TREE CANOPY ASSESSMENT

For

CITY OF DURHAM, NC

By SavATree Consulting Group

In collaboration with University of Vermont Spatial Analysis Lab

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CONTENTS

EXECUTIVE SUMMARY

Durham has 36,600 acres of tree canopy, covering 52% of the City. This compares favorably with many urban areas. There is a statistically significant inverse relationship between tree canopy and surface temperature providing heat island mitigation. All land uses have relatively high canopy cover, but as most of the vast majority of the land in the city is residential, a canopy strategy for that land use is critical to achieving the tree canopy cover goal.

In order to maintain the present level of tree canopy cover in road rights-of-way, Durham will have to plant at least 500 trees annually through 2040.

WHY DID SAVATREE CONSULTING GROUP EXAMINE THE TREE CANOPY IN DURHAM, NC?

In July of 2016, the City of Durham issued a Request For Proposals, Street Tree Inventory And Canopy Assessment. The purpose of the project is twofold. The first is to inventory and assess the oldest and largest street trees in Durham's urban core neighborhoods to inform both short and long-term resource allocation and risk management strategy. The second is to provide a Tree Canopy Assessment which will establish a baseline measure of the City of Durham's tree canopy coverage and available planting space, focusing on the land directly owned and controlled by the City of Durham within rights-of-way, to inform future policy decisions. These may include (but are not limited to) street tree planting and canopy coverage goals, social justice initiatives, and long-term sustainability issues impacting stormwater, transportation and energy distribution networks. SavATree was awarded the contract to deliver the canopy assessment portion of the project.

This tree canopy assessment provides a comprehensive, accurate, and detailed inventory of Durham's tree canopy. This information can assist decision makers in understanding the distribution of the existing tree canopy along with coming up with a viable tree canopy goal.

It also provides the results of scenario model runs to project how various annual levels of tree planting in public rights-of-way (PROW) will impact the amount of tree canopy in the PROW through 2040.

HOW DID SAVATREE CONSULTING GROUP EXAMINE THE TREE CANOPY IN DURHAM, NC?

HOW WAS THE TREE CANOPY MAPPED?

Federal, state, and local organizations have made large investments in remotely sensed data, such as high-resolution imagery and LiDAR for the Durham, NC area. Advanced artificial intelligence algorithms were applied to the imagery and LiDAR data to automatically extract tree canopy and other land cover features, a process that was then followed with a detailed manual editing process to correct for any errors (Figure 1). The end result of this mapping process was the most accurate accounting of Durham's tree canopy every conducted. The tree canopy and land cover mapping is based on 2015 ground conditions. This information was then summarized at various geographical units of analysis, from the property parcel to the watershed.

Figure 1. Lidar (A) and imagery (B) were used to map tree canopy (C) and land cover (D) for the entirety of the city.

HOW WAS DURHAM'S PROW CANOPY PROJECTED?

Durham has an existing partial public tree inventory that is recorded in the OpenTreeMap platform. You provided SavATree with administrative privileges to download the existing tree inventory data. We uploaded these data into the US Forest Service's iTree Eco software platform and formatted them to be used in a model run.

We then ran a series of three model runs using the Forecast tool of iTree Eco to project how much tree canopy the PROW tree inventory would provide through 2040 using the scenarios described in the RFP:

- Base case (existing inventory);
- Base case + 500 trees planted per year;
- Base case + 1,000 trees planted per year; and,
- Base case + 1,500 trees planted per year.

We used the following iTree Eco Forecast defaults for mortality in each model run:

- Base annual mortality rate for healthy trees 3.0%
- Base annual mortality rate for sick trees 13.1%
- Base annual mortality rate for dying trees 50.0%.

WHAT DID SAVATREE CONSULTING GROUP FIND?

HOW MUCH TREE CANOPY DOES DURHAM HAVE?

Existing tree canopy, the amount of tree canopy covering the city's land, totals 36,600 acres. This amounts to 52% of all city land being comprised of tree canopy, substantially higher than most other comparable cities in the USDA Forest Service's database of tree canopy assessments (Figure 2). The amount of land that is available to plant new trees is termed possible tree canopy. There are two categories of possible tree canopy, vegetated and impervious. Vegetated possible tree canopy consists of grass and shrubby areas without overhanging tree canopy. These areas are generally easier to establish new tree canopy on, but not all are socially desirable. For example, a baseball field would be classified as possible tree canopy, indicating that trees could be there, but such a planting plan would not be popular. Impervious possible tree canopy consists of non-road, non-building impervious surfaces such as parking lots. Establishing tree canopy on these areas would be financially costlier, but would yield substantial gains in ecosystem services such as reduction in the urban heat island and decreased storm water runoff. This analysis showed that Durham does have room to establish new tree canopy. This assessment, in conjunction with site surveys, can help the city prioritize locations for planting new trees and where tree preservation efforts should be targeted.

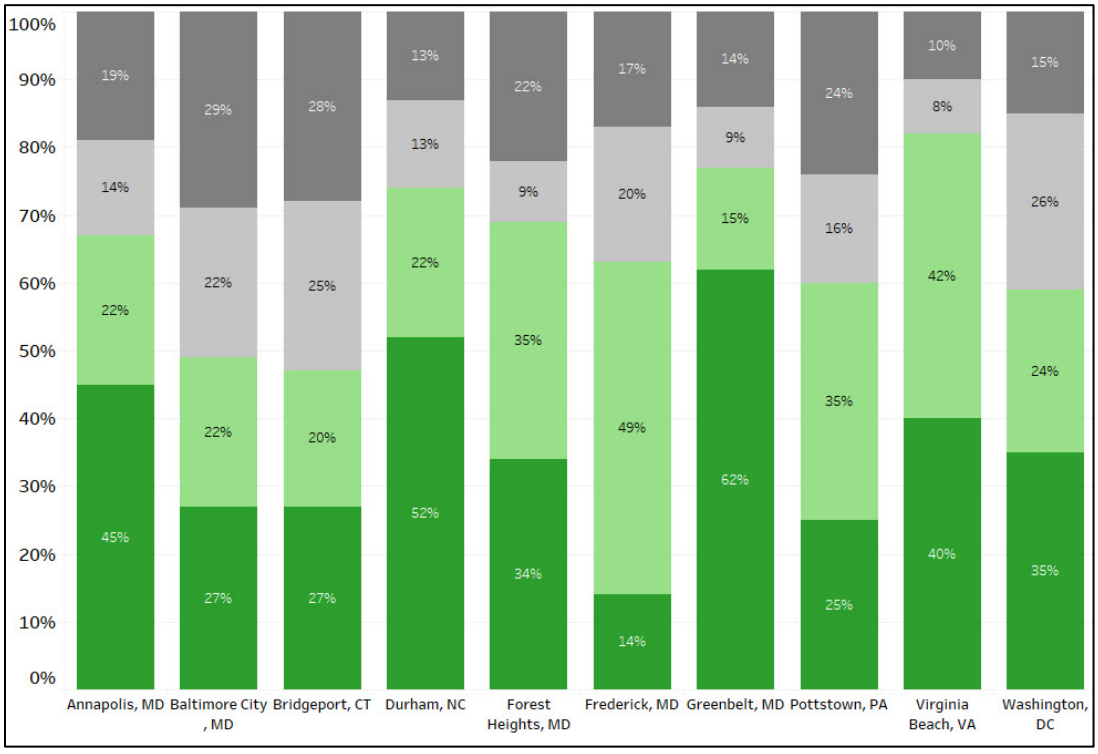

Figure 2. Tree canopy metrics for Durham and comparable cities: existing tree canopy (dark green), possible tree canopy that is vegetation (light green), possible tree canopy that is impervious (light gray), and land not suitable for tree canopy (dark gray).

WHAT DOES DURHAM'S TREE CANOPY MITIGATE THE URBAN HEAT ISLAND?

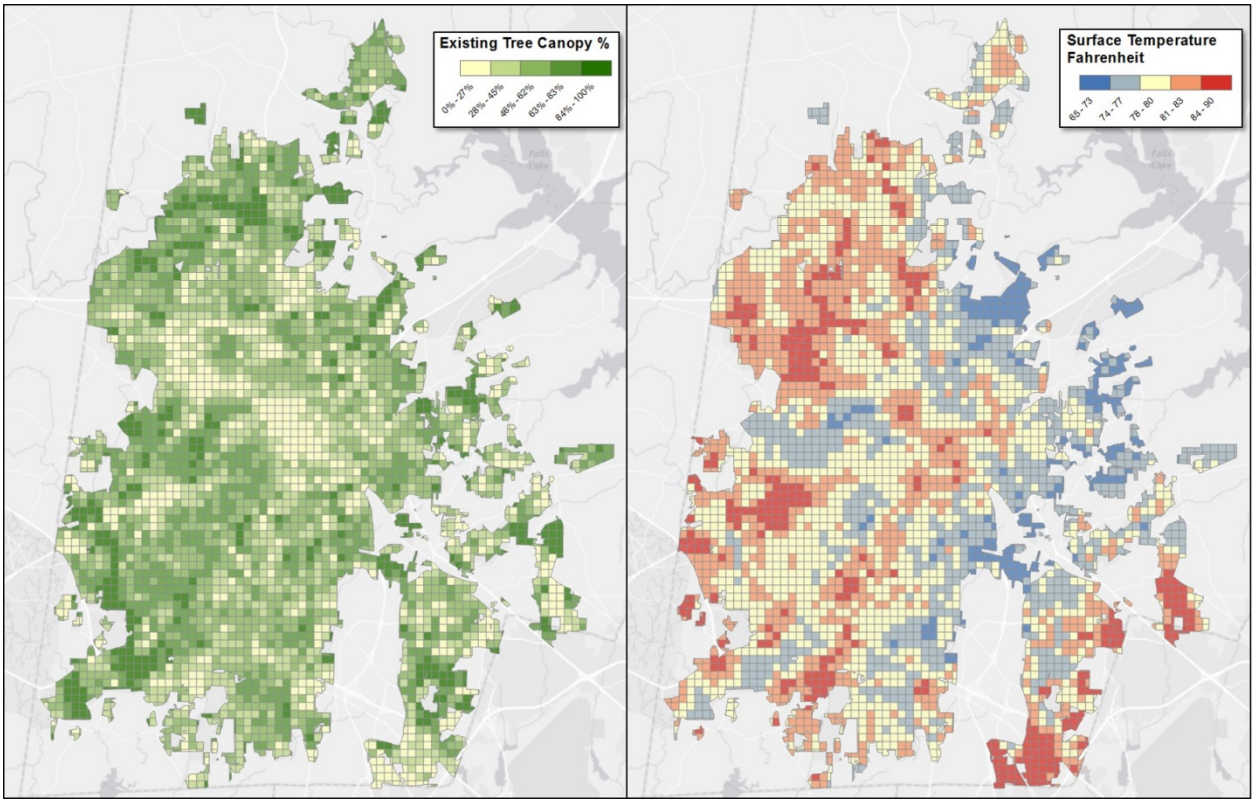

Figure 3. Existing tree canopy (left) and surface temperature (right) summarized by 1000-foot grid cells.

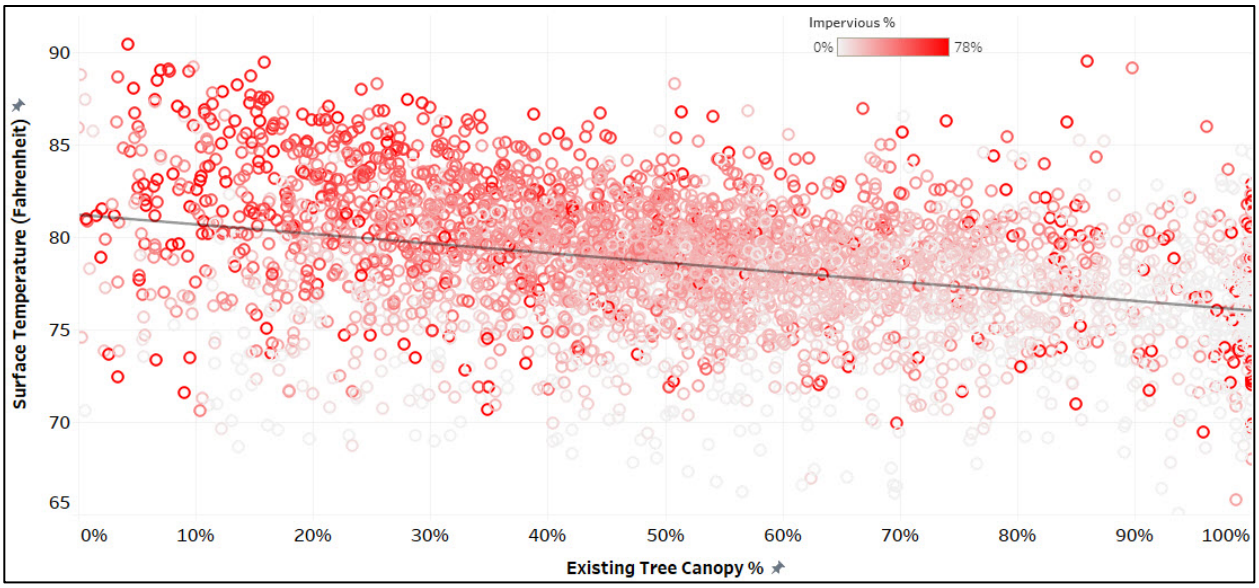

Figure 4. Surface temperature in relation to tree canopy. Each circle represents a 1000-foot grid cell and is color coded based on the impervious surface percentage.

One of the most direct indications of the impact of tree canopy is measuring how it reduces the urban heat island effect. Paved surfaces absorb heat causing urbanized areas to be significantly warmer than the surrounding countryside. While any type of vegetation can reduce the urban heat island, trees are particularly valuable due to the amount of heat they remove through transpiration. For this study, we obtained thermal imagery from the Landsat satellite to derive surface temperature. We then divided the city into 1000 by 1000 foot grids cells, summarizing the percent existing tree canopy and surface temperature for each grid cell (Figure 3 and Figure 4). We found that there is a statistically significant inverse relationship between tree canopy and surface temperature, pointing to the likelihood that tree canopy helps to keep the city cool.

HOW IS DURHAM'S TREE CANOPY DISTRIBUTED BY LAND USE?

Figure 5. Percent of land in each property covered by tree canopy.

To understand how tree canopy is distributed by land use we first summarized tree canopy for each and every property parcel in the city along with the rights-of-way (PROW) (Figure 5). Using the land use code assigned to each parcel we grouped them into ten generalized classes, plus the PROW (Figure 6). Unlike most other communities, the percent existing tree canopy in each land use class is remarkably consistent. Typically, industrial and commercial areas have substantially lower tree canopy than residential, recreational, and wild areas, but this is not the case for Durham. In terms of overall control of tree canopy, it is the city's residents that are the clear majority owners. The future of the city's tree canopy rests largely with Durham's residents, who control the majority of the tree canopy.

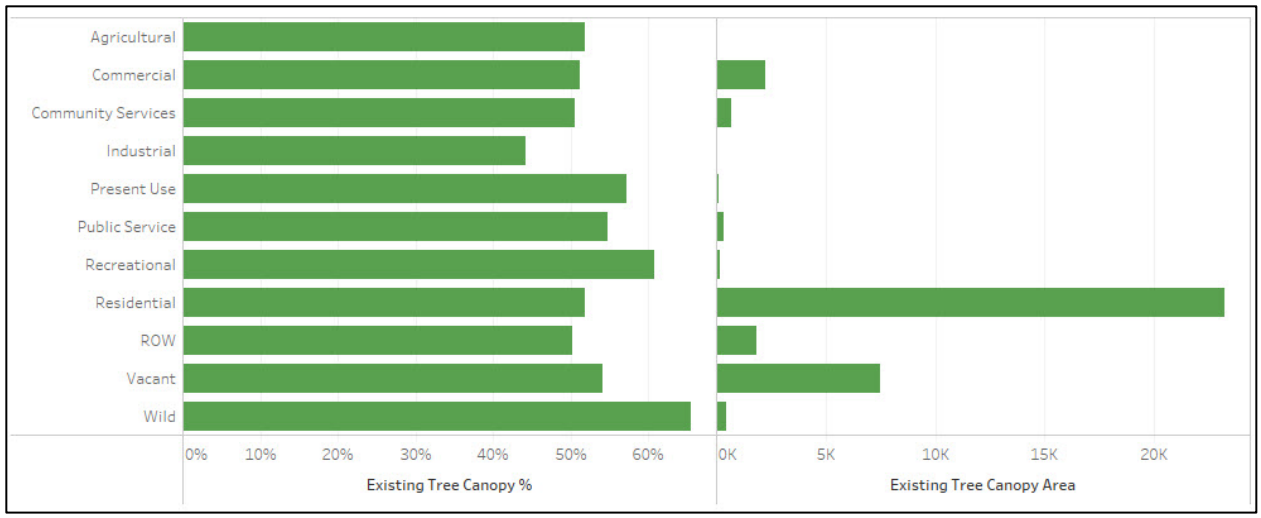

Figure 6. Percent existing tree canopy and total tree canopy area in each generalized land use type.

HOW MUCH TREE CANOPY AND HOW MUCH ROOM TO PLANT TREES IS WITHIN EACH WATERSHED?

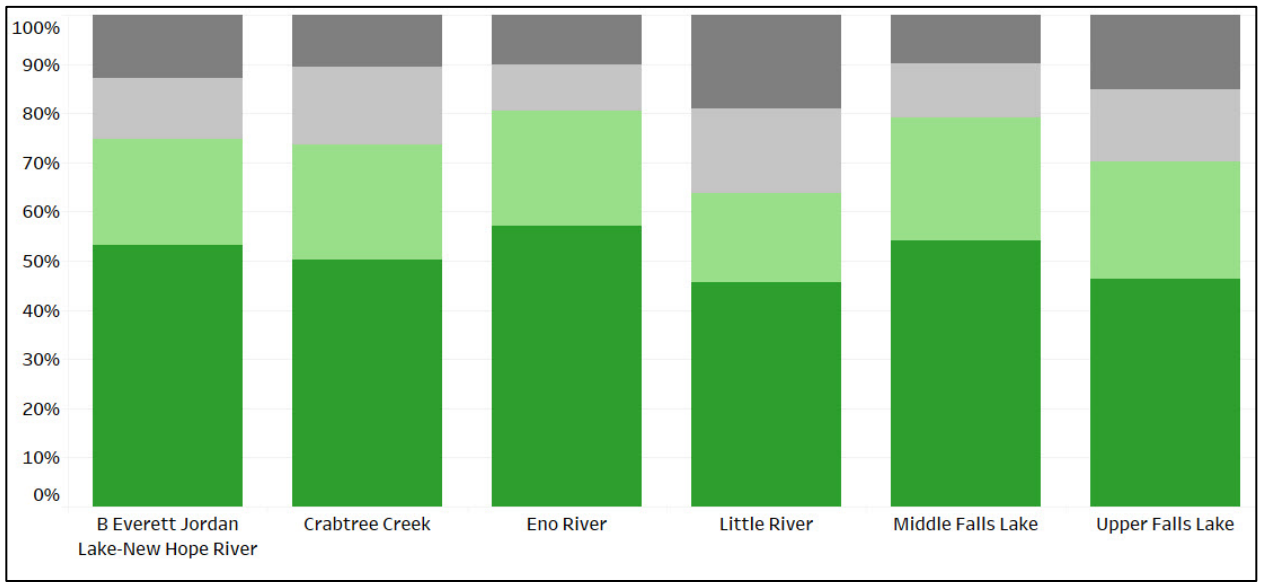

Figure 7. Tree canopy metrics for the portions of watersheds that fall within the city boundary: existing tree canopy (dark green), possible tree canopy that is vegetation (light green), possible tree canopy that is impervious (light gray), and land not suitable for tree canopy (dark gray).

Trees play an important role in the health of aquatic ecosystems, particularly in urbanized and agricultural areas where trees help to reduce runoff. Tree canopy metrics were generated for the portion of each watershed that fell within city limits (Figure 7). All watersheds have close to 50% tree canopy or slightly above. Maintaining this amount of tree canopy will help insure that Durham's rivers and streams are functional ecosystems for years to come.

HOW CAN THE TREE CANOPY ASSESSMENT HELP DURHAM DECIDE WHERE TO PLANT TREES?

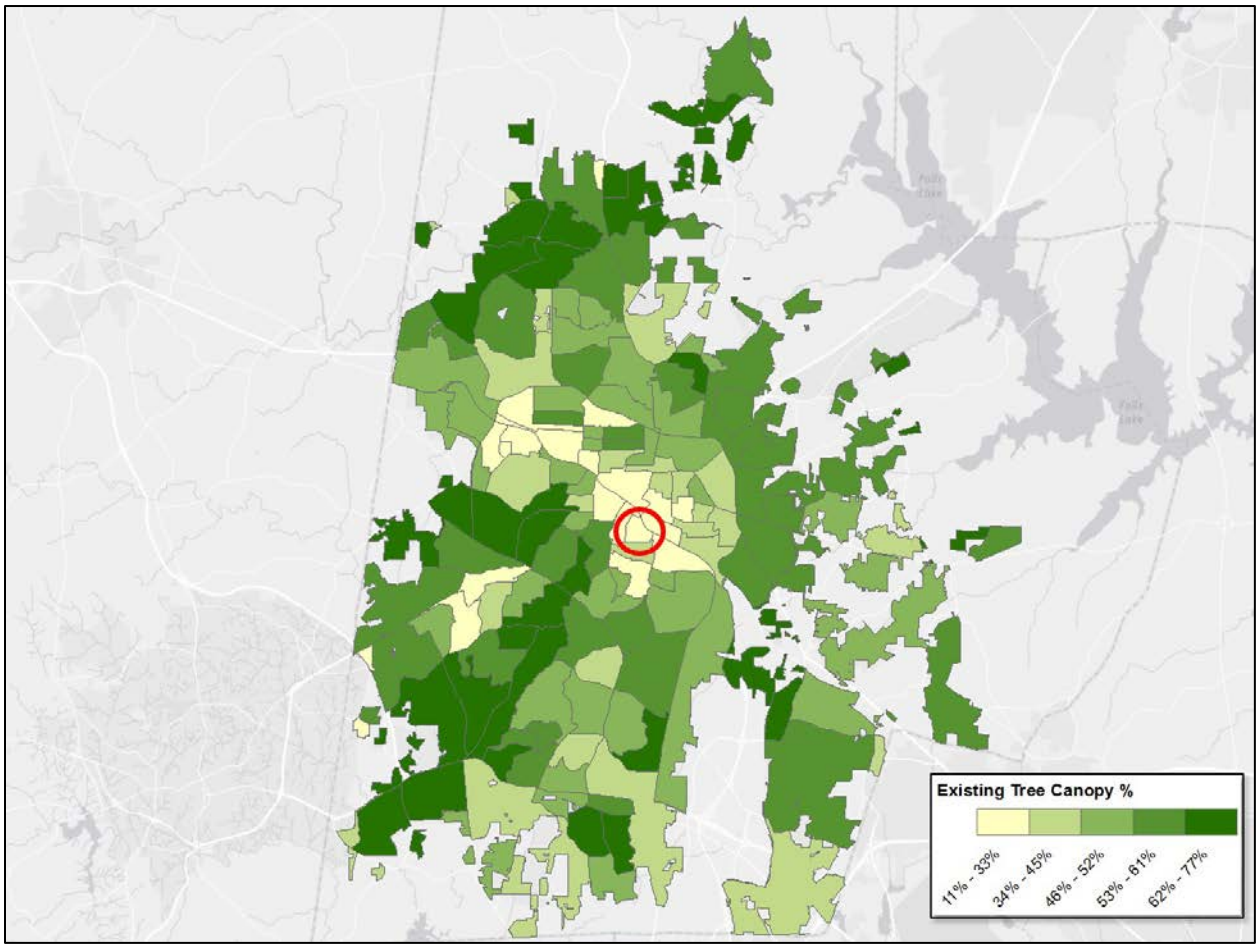

Figure 8. Percent existing tree canopy summarized for each Census block group.

The smallest unit of analysis for examining the relationship between sociodemographic information and tree canopy is the Census block group. Issues of environmental justice arise when tree canopy is unequally distributed based on factors such as income or ethnicity. Planting initiatives can help address these issues. We summarized tree canopy for each Census block group (Figure 8). The Census block group highlighted in Figure 8 has only 11% existing tree canopy, far below the city average. This area has a high diversity index (the likelihood that two persons randomly sampled are of a different race), lower than average income within the city, and the presence of young children is high compared to the average. In addition, there has been some recent construction in that area. The combination of these factors may make it an excellent candidate for a street tree planting initiative. Using the tree canopy data, we know that 29% of the ROW is vegetation without tree canopy, indicating that there is room to establish new street trees.

HOW CAN THE ASSESSMENT HELP DURHAM DECIDE HOW MANY TREES TO PLANT ANNUALLY?

The second part of the project was to help Durham decide on how its street tree management program can support a tree canopy goal through 2040.

There are 6,236 in the OpenTreeMap tree inventory dataset. The majority of these trees, 58%, are oaks. 5,642 of these were able to be assessed by iTree Eco (Figure 9).

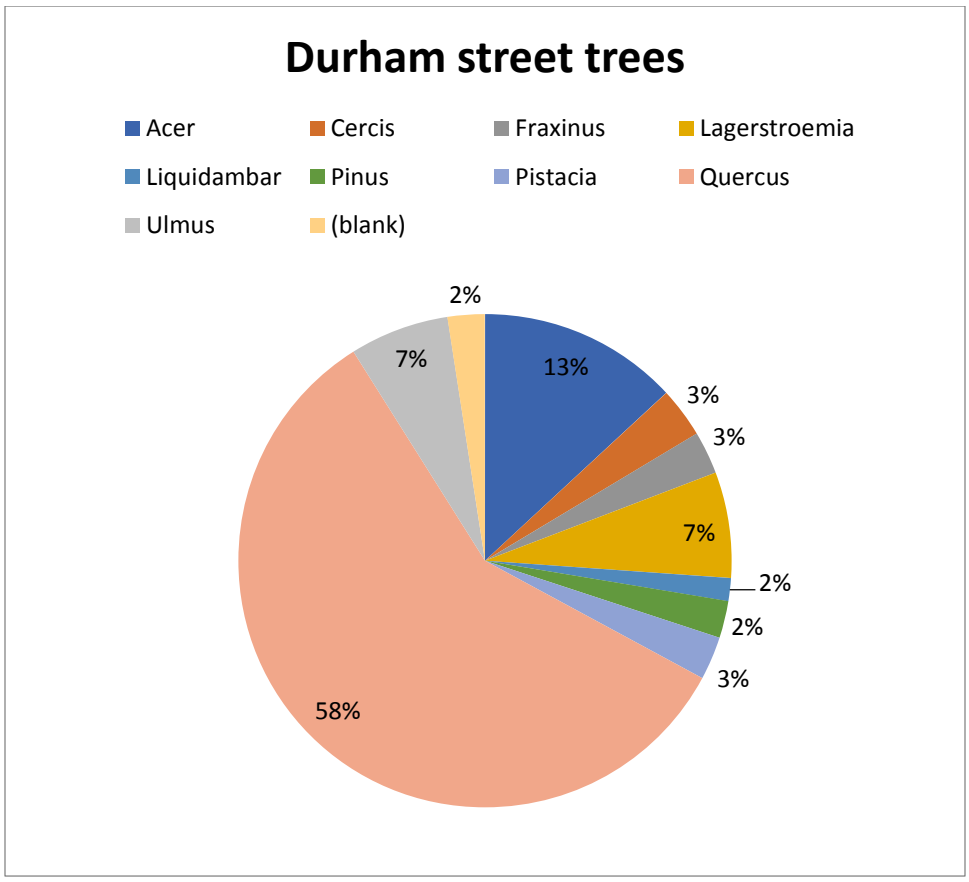

Figure 9. Durham's street trees by species.

Table 1 below show the canopy cover in acres provided by Durham's street trees under the present case (no tree planting program), and under the RFP scenarios of 500, 1,000, and 1,500 street trees planted annually.

Table 1 - Tree canopy provided by street trees through 2040 under various planting scenarios

Year	Time	Present case	500+ per year	1000+ per year	1500+ per year
2016	0	113.9	113.9	113.9	113.9
2017	1	111	111.9	112.7	113.2

2018	2	108.6	109.9	111.5	113.1
2019	3	106.3	108.4	110.9	113.7
2020	4	103.6	106.8	110.5	114.7
2021	5	101.2	105.8	110.8	116.6
2022	6	98.7	105.1	111.5	118.6
2023	7	96.6	104.4	112.4	121.1
2024	8	94.5	103.9	113.5	124.4
2025	9	92.1	103.5	115.3	128
2026	10	89.9	103.2	117.3	132.3
2027	11	87.9	102.9	119.7	137.1
2028	12	85.6	103.3	122.5	142
2029	13	83.8	103.7	125.3	147.5
2030	14	81.8	104.3	128.8	153.7
2031	15	79.8	105.2	132.4	160.2
2032	16	77.8	106.2	136.1	167.3
2033	17	75.6	107	140.6	175
2034	18	73.6	107.9	145.4	183.1
2035	19	71.6	109.1	150.3	191.7
2036	20	69.8	111	155.6	200.7
2037	21	68.2	112.7	161	209.6
2038	22	66.4	114.6	166.9	219.2
2039	23	64.6	117	172.4	229.3
2040	24	63.3	119.4	178.9	239.5

Impacts of planting scenarios in PROW tree canopy in 2040:

- Base case (no planting program): approximately 50% reduction
- 500 trees planted annually: approximately break-even
- 1,000 trees planted annually: greater than 50% increase
- 1,500 trees planted annually: more than double.

Value of pollutant reduction by PROW trees today is $23,874. Value of pollutant reduction under planting scenarios today and through 2040:

- Base case (no planting program): $13,599
- 500 trees planted annually: $38,578
- 1,000 trees planted annually: $63,179
- 1,500 trees planted annually: $87,778.

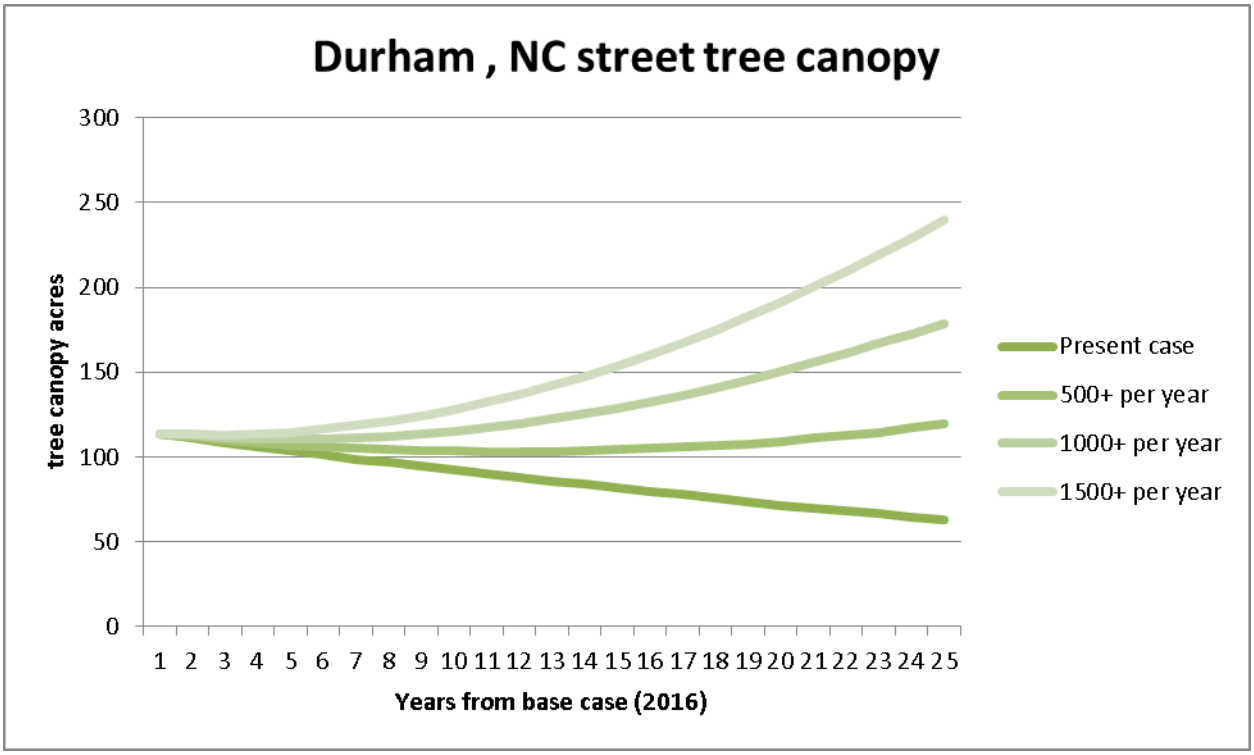

Figure 10 – Tree canopy provided by street trees through 2040 under various planting scenarios.

WHAT DOES SAVATREE RECOMMEND BASED ON OUR FINDINGS?

Based on our findings, we recommend the following:

- That the City use the data products from this assessment to begin a public engagement process to establish a tree canopy cover goal for the City. The goal should be to have a certain amount of tree canopy cover within a certain timeframe.
- That part of the process can be to look at strategies to maintain or enhance tree cover on private property since residential land use is by far the dominant land use in the City and therefore no strategy can be successful without it. Approaches could include both

voluntary program such as tree planting giveways and incentives, and regulatory programs such as tree preservation ordinances.

- That the City use a lead by example approach and plant at least 500 trees annually in order to maintain the present level of PROW tree canopy through 2040.
- That the new street tree inventory data be run through iTree Eco Forecast to get a more exact accounting of the canopy provided by the present street tree inventory and the projected canopy needs over the study period.
- That the City use census data to identify underserved communities to focus planting efforts in.
- That the City use the tree canopy data products and census data to identify vulnerable communities (census blocks with high numbers of children and elderly, those most vulnerable in heat waves) to target for heat island mitigation plantings.