequity burdens, and lower urban canopy cover. The program can be improved by targeting future planting areas based on DACs, UFEC, CES 4, low-canopy, and heat burdened census tracts. On the other hand, tree adoptions and plantings within various Tree Ambassador home zip codes indicate the success and importance of the place-based, community leader Tree Ambassador program model in meeting the goal of benefiting the communities Tree Ambassadors represent.

The interviews with policy officials and leaders show that there are a great deal of opportunities to make changes to codes and street policies in order to maximize dense urban spaces for their tree planting potential. The street widening policy, which requires developers for newly redeveloped buildings to pay to widen the surrounding street by 5 feet, remains an example of how policy may create more constraints for street tree planting spaces, even as a motion to explore ending this requirement has been introduced. In addition, urban forestry efforts in the City of LA would benefit from incorporating alternatives to trees, such as infrastructural shade structures and solar panels that incorporate innovative short-term shade relief, especially in areas where large-stature trees are not currently feasible. Finally, siloed departments generally responsible for maintaining streets could benefit from improving collaboration or merging with other departments. This would allow departments that are actively trying to close the urban forest equity gap to streamline the necessary infrastructural changes to allow for more street trees in impervious areas.

9.2. Recommendations for the Tree Ambassador Program

Our research points to one critical finding above all others: more funding should be allocated to the Tree Ambassador program to help advance urban forest equity. To bolster program capacity, we recommend hiring Tree Ambassadors (TAs) as full-time employees. The part-time nature of these positions may mean that TAs have to acquire additional jobs to make ends meet, and indeed, several TAs in the first two training rounds left the program early upon finding full-time work elsewhere. One TA who was highly successful in getting residents to sign “Commitment to Water” forms during the pilot round cited the spare time afforded by not having an additional job as a key factor in her success.

We found the community-based model to be highly effective in getting trees planted in Tree Ambassador communities. As discussed in section 7.3.2, 41% of TA trees were planted within just 0.2 miles of a TA home zip code. Proximity of planting location to TA home zip code should be formalized as a metric of success for the program going forward.

To further increase the Tree Ambassador program’s impact, future iterations could incorporate data from CalEnviroScreen 4.0 scores and the UFEC prioritization process as part of the TA selection process. The maps initially created in this report can also be built-upon in future program iterations, with future TA tree distributions overlaid on pilot round distributions for comparison. These comparisons would create one standard against which each year of the program may be objectively evaluated.

Intercept surveys covering the same themes we covered in our project (tree value, community role in tree stewardship, etc.) could also be conducted in communities targeted by future program iterations. The program can aim to survey a minimum number or proportion of people from each target community, and use the resulting data to guide operations.

City Plants should also continue to invest in and conduct research on the health of trees planted by the Tree Ambassador pilot and beyond. This could include 1) conducting longer-term assessments into the summer months and over multiple years on trees already studied from the pilot round, and 2) broadening City Plants’ evaluation of tree survival and health to include other trees planted through future TA program rounds. These findings can be used to influence education and engagement around tree care.

The TA program could also make improvements in communication towards residents about tree watering needs. Specifically, the program could employ behavior change strategies to remind tree recipients when and how to water. This could be through providing tree recipients with suggested time spans to resume watering after rain events or general watering schedules. This information should be in languages commonly spoken in neighborhoods the TA program serves, as well as something that a resident will see frequently, such as a refrigerator magnet. For example, City Plants may want to utilize behavior change strategies to test approaches in fostering tree stewardship behaviors. One such strategy, modifying messages to tree recipients, has limited effect on stewardship behaviors (de Guzman et al., 2023, p. 13). Another set of strategies, including demonstration of tree care actions to residents and door-to-door pamphlet distribution and verbal engagement with residents, results in greater improvements in tree stewardship and health (de Guzman et al., 2018, p. 302). Combining proven behavior change strategies while addressing a community's specific needs is thus important to foster tree stewardship. The degree to which both tactics are employed by future rounds of the TA program can be an evaluation metric.

9.3. Potential Alternatives to Providing Establishment Period Care for Trees in Los Angeles

Currently, the City of Los Angeles relies largely on voluntary watering by residents to care for its urban trees. The question of whether this responsibility of care should be on residents is still outstanding. While the residents we surveyed indicated that they did not think tree maintenance was too difficult, our soil moisture measurements revealed some communities were better at upholding watering commitments than others. Of course, relying on residents to water is not the only way to care for Los Angeles' trees. While the City should continue to invest deeply in neighborhood-based programs like the Tree Ambassador program, there are alternatives to tree care that should be considered.

One option is to shift the responsibility of tree watering and maintenance to the City of LA itself. As described in section 8.3.1, San Francisco's Friends of the Urban Forest (FUF) saw street tree health decline when the responsibility of tree care was handed to private residents; when tree care was later given back to the City, tree health improved. This was made possible by annually allocating $19 million of San Francisco's general fund to tree and surrounding sidewalk maintenance. San Francisco's success with this transfer of responsibility, as well as the importance of urban tree canopy as highlighted in this report, can serve to further bolster the City of LA's efforts to increase its urban forestry budget. Establishing City funding that could pay for tree planting and attached maintenance will be crucial to supporting urban forest equity.

As described in detail in section 8.3.2, City Plants can pilot the transfer of watering responsibility to relevant departments of the City of LA and observe any effects on street tree health and residents' perception of street tree health. Select neighborhoods with existing street trees can be chosen for the pilot, which should last at least half a year and include summer. Observations of street tree health and residents' perception of street tree health can follow methodologies developed through our study in sections 5.1 and 6.1. Tree Ambassadors are likely candidates to undertake this research, given their background in urban forestry. Comparing tree health and resident opinions between neighborhoods under each watering plan will hopefully provide insight into whether transferring street tree watering responsibility from residents to the City of LA would be effective.

Several technological alternatives exist which can help support improved urban forest health. For example, installing watering bags around tree bases may be a relatively low-cost and low-tech option. These bags allow for multiple gallons of water to be deployed at a tree at once and slowly absorb into the soil over time, reducing the frequency of watering needed. A more high-tech, higher-cost alternative could be to install smart irrigation technology, which uses sensors to adjust the amount of watering provided according to weather and soil moisture conditions (Gotcher et al., 2017). Something like this could first have to be piloted on a street-level basis in a single neighborhood. If deemed successful, such an approach could be installed first in priority urban forest equity zones. Still other alternatives could include installing more stormwater capture infrastructure, incentivizing rainwater harvesting systems, and working across city departments and nonprofit partners to pilot innovative tree planting interventions in areas where traditional tree planting spaces are few or far between. Additionally, where trees are particularly difficult to accommodate, shade structures and other alternatives can be incorporated into a suite of solutions that creates livable neighborhoods into the future.

10 - Literature Cited

10. Literature Cited

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11. Appendices

Appendices providing additional results and documentation of the research conducted for this report are available at https://tinyurl.com/UCLAPracticumAppendices

Appendix A: Community Engagement Surveys

Appendix B: Tree Health Assessments

Appendix C: GIS Analysis