Tree Canopy and Land Cover Assessment Report

Fairfax City, Virginia
Community Development and Planning Department
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SUMMARY

Fairfax City's Community Development and Planning Department requested a tree canopy and land cover assessment to be included in their 2035 Comprehensive Plan, along with guides for future assessments. Using ArcGIS and Pictometry imagery from March 2015, a survey of 1,000 randomly generated points were classified as either; canopy, grass and bare soil, impervious surface, or water, within the boundaries of Fairfax City. In addition, another survey was conducted the same way but through the US Forest Service's iTree Canopy Software. The results from the survey in ArcGIS were used as a control to compare against the results from iTree. The findings suggest that iTree Software is a reliable and accurate means of generating future land cover assessments.

The current canopy, which consists of trees and shrubs, covers 37.6% of Fairfax City's total area, with grass and bare soils covering an additional 21.30%. Impervious surfaces such as roofs, roads, and sidewalks occupy 40.6% of the city's area, with water only covering 0.05%.

Considering its urban setting and small size, Fairfax City seems to have a strong and healthy tree canopy. In order to monitor the canopy's size and track changes in land cover, Fairfax City should include the utilization of the US Forest Service's iTree Canopy Software in the 2035 Comprehensive Plan.

IMPORTANCE AND BENEFITS OF TREE CANOPY

Fairfax City is on a path to becoming a more urbanized center. The percentage of tree canopy decreases as an area becomes more urban, but recent studies have shown the importance of preserving a balance between infrastructure growth and tree canopy sustainability. Although the monetary benefits of canopy and trees and be difficult to quantify, an increasing number of rapidly growing urban centers are dedicating more resources toward tree and shrub preservation, especially in the Washington Metro Region. Although the aesthetic values may seem slight, residential property values are greatly reliant on green spaces. Within residential areas, trees and shrubs act as a noise buffer, which will become increasingly valuable as Fairfax City's traffic increases. Also, studies have shown that people are more likely to shop in areas with more canopy and pay more for property that has greater shade.

Another inevitable result of the city's growth will be a rise in air pollution. Trees are nature's most reliable method in the removal of airborne contaminants that can be harmful to humans and

animals such as carbon monoxide, nitrogen dioxide, and sulfur dioxide. Trees also absorb carbon dioxide, which can help growing cities to sequester their increasing levels CO_2 production.

Fairfax City's increase in development will be accompanied by a necessary expansion of impervious surfaces, which will result in greater volumes of stormwater runoff. Trees can help lessen the impact and cost of stormwater management. For example, tree roots absorb water in the soil leading to less runoff, and canopy reduces erosion as it acts as a barrier diminishing the impact of raindrops on the ground. Trees can also offset the associated costs of impervious surfaces by cooling urban heat islands. The actual shade from the tree seriously affects the amount of energy local businesses have to spend on heating and cooling.

METHODOLOGY

The need for a functional and reasonable means of land cover data collection will be necessary as Fairfax City grows. The iTree Canopy web application is a cost effective and simple way to conduct a land cover assessment. The imagery used is the most recent aerial images from Google Earth. Because the imagery is updated so often, it is a useful tool to measure tree canopy once or several times a year. The software was specifically created to be user friendly to those who are unfamiliar with GIS, which would allow for untrained community members to conduct the assessments. In order to determine the feasibility and accuracy of data collected through iTree Canopy, it was compared to data collected using the same method within ArcGIS, using higher resolution imagery Pictometry. In summary, this study was conducted to compare the tree canopy cover estimates from two different sources of remotely sensed data; freely accessible imagery from Google, and vendor only imagery from Pictometry.

The random point sampling method was chosen to use in ArcGIS for two reasons: it mimics iTree's sampling method, and other methods like plot/grid have been shown to be ineffective or unnecessary in urban areas. Studies have revealed that the random point sampling method shows too little of a significant difference than the plot/grid method to make the latter economically viable. This method is also preferred because it is less time consuming, requires minimal effort, and fewer opportunities for classification problems might arise, while still producing accurate results (US Forest Service: Southern Research Station, 2015).

In this study, the goal was to collect land cover data of four different types: trees and shrubs (current canopy), grass and bare soil, impervious surfaces, and water. The method of data collection adhered to a consistent procedure, in order to serve as a model for future assessments.

Guides were created to outline two means of data collection; one to be used by a GIS professional with vendor aerial imagery in ArcMap, and the other to be used by an average citizen with Google's aerial imagery in iTree Canopy.

In ArcMap, raster files provided by Pictomety were used as base layer imagery. Using the boundaries of Fairfax City as a constraint, 1000 random points were generated with a minimum buffer of one meter between points.

DATA AND ANALYSIS

ArcMap Data Summary			
Cover Class	**Total Points**	**Percent Cover**	**± Standard Error**
Trees and Shrubs (Canopy)	376	37.60%	1.53
Grass and Bare Soils	213	21.30%	1.29
Impervious Surfaces	406	40.60%	1.55
Water	5	0.05%	0.07

iTree Data Summary			
Cover Class	**Total Points**	**Percent Cover**	**± Standard Error**
Trees and Shrubs (Canopy)	379	37.90%	1.53
Grass and Bare Soils	241	24.10%	1.35
Impervious Surfaces	378	37.80%	1.53
Water	2	0.02%	0.14

The standard error was determined as such:

$$SE = \sqrt{(pq/N)}$$

SE=Standard of Error

p= total number of points classified as canopy/total number of points sampled

q= 1-p

N=Total points classified as canopy

For Canopy:
Difference between two percentages of canopy: **0.3%**
95% Confidence Interval: -4.01 to 4.61
Chi-squared: 0.019
Degrees of Freedom: 1
*Significance leve*l: **P=0.089**

For Grass and Bare Soils:
Difference between two percentages of canopy: **2.8%**
95% Confidence Interval: -0.941 to 6.53
Chi-squared: 2.233
Degrees of Freedom: 1
*Significance leve*l: **P=0.1351**

For Impervious Surfaces:
Difference between two percentages of canopy: **2.8%**
95% Confidence Interval: -1.54 to 7.13
Chi-squared: 1.644
Degrees of Freedom: 1
*Significance leve*l: **P=0.1998**

For Water:
Difference between two percentages of canopy: **0.03%**
95% Confidence Interval: -0.362 to 0.446
Chi-squared: 0.129
Degrees of Freedom: 1
*Significance leve*l: **P=0.7199**

RESULTS AND RECOMMENDATIONS

With a confidence interval of 95% and a resulting p-value of 0.89 , the difference in percent canopy cover estimated from ArcGIS (37.60%) and canopy estimated using iTree (37.90%) is statistically insignificant. This verifies that using iTree is statistically defendable and a reliable and accurate means of conducting tree canopy and or land cover assessments within Fairfax City.

This study has shown that iTree Canopy can be used by city officials and community members alike to conduct estimates for tree canopy. These findings will ensure that the City's canopy can be assessed consistently and accurately in the future. iTree also has the option of comparing a set of points classified in the past, and reclassifying them in the future. For example, with the saved random point locations from this study, it would be possible for someone next year to analyze the exact same points. This would be a useful tool in observing where the canopy is changing.

As Fairfax City continues to grow, it is inevitable there will be some canopy lost, but if the City has strict guidelines in place for both developers and home owners, damage to the canopy can be reduced. Tree stewardship and management becomes more complicated as more development occurs, but it should not be pushed aside as a second tier issue. If possible, the City would greatly benefit from hiring an arborist, or simply appoint a few individuals to be responsible for

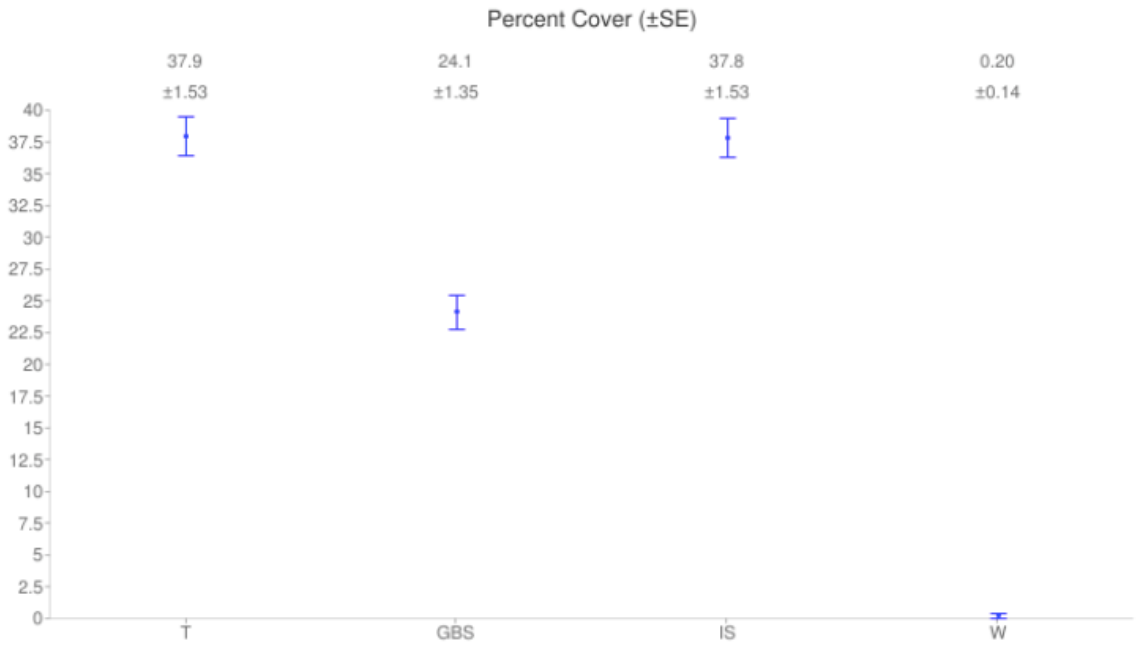
monitoring the urban forests' health. Community involvement should also be utilized. There should be workshops available for community members who are interested in planting sustainable tree species on their private property. Tree giveaway days could also be considered, if they are accompanied by community education.

In conclusion, Fairfax City currently has a healthy and sustainable canopy. In order to keep this canopy strong, long term guidelines need to be established to protect and sustain it. Tree canopy assessments should be conducted and monitored often. iTree Canopy software can be used quickly and easily for frequent tree assessments and aid in Fairfax City's plan for tree canopy management.

i-Tree Canopy v6.1

Cover Assessment and Tree Benefits Report

Estimated using random sampling statistics on 9/25/16



Cover Class	Description	Abbr.	Points	% Cover
Trees and Shrubs	Current Canopy	T	379	37.9 ±1.53
Grass and Bare Soils	Grass and bare soil	GBS	241	24.1 ±1.35
Impervious Surfaces	Pavement, roofs, sidewalks, etc.	IS	378	37.8 ±1.53
Water	Streams, Ponds, etc.	W	2	0.20 ±0.14

Tree Benefit Estimates

Abbr.	Benefit Description	Value	±SE	Amount	±SE
CO	Carbon Monoxide removed annually	$49.87	±2.02	1,241.17 lb	±50.24
NO2	Nitrogen Dioxide removed annually	$118.51	±4.80	3.68 T	±0.15
O3	Ozone removed annually	$5,325.02	±215.55	36.22 T	±1.47
PM2.5	Particulate Matter less than 2.5 microns removed annually	$9,977.89	±403.89	1.65 T	±0.07
SO2	Sulfur Dioxide removed annually	$28.95	±1.17	2.85 T	±0.12
PM10*	Particulate Matter greater than 2.5 microns and less than 10 microns removed annually	$2,963.60	±119.96	7.28 T	±0.29
CO2seq	Carbon Dioxide sequestered annually in trees	$268,270.93	±10,859.25	7,419.13 T	±300.32
CO2stor	Carbon Dioxide stored in trees (Note: this benefit is not an annual rate)	$7,040,967.65	±285,008.98	194,720.47 T	±7,882.03