HERO 2022 Stakeholder Report




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1. Introduction

Urban forests are defined as the trees located within public and private lands in urban areas such as towns, suburbs, or cities and are the result of biophysical and human processes (Roman et al. 2018). Through surveying residents and the urban landscape, this study examines both how residents perceive urban forestry and environmental issues and how trees can impact heat and pollution in four study locations in Rhode Island. This study collaborated with Groundwork RI to identify the places where urban forestry would be the most beneficial. Groundwork RI is a nonprofit organization focused on building urban resilience through environmental stewardship and economic opportunities. Each of the study locations included in this research were identified as Environmental Justice Communities (EJCs), meeting certain criteria for fraction of minority and foreign born residents and low average household income and English proficiency. EJCs are areas that lack access to sufficient urban tree canopy cover given the lack of equitable urban tree canopy cover in the United States (Riedman et al., 2022). This research also uses the survey of residents to elevate the voices of individuals in EJCs. Increasing environmental justice means affected individuals and communities must be included in decision making processes. Places considered EJCs often experience higher temperatures and poorer air quality due to low percent canopy cover, and more affluent areas often have higher percent canopy cover, in turn experiencing lower temperatures, better air quality, and other services trees can provide, like reduced flooding (Saverino et al., 2021; Loughner et al., 2012). The urban heat island (UHI), the difference in temperature between urban and rural areas, often corresponds with environmental concerns such as poor air quality and flooding. Understanding the way tree canopy cover is distributed throughout cities and how urban trees may impact more vulnerable residents can provide important information on how to proceed with urban tree planting programs to best serve those belonging to EJCs and to redistribute environmental burdens and benefits more equitably.

2. Research Questions and Goals

This research was centered around the question: How do human and biophysical interactions impact the urban environment and inform urban forestry efforts to create a more resilient and equitable city? In answering this question, this research had multiple goals. The first goal was to understand residents' perceptions. To achieve this goal, this study surveyed residents to understand their perceptions and experiences with urban trees and to understand their concerns about the environment. The second goal of this study was a survey of trees and the urban landscape. To achieve this goal, this study surveyed Groundwork tree planting, the current distribution of trees and potential planting locations, and efforts to understand the impact of trees on heat and pollution.

3. Study Area

The study areas in Rhode Island included the town of Cumberland, the city of Central Falls, and the neighborhoods of Washington Park and Lower South Providence in Providence.

Each of the study locations were connected by the Blackstone watershed, and most of them were located along the Blackstone River. In Cumberland, three neighborhoods along Broad St. were surveyed. In Central Falls and South Providence, neighborhoods where Groundwork had recently planted trees were surveyed. In Washington Park, transects according to a list of potential planting sites that Groundwork RI provided to the HERO team were surveyed.

Figure 1. Study Area Map of Each Study Location in the Blackstone Watershed

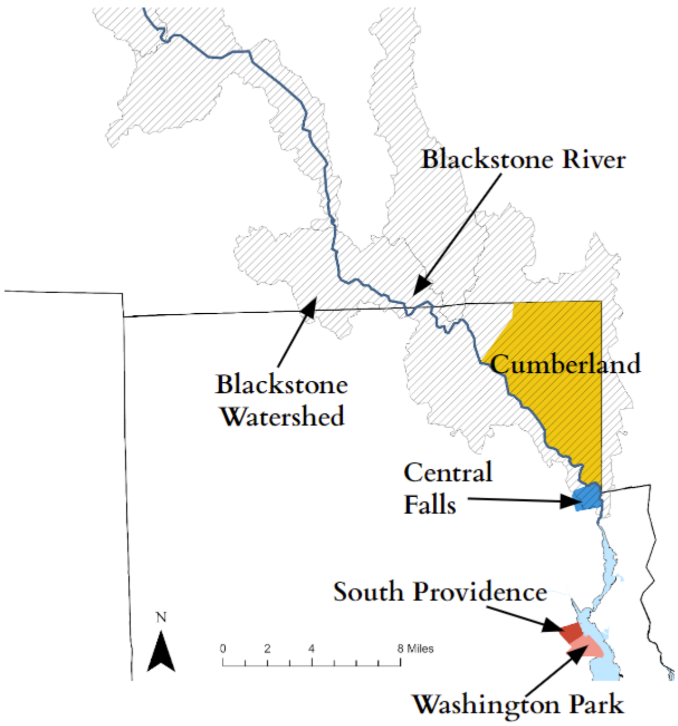


Figure 2. Study Area Map of Lower South Providence Neighborhood in Providence, RI. Surveyed 230 sites, 143 sites were trees (green points), 35 of 143 trees were Groundwork RI trees, 26 sites were available planting sites (yellow points), and 61 sites were impervious sites (black points).

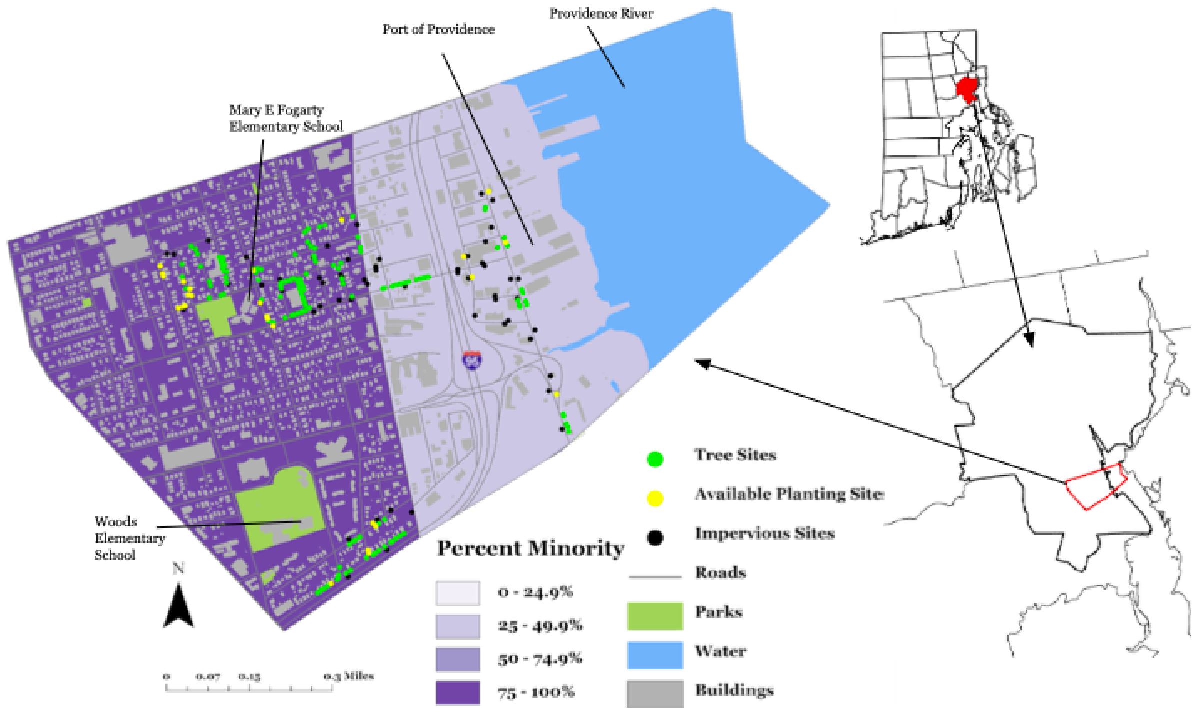


Figure 3. Study Area Map of Washington Park Neighborhood in Providence, RI. Surveyed 287 sites, 62 sites were trees (green points), 218 sites were available planting sites (yellow points), and zero sites were impervious sites (black points).

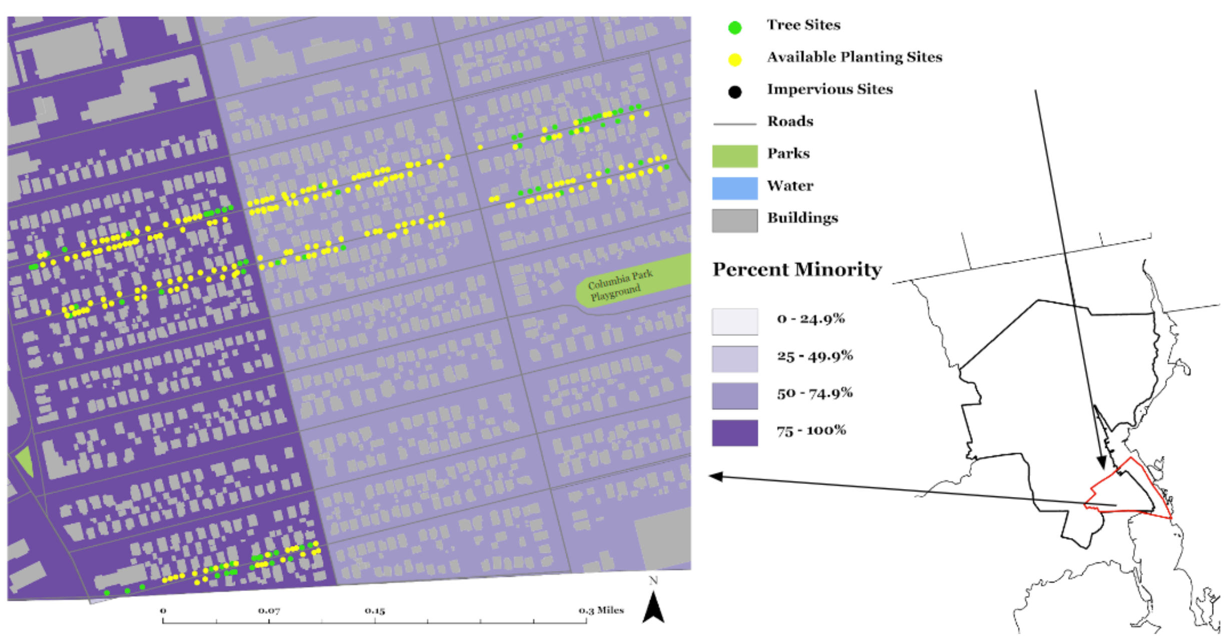


Figure 4. Study Area Map of Central Falls, RI. Surveyed 184 sites, 109 sites were trees (green points), 59 of 109 trees were Groundwork RI trees, nine sites were available planting sites (yellow points), and 66 sites were impervious sites (black points).

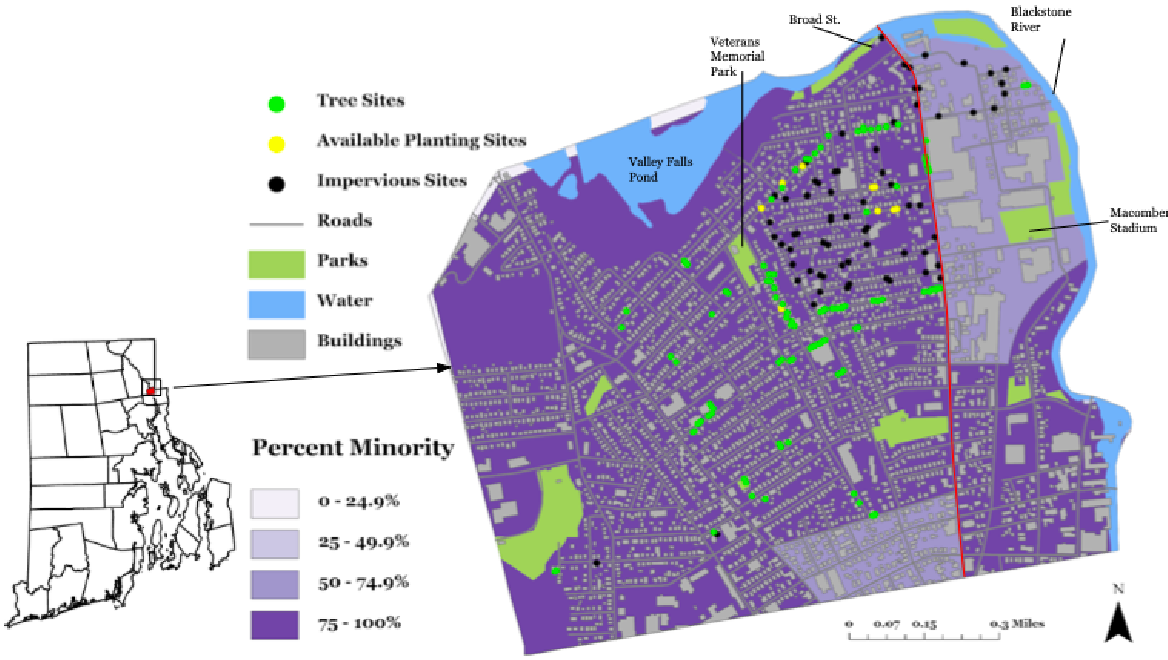


Figure 5. Study Area Map of Cumberland, RI. Surveyed 197 sites, 59 sites were trees (green points), 27 sites were available planting sites (yellow points), and 111 sites were impervious sites (black points).

4. Methods

4.1. Tree and Temperature Survey Methods

At each site, ozone and particulate matter was measured using an Aeroqual air quality sensor, which has a 95% confidence rate. Particulate matter 2.5 are particles that are too small to see. Particulate matter 10 are particles that can be seen, such as dust or pollen. Readings were taken at the center of every block, but some blocks were segmented due to the presence of roads, so readings were taken at the middle point of each segment. A HT-86 Digital Humidity and

Temperature Meter was used to measure air temperature and relative humidity. Measurements were taken under trees, at potential planting locations, and at impervious sites. A cup and plate were placed over the meter to block wind and sun to get a more accurate reading. An Etekcity Lasergrip 1080 Non-contact Digital Laser Infrared Thermometer was used to measure land surface temperature. The thermometer would be pointed from 1.5 feet at the center of the road or near the curb to measure land surface temperature in the sun. Under the shadow of a tree canopy the same methods were taken to measure the surface temperature in the shade. The tree survey followed the USFS urban tree monitoring guidelines for data collection (Roman et al., 2020; Breger et al., 2019). The diameter at breast height (DBH) of the tree is measured at a height of 54 inches from the ground when possible. To take the diameter measurement, a DBH measuring tape with diameter markings was used. For trees, the distance from impervious surfaces was also taken by measuring from the base of the tree to sidewalk or road, whichever side was closer. Lastly the vigor, or health, of the tree was noted. It was visually determined by a scale of one to five, with one having a full canopy to five being dead.

4.2. Site Types, Land Use, and RI Tree Species

Three common site types that were encountered were sidewalk cutouts, planting strips, and impervious surfaces. About 25% of site types found were impervious surfaces, where opportunity for tree planting necessitates creating available planting spots by cutting the sidewalk. However, many of the existing sidewalk cutouts and planting strips are difficult to plant trees in, either because they are too narrow, or because the spaces are being used for other purposes.

The four notable land use types that were found in the field were single family residences, multi family residences, industrial, and commercial. A Single Family Residence is a building that houses one family. A Multi Family Residence is a building that has fewer than four floors, such as a duplex or a triple decker. Sites classified as industrial include industrial buildings such as factories, and sites classified as commercial (small or large) include buildings used for businesses.

4.4 Impact of Trees on the Urban Heat Island Effect

The sites' temperatures in Cumberland and Central Falls were compared to the Smithfield Airport. Sites' temperatures located in Washington Park and Lower South Providence were compared to the Providence airport in Warwick. The difference in temperature between the urban sites we measured and the rural airports was used to calculate the impact of the UHI.

5. Results

5.1. Residents' Perceptions of Urban Trees

Residents' responses showed a complicated relationship with urban trees. Our survey aimed to capture both the perceptions of trees as well as residents' interactions and experiences with trees on their property. Residents had overwhelming positive perceptions with trees in

Washington Park, Cumberland and Central Falls. While heat was the most common environmental concern, air quality was the benefit that residents perceived the most frequently from trees (Figure 7 and Figure 9). Shade was third most common but it is interesting to note that some residents may not associate trees with heat reduction (Figure 7).

Residents were most concerned about damage from trees (Figure 7). Damage was a catch all term for sidewalk and property damage. Many residents described preemptively removing trees due to potential damage. The fear of trees causing damage was often mentioned alongside the threat of storms. However, only a quarter of residents highlighted storms as an environmental concern (Figure 9). This shows that while damage from trees was a negative perception, it was often not a very large concern. In fact, a few residents noted damage from trees but still either requested new trees or said they would continue to maintain the trees on their property.

Table 1. Comparison between Survey and City Demographics. The columns in green show the demographics for all cities combined compared to the total demographics for all of our surveys combined.

*2019 ACS Data	Total Survey	All Cities Census*	Washington Park Survey	Providence Census*	Central Falls Survey	Central Falls Census*	Cumberland Survey	Cumberland Census*
Median Age	45-54	34.4	45-54	30.6	45-54	30.1	55-64	42.5
Median Income	$15,000-24,999	$59,078	$15,000-24,999	$45,610	$15,000-24,999	$34,689	$75,000-99,999	$96,936
Average Non White	59%	43%	70%	67%	33%	51%	50%	12%
Average Educational Attainment	33%	34%	25%	34%	40%	9%	25%	57%
Average Female	50%	51%	50%	52%	75%	49%	25%	52%

Figure 6. Bar graphs showing demographics of the residents interviewed

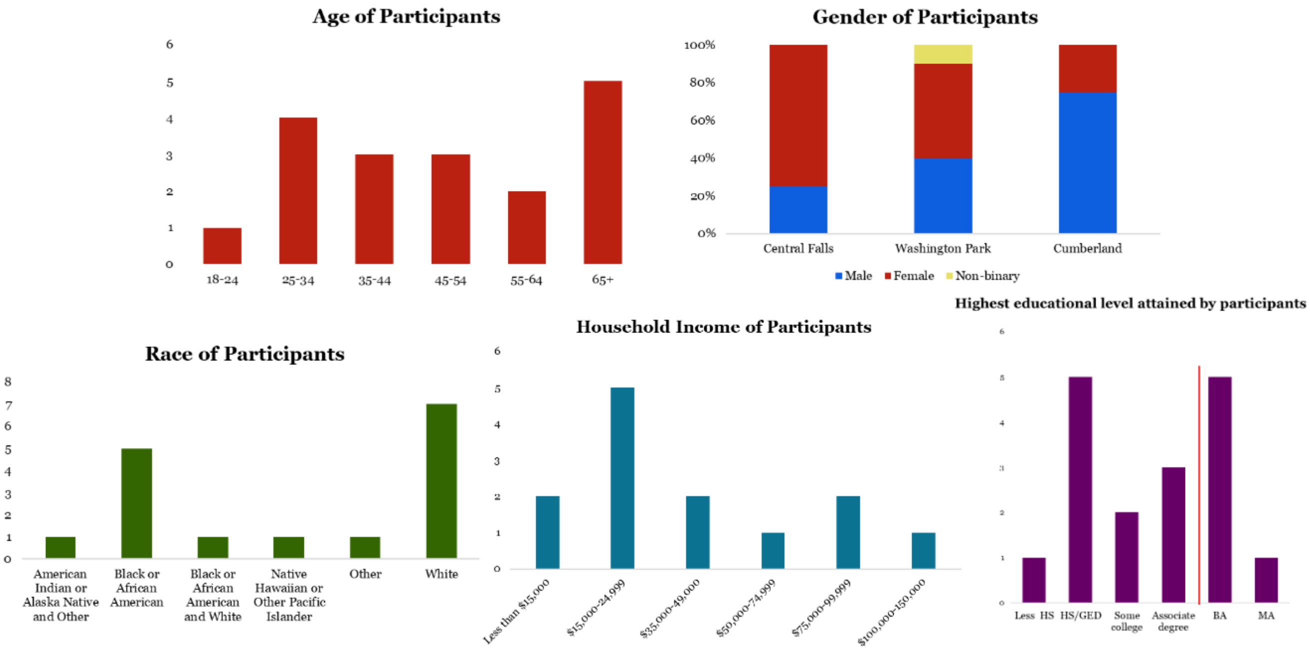


Figure 7. Bar graph on left of responses to survey question: "What benefits or impacts of trees do you appreciate the most?" Bar graph on right of responses to survey question: "Which of the following are potential negative impacts of having trees in your neighborhood?"

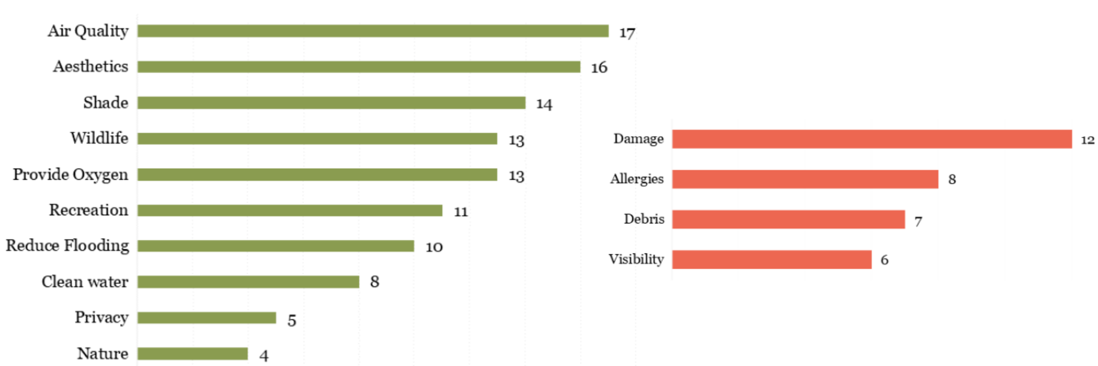


Figure 8. Graph on left showing survey responses to the question: "Have you engaged in tree stewardship before?" Graph on right showing responses to the survey question: "Which of the following tree issues have bothered you the most?

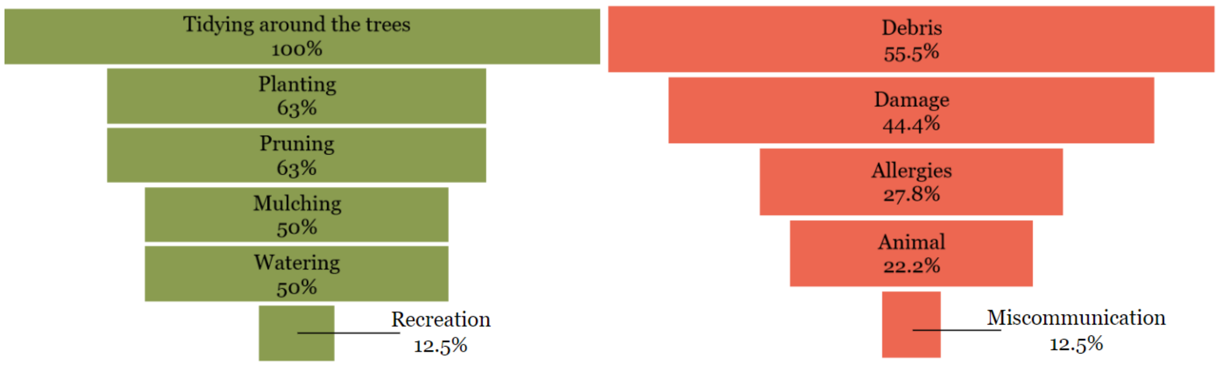


Figure 9. Bar graph showing responses to the survey question: "What are the most pressing environmental issues your neighborhood faces?"

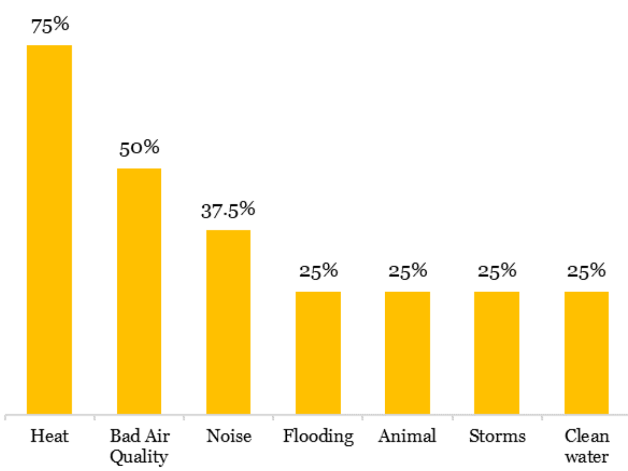
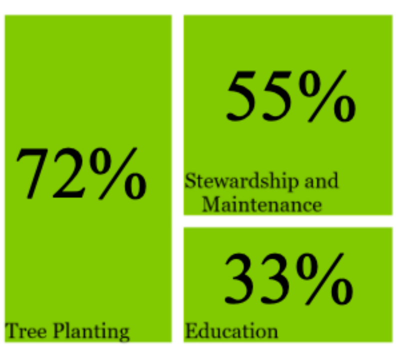


Figure 10. Graph showing responses to the survey question: "How should resources for trees be prioritized?"



5.2. Survey of Trees and the Urban Landscape

The tree survey found 369 tree sites out of 912 sites in total. The most common land use at the sites was residential, with 45% being Single Family Residential and 27% being Multi Family Residential (Figure 11). A total of 62 total tree species were surveyed, with Acer Rubrum (Red Maple) being the most common (Figure 13). Other frequently observed tree species were Callery Pear, London Plane, Ginkgo, Cherry, Japanese Zelkova, Honey Locust, Norway Maple, American Linden, and Paper Birch (Figure 13). Of these trees, 61% of trees were classified as juvenile (with a DBH of less than five inches). Maximum air temperature was in Washington Park, as well as nine out of ten highest temperatures. The maximum heat index was found in Washington Park as well as the top 25 highest heat indexes. The air temperature at tree sites was generally lower than the air temperature at non-tree sites on extreme heat days (temperature greater than 90 degrees Fahrenheit) in each city, although the effect was largest in Cumberland (Figure 23). The maximum temperature difference, the metric for the strength of the UHI, was found in Central Falls. Analysis of the effect of trees on the UHI showed that for every increase in 4 inches of DBH there was a corresponding 1 °F reduction in the temperature difference (Figure 22). All of the air quality measurements of ozone and particulate matter were within the EPA's healthy standards. For ozone, most of the readings were between 0.02 ppm and 0.03 ppm but there were three points that were lower than expected (Figure 24). For PM 2.5, most of the readings were between 0 μg/m3 and 1 μg/m3, however, there were five values that were higher than the expected maximum of 2 μg/m3 (Figure 24). This means that the outliers are closer to the harmful levels of PM 2.5 despite not being considered harmful by EPA's parameters (Figure 24). For PM 10 most of the data was between 2 μg/m3 and 4 μg/m3 although there were 12 points that were higher than the expected maximum of 7 μg/m3(Figure 24).

The street tree survey of the South Providence and Washington Park neighborhoods of Providence displayed evidence of recent tree planting and many opportunities for additional tree planting. In South Providence, 62% of the sites had trees planted while only 11% of sites were empty. This shows that the majority of available sites have trees in them. South Providence also had the highest number of tree species (Figure 14). Two of the three most common species had very small DBH (Figure 15). Any additional planting along streets will require removal of impervious surface. In Washington Park, only 21% of the sites visited had trees while 76% of the sites were empty. No impervious sites were found during the survey. There was a lot of opportunity for tree planting in empty sites. The tree survey reflected the lack of recent tree planting with only 16 species of trees (Figure 16) and of the most common species, two had very large DBH ranges (Figure 17).

The street tree survey of Central Falls and Cumberland found similar results. Central Falls had recently experienced increased tree planting with 60% of the sites having trees and only 5% of the sites being empty. There was also high species diversity, with 32 tree species (Figure 18). This recent planting was confirmed when DBH was examined for the three most commonly planted tree species (Figure 19). 80% of all street trees in Central Falls had a DBH of five inches or lower. This was in strong contrast with Cumberland where only 30% of the sites had trees and only 14% of sites were empty sites that would be available for planting. Over 50% of the sites in Cumberland were impervious surfaces that would need to be removed for tree planting. Cumberland also had the fewest number of tree species (Figure 20). Of these trees, the most commonly occurring all had a median DBH greater than five, so most trees found were fully mature (Figure 21).

5.3 Groundwork Tree Survey

This study surveyed the trees Groundwork planted in Central Falls and South Providence. Groundwork provided addresses of 126 trees that were recently planted within the last two years in Central Falls and South Providence. Out of 87 total trees surveyed, only five were dead and two were missing; making the survival rate 92.55%.

Figure 11. Pie Chart of Land Use Types from All Sites

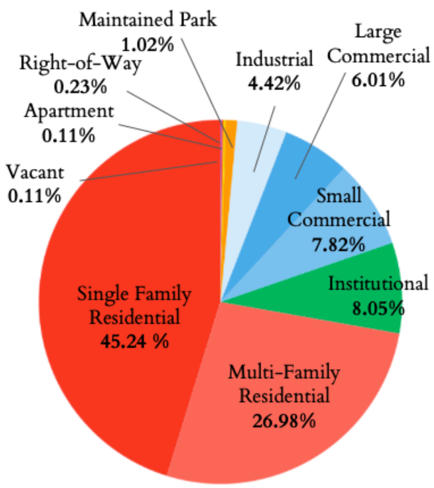


Figure 12. Pie Chart of Potential Planting Site Types from All Sites

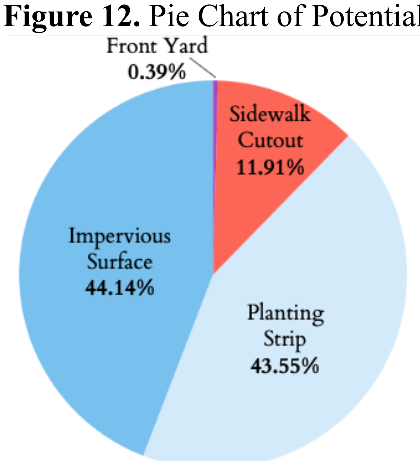


Figure 13. Bar Graph of Most Frequent Tree Species Surveyed in Rhode Island

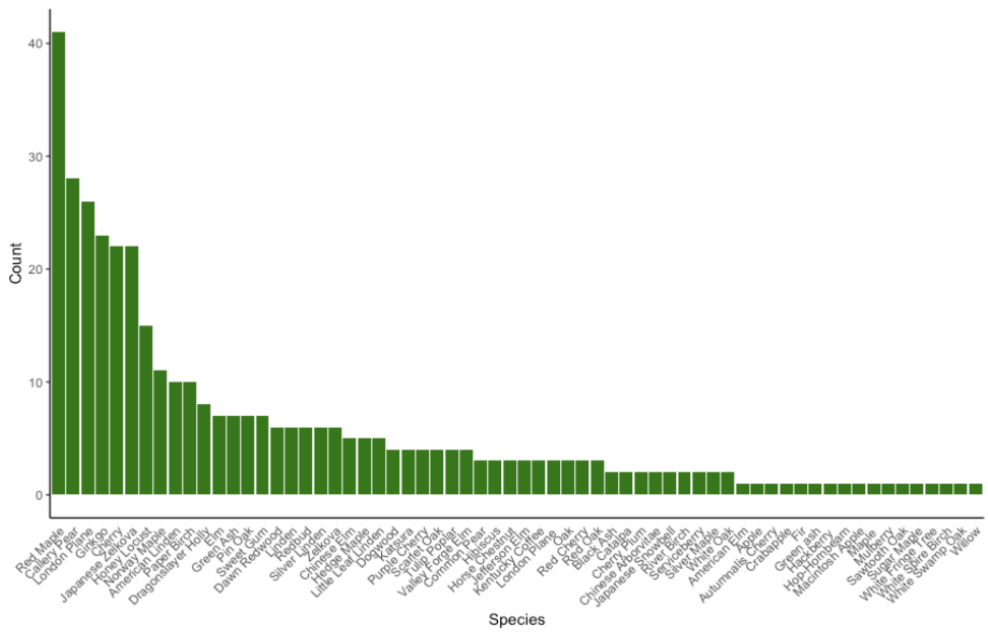


Figure 14. Bar Graph of Species Breakdown for the Neighborhood of South Providence.

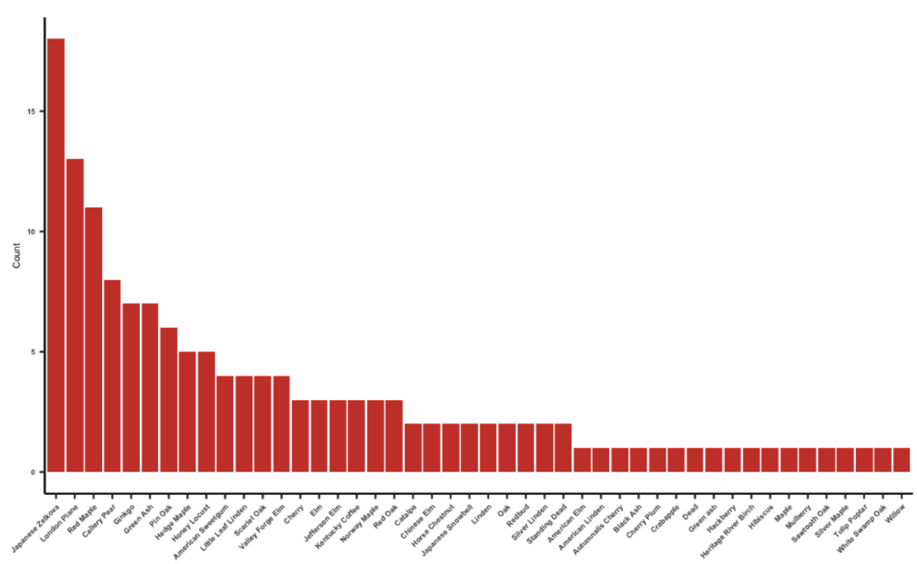


Figure 15. Boxplot of Top 3 Species DBH for South Providence

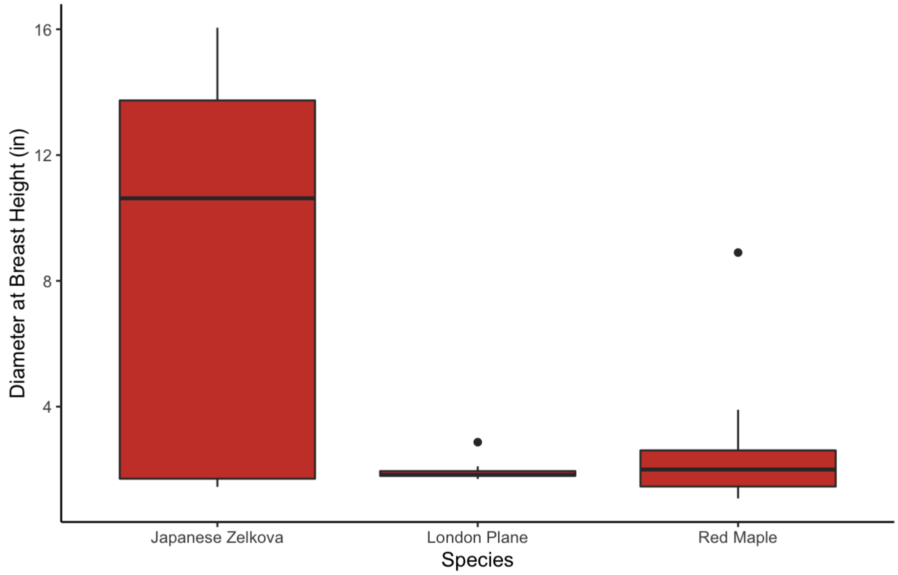


Figure 16. Bar Graph of Species Breakdown for the Neighborhood of Washington Park

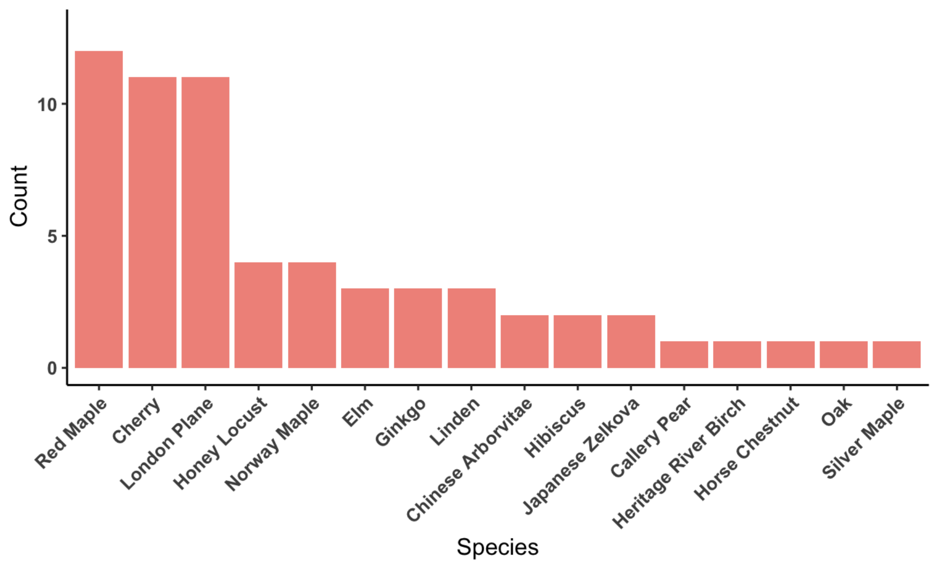


Figure 17. Boxplot of Top 3 Species DBH for Washington Park

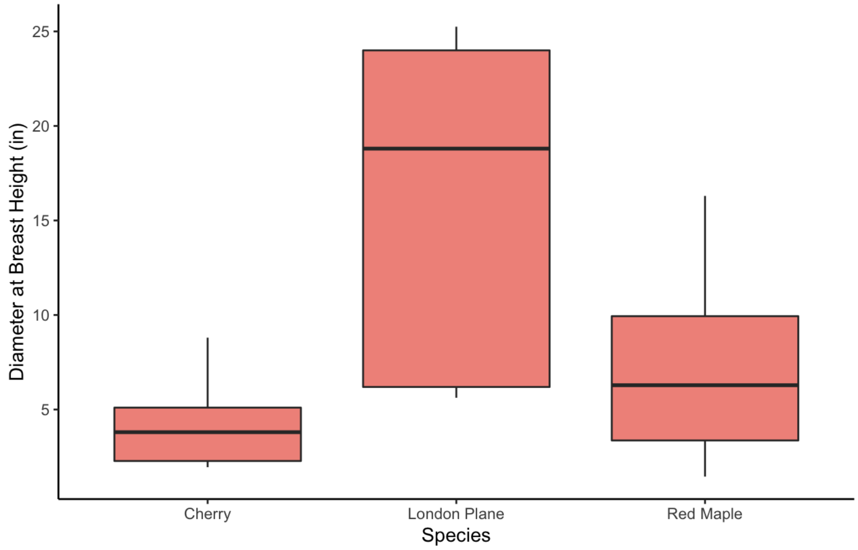


Figure 18. Bar Graph of Species Breakdown for Central Falls, RI

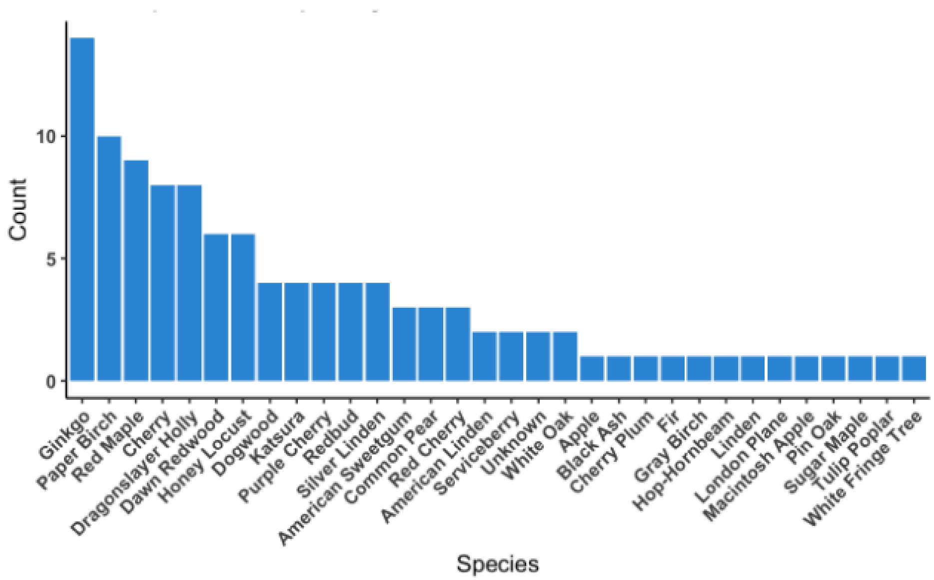


Figure 19. Boxplot of Top 3 Species DBH for Central Falls, RI

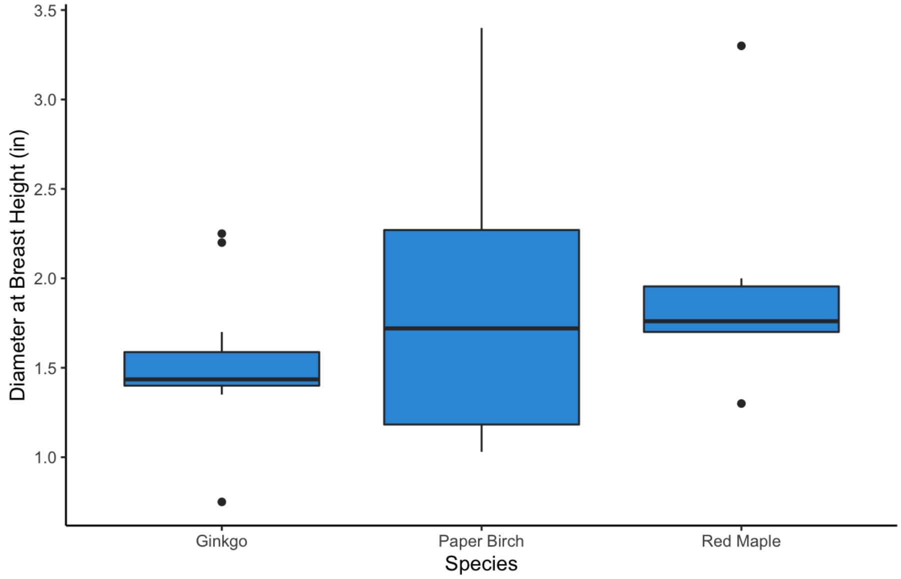


Figure 20. Bar Graph of Species Breakdown for Cumberland, RI

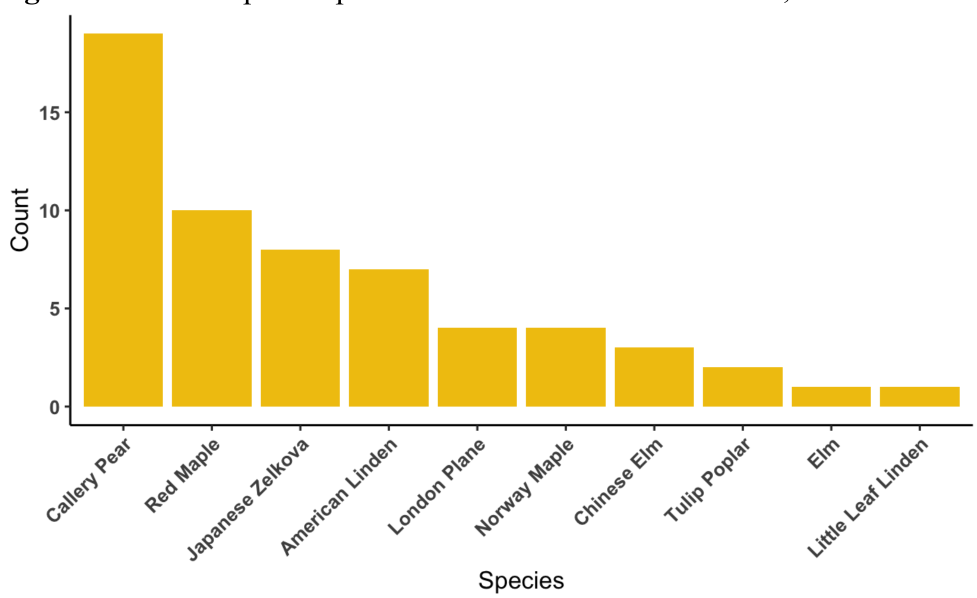


Figure 21. Boxplot of Top 3 Species DBH for Cumberland, RI

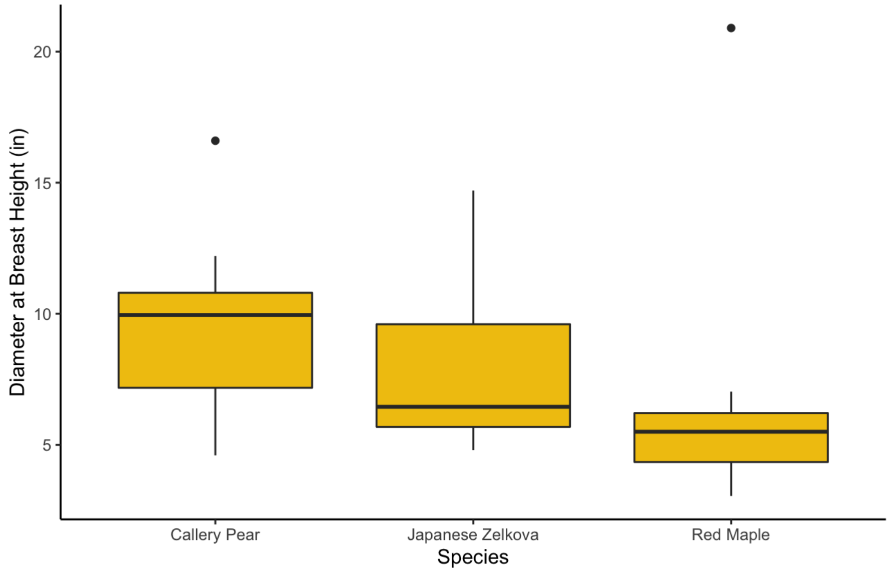


Figure 22. Scatterplot of DBH by Difference in Measured air temperature from airport temperature

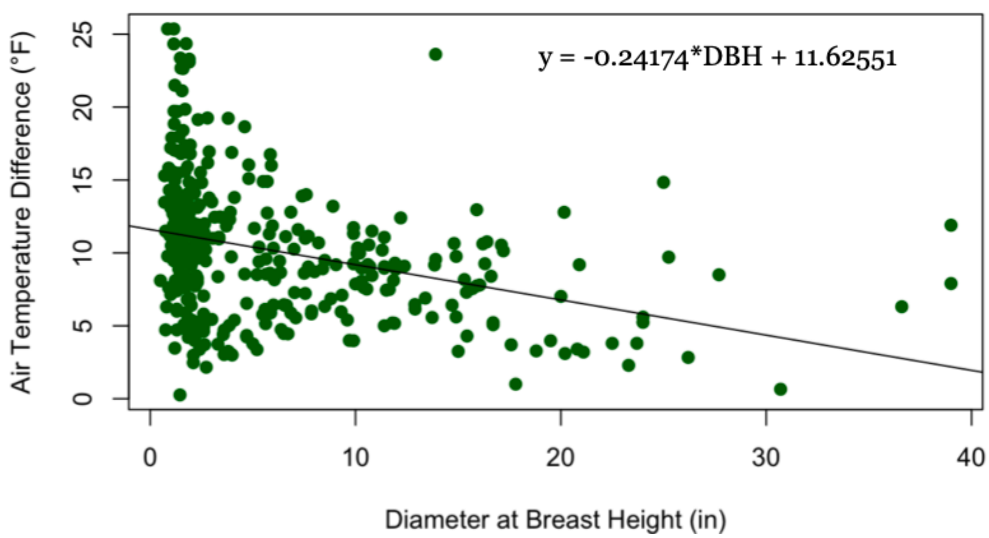


Figure 23. Boxplot side by side comparison of the four study areas showing Sites with no trees (unique colors) vs. Sites with trees (Green) on Extreme Heat Days (Air Temp > 90℉); From Left to Right (Cumberland, Central Falls, South Providence, and Washington Park)

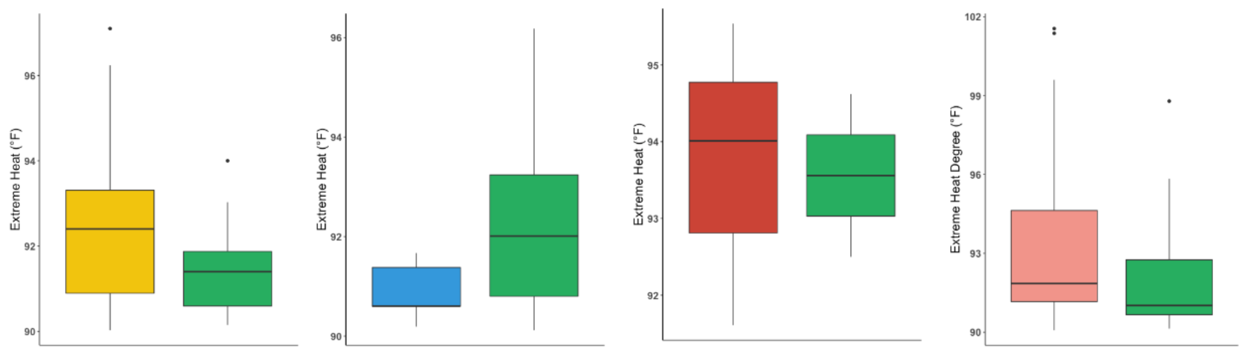
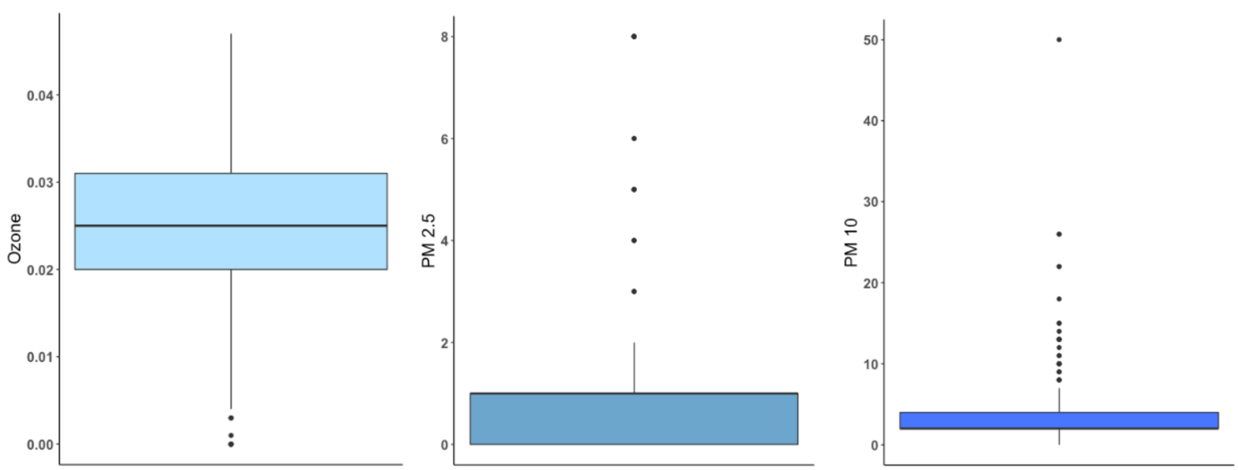


Figure 24. Boxplot side by side comparison of the ozone, PM 2.5, and PM 10 values of all of the areas studied in Rhode Island.



6. Discussion

4.1 Residents' Perceptions of Urban Trees

Residents had mostly positive perceptions of trees. Many individuals who were surveyed expressed interest in receiving a free tree from Groundwork. Many also expressed the importance of trees' impact on air quality. Most residents were in favor of more tree planting, and liked the idea that available resources should be devoted to tree planting. Residents' top two environmental concerns were extreme heat and poor air quality, each issues that increased tree canopy can improve. Better communication between urban residents and weather and air quality forecasts must occur in order to close the gap of climate education within these communities. There seems to be a disconnect between the information residents receive from their weather and air quality forecasts and the measurements taken in the field. This disconnect exemplifies the UHI effect in neighborhoods studied, and increased tree planting efforts have the potential to diminish this gap between forecasts and local temperatures and air quality.

4.2 Survey of Trees and the Urban Landscape

Washington Park has older tree populations while Central Falls and South Providence have many young trees. There were small differences in the UHI metric across sites with and without trees on days with extreme heat in Cumberland, Washington Park and South Providence. Overall, the UHI was reduced by 1°F with every 4 inch increase of DBH. Japanese Zelkova and London Plane were some of the most frequently planted and largest trees across the sites. Groundwork trees are doing well with a survivorship rate of 92.55%, demonstrating that their model of tree planting in urban areas is successful.

4.3 Implications for Tree Planting

South Providence and Central Falls demonstrate tree planting is possible while there is ample tree planting opportunity in Washington Park. South Providence and Central Falls have higher percentages of juvenile trees which were recently planted. In Washington Park, the sections surveyed in this research show high opportunity for tree planting, in the form of empty sidewalk cutouts and planting strips. In Cumberland, there are fewer available planting sites, but still many opportunities for juvenile trees to be planted. Opportunities exist in every town for urban forestry expansion.

7. Conclusion

This study is an initial survey of select neighborhoods in South Providence, Washington Park, Cumberland and Central Falls. While the survey did not take a representative sample, the results do provide a snapshot of the urban forest in these locations as well as initial resident perceptions. These results can also be used to inform tree planting that is scheduled to occur in Washington Park, Central Falls and Cumberland over the next three years to increase air quality and reduce the UHI effect. Next steps include expanding the survey to be representative of the entire study area. More resident interviews are needed in Central Falls and Cumberland to gauge the full range of resident perceptions of trees. A comprehensive study of environmental conditions, including measuring extreme temperatures and air quality, is needed to fully understand how environmental conditions may correlate to canopy cover, specifying between juvenile and mature trees.

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