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Do Trees in Halifax Grow on Money?: A Comparison of Urban Tree Canopy Cover and Median Household Income in North End and South End Halifax

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Abstract

Trees in the city provide numerous ecological, health, and social benefits to urban residents. Studies from large North American cities have confirmed a spatial pattern that higher urban forest tree canopy positively correlates with higher levels of affluence. The just distribution of trees will become increasingly important for urban planners and foresters as there is a national trend towards living in cities. This research report investigates the equity of distribution of urban tree canopy cover in two neighbourhoods on the peninsula of Halifax, Nova Scotia. High spatial resolution land cover data from 2007 and 2006 Statistics Canada census data was used to create maps and tables to answer the research question of whether or not canopy cover differs significantly in two neighbourhoods with varying socio-economic status. The socio-economic indicator of median household income is represented based on census tract dissemination areas from the 2006 Statistics Canada long survey. Preliminary results indicate lower median household income in the chosen study area of North End Halifax compared to higher median household income in the chosen study area of South End Halifax. Tree canopy cover density is slightly lower in North End Halifax (5.3%) than in South End Halifax (7.6%). These preliminary results coincide with findings of other researchers that higher household income at the neighbourhood level may result in increased urban forest canopy. However, further research and more reliant tree canopy cover data is needed to determine the accuracy of these findings.

1.0 Introduction to Urban Forestry

All urban residents should be able to access trees in the city to take advantage of trees' ecological, health, and social benefits. Increasingly, researchers are exploring the environmental justice of tree placement in urban neighbourhoods. This is most often measured through the environmental amenity of tree canopy cover. A just distribution of urban tree canopy cover across neighbourhoods with varying degrees of socio-economic status is important. Urban trees provide benefits to urban citizens, and all citizens deserve equal access to those benefits. This research report investigates the equity of distribution of urban tree canopy cover in sections of two neighbourhoods on the peninsula of Halifax, Nova Scotia.

Ensuring just distribution of urban tree canopy cover is important because trees provide ample ecological, health, and social benefits to residents. Ecological benefits include improved air quality when leaves trap airborne dust particles to later be washed away by rain (van Wassenaer, Schaeffer, & Kenney, 2000). Fuel is conserved when a parked vehicle is shaded because the vehicle is less likely to heat up and emit hydrocarbons from its tank than a vehicle that has been exposed to sunlight (Duinker et al., 2015). In the case of a well forested parking lots or street where cares park, urban trees provide ecological benefits while creating economic savings. Human health and well-being can be improved through the use of recreational green spaces for picnics, hiking, running, and biking (Duinker et al., 2015). Recent research indicates a reduction of fear levels from living in greener urban environments (Duinker et al., 2015). Abundant canopy cover makes urban environments more pleasant, increasing the likelihood for people to enjoy time in public spaces (Holton, Dieterlen & Sullivan, 2015). Just distribution of urban tree canopy cover ensures more residents enjoy these, and other, benefits.

1.1 Purpose of this Study

Canada is following a worldwide trend towards urbanization. Roughly 80% of all Canadians live in urban areas (Statistics Canada, 2017a). Accessibility of green space in the form of urban trees is increasingly important for urban residents to enjoy the benefits of a full urban canopy. Researchers in North American cities with populations greater than that of Halifax are concerned with the equitable distribution of trees across neighbourhoods with varying incomes and socio-economic status. However, the just and equitable placement of trees has never been professionally studied and reported on in Halifax.

This study aims to identify whether or not tree canopy is equally distributed throughout two Halifax neighbourhoods. The purpose of this study is to ensure urban forest planners in Halifax consider the equitable placement of trees in future planting. The Halifax Urban Forest Planning Team (2013) is devoted to maintaining trees for the benefit and enjoyment of every urban resident. The Halifax Urban Forest Planning Team (2013) has set an ambition goal of increasing total canopy cover in Halifax to 50%. The just distribution of the trees to be planted should be carefully considered.

2.0 Context: Similar Studies on the Equitable Placement of Urban Trees in North America

Environmental justice rose to importance in North American research agendas in the 1980's (Kedron, 2016). The study of environmental justice is focused on relationships between the environment and social forms (Kedron, 2016). The research focus of environmental justice is shifting from the placement of hazardous sites near marginalized communities to the placement and accessibility of environmental amenities, such as trees, near those same communities (Berland, Schwartz & Hermann, 2015).

Urban forestry goals are usually based on the indicator of canopy cover (Berland et al., 2015, HRM Urban Forest Planning Team, 2013). Studies similar to this have identified a positive correlation between canopy cover and affluence in urban environments (Steenberg, Robinson, & Millward, 2017). Socio-economic status can be defined by income, level of education, occupation, and ethno-cultural background, among others (Steenberg et al., 2017). Since little research into this correlation has been done in Halifax, and none has been published, this study examines research questions similar to other studies from larger cities within the study area of Halifax.

Similar studies look for correlation between tree canopy cover and affluence in cities with populations greater than Halifax. Schwarz et al., (2015) discovered a positive correlation between higher urban tree canopy cover and higher income in Baltimore, MD, Los Angeles, CA, Philadelphia, PA, Sacramento, CA, and Washington, DC, and no correlation in New York, NY and Raleigh, NC. Schwarz et al., (2015) studied Raleigh, NC, and although the smallest city in their study (population 276,093 in 2000) it had the highest mean percent tree canopy cover of 55% (Schwarz et al., 2015). Their findings indicated that urban tree canopy cover did not positively correlate with affluence in Raleigh (Schwarz et al., 2015). This could be because Raleigh is a generally affluent city with a median household income $46,612 (Schwarz et al., 2015). Although tree canopy cover and affluence correlations were not discovered within Raleigh, comparisons between their high canopy cover and high median household income can be drawn to cities with lower canopy cover and affluence.

In Baltimore, researchers found a positive relationship between urban tree canopy density at a neighbourhood level with amount of social capital at an individual level (Holton, Dieterlan & Sullivan, 2015). Indicators of social capital came from a Greater Baltimore Recreation and Neighbourhood Questionnaire, which asks about attitudes towards recreation, amenities, and quality of life in Baltimore (Holton et al., 2015). Holton et al., (2015) went beyond the scope of my study by investigating social capital. They define social capital as "the shared knowledges, norm, rules and networks that facilitate collective experience within a neighbourhood," referencing literature that links individual access to green space with stronger community social ties and trust (Holton et al., 2015, p. 505).

A study from Miami-Dade County discovered inequities in canopy cover between white, Hispanic, and African American neighbourhoods (Flocks, Escobedo, Wade, Varela & Wald, 2011). The researchers found predominantly white areas to have greater tree diversity (Flocks et al., 2011). However, predominantly Hispanic and African American neighbourhoods had more individual street trees (Flocks et al., 2011). The researchers addressed this limitation by noting that the predominant use of canopy cover as the main indicator of amount of green space in a city may be problematic (Flocks et al., 2011). Since canopy cover is the most common indicator of how much green space is in a city, their results suggest that the Hispanic and African American communities were greener. This would not be accurate without an assessment of tree quality. More research is needed on desirable tree characteristics beyond a full canopy cover.

Increasingly, researchers in large Canadian cities are investigating the just distribution of canopy cover. A recent study from Toronto, Ontario examined the spatial relationships between median household income and tree canopy cover (Greene, Robinson & Millward, 2018). Greene et al. (2018) used Moran's I statistic to determine a significant inequality in access to urban canopy cover across 531 census tract neighbourhoods. Median household income was selected as the indicator of socio-economic status for consistency with similar studies (Greene et al., 2018). Greene et al.'s findings that neighbourhoods with higher median household income are more likely to have higher canopy cover should contribute to future policy decisions related to urban forest management in Toronto.

2.1 Context: Public Interactions with the Urban Forest

Public interaction with the urban forest through citizen tree planting is important for increasing urban tree canopy. Home and business owners contribute to canopy cover by planting trees on their private property. In New York City (NYC), Grove, Locke & O'Neil-Dunne (2014), studied the demographic and socio-economic factors affecting the motivation and capacity of landowners to plant trees. Their study used diverse data sources including a NYC property database, time-series demographics, socio-economic data from the U.S. Census, and land cover data to answer research questions (Grove et al., 2014). An important consideration is that lower income individuals do not have the time and/or resources to plant trees on private lands that many higher income individuals do. The Halifax UFMP states that residents and businesses in wealthier neighbourhoods have more capacity to contribute resources to the urban forest and recommend the city provide resources to help lower income neighbourhoods gain equal access to urban forest benefits (HRM Urban Forest Planning Team, 2013). Understanding the motivations for planting or not planting trees on private land is important as society becomes increasingly urban.

This type of research has mainly been conducted in Canadian cities with populations larger than that of Halifax. In Toronto, Ontario, Steenberg, Robinson, & Millward (2017) confirmed their hypothesis that single-unit parcels, which are more likely to be lived in by the owners, had twice the rate of individual tree plantings than multi-unit parcels, which are more likely to be rented by occupants. Furthermore, they determined that home ownership in single-parcel units linked to lower rates of tree mortality than in multi-unit parcels (Steenberg et al., 2017). Lower income neighbourhoods are more likely to be dominated by renters than higher-income neighbourhoods. Renting restricts private tree planting options.

Steenberg et al. (2017), measured and inventoried 806 public street trees and private trees in front yards in Harbord Village, a neighbourhood in Toronto. They were interested in testing their hypothesis in Harbord Village because the neighbourhood is undergoing a process of gentrification as income and home ownership rates increase (Steenberg et al., 2017). The researchers conducted a preliminary study of whether or not gentrification leads to increased canopy cover. Grove et al. (2014) and Steenberg et al., (2017) recommend further consideration of how social and ecological neighbourhood changes affect canopy cover and the number of plantable spots.

3.0 Methods: Study Area

The study area is located within Halifax, the capital of Nova Scotia, which holds roughly 37% of the province's population (Statistics Canada, 2017b). European settlers navigated to what is known today as Halifax and established Peace and Friendship treaties with the Mi'kmaq and Maliseet who had enjoyed autonomy over the land for thousands of years prior to settler contact (Patterson, 2009). The study areas occupy unceded traditional Mi'kmaq territory. The researcher recognizes her privileged status as a student at Dalhousie University.

Halifax is a relatively well-forested city. With canopy covering 41% of land, Halifax is doing better than some of its urban counterparts, like Montreal (20% canopy cover) and Toronto (30% canopy cover) (Natural Resources Canada, 2016). Urban forest planning, monitoring, and maintenance is conducted by Halifax city planners, urban foresters, and a team at Dalhousie University (HRM Urban Forest Planning Team, 2013). They have divided

Halifax into 111 neighbourhoods for observation, all with varying social-economic indicators of wealth and well-being (HRM Urban Forest Planning Team, 2013).

Figure 1. Map 1: Study Area Map

The scope of this study has been narrowed down to small sections of two Halifax neighbourhoods, North End and South End. According to the boundaries set in the Halifax UFMP, North End is bounded by Robie Street, Africville Memorial Park, Barrington Street, North Street, and Agricola Street (HRM Urban Forest Planning Team, 2013). South End is bounded by the CNR rail line, Coburg Road, South Street, Robie Street, and the Halifax Port Authority (HRM Urban Forest Planning Team, 2013). The study areas for this project adhere to dissemination boundaries set by Statistics Canada (2016). Although based on Statistics Canada (2016a) boundaries, the two study areas of this map are located within the boundaries set by the Halifax UFMP.

Figure 1 outlines the boundaries of North End and South End Halifax used for this study. Within the boundaries of each neighbourhood there is a public park, a mix of multi-parcel and single-parcel residential units, and a school. The park in the North End is Merv Sullivan Park, known as The Pit because it is used for its baseball diamonds. A walking tour of Merv Sullivan Park indicated this park has a lower canopy cover than other urban parks, such as Point Pleasant Park. The park in the South End is Point Pleasant Park. Point Pleasant Park is a large, well treed, and culturally significant public park within walking distance to downtown Halifax (NIPpaysage & Ekistics Planning and Design, 2008). Point Pleasant Park is larger than Merv Sullivan Park, and this is likely to skew results within the South End neighbourhood. Point Pleasant Park was included in this study because the South End benefits from increased amenities provided by trees in a public park that is larger and has a greater canopy cover than that in the North End. The school in the North End is Nova Scotia Community College Institute of Technology. The school in the South End is Saint Mary's University. A walking tour of both sites indicated higher canopy cover density at both the school and the park in the South End.

3.1 Methods: Available Data - ArcMap10.5

ArcMap10.5 software was accessed through Dalhousie's technological services. Three maps were created (Figure 1: Map 1:

Study Area Map, Figure 2: Map 2: Median Household Income, Halifax, 2006, and Figure 3: Map 3: 2007 Canopy Cover in North End Halifax, 2007 Canopy Cover in South End, Halifax). The maps were created to visualize both the study area, as well as tree canopy cover density and median household income.

3.2 Methods: Available Data - Social Data

GIS layers from census dissemination areas were based on 2006 Statistics Canada long survey results. Information on median household income was downloaded from The University of Toronto Computing in the Humanities and Social Sciences (CHASS) data centre using the Canadian Census Analyser. The 2006 long survey was used because response was mandatory, unlike the optional 2011 long survey. 2016 long survey responses were not available at the time of this study. Furthermore, data from the 2006 long survey more closely aligned with tree canopy cover data, which was from 2007.

3.3 Methods: Available Data - High Resolution Tree Canopy

A shapefile with tree canopy cover for Halifax from 2007 was obtained from Dr. James Steenberg (Dalhousie University). The shapefile is an unsupervised classification of QuickBird Satellite Imagery and appears on Figure 3 as a map layer (DigitalGlobe, n.d.). QuickBird Satellite Imagery offers sub-meter resolution (55 cm panchromatic at nadir and 2.16 m multispectral at nadir) imagery and high geolocational accuracy (DigitalGlobe, n.d.). The satellite operates at a 400km altitude (DigitalGlobe, n.d). Since QuickBird Satellite Imagery is spectral data, vegetation is easy to identify. The data used for this report was high resolution and pan-chromatic. A limitation of this study is that canopy cover data come from 2007. The urban forest has likely changed in that some trees will provide greater canopy cover today than in 2007 while other trees have been removed or have died.

3.4 Methods – Comparison to Similar Studies

This study used visual comparison of tree canopy cover data and median household income displayed in maps (See Figure 1, Figure 2 and Figure 3). Numerical comparisons of median household income and tree canopy cover density are displayed in Tables 1, 2, 3, and 4. Greene et al. (2018) also compared median household income based on 2006 Statistics Canada long survey data and tree canopy cover from QuickBird satellite imagery visually in maps for Toronto. Greene et al. (2018) furthered the validity of their results by applying a local indicator of spatial autocorrelation (LISA) to the location, size, significance, and nature of spatial clusters of correlated extreme values between canopy and resident income variables. One limitation of this study is that similar measures were not taken to determine geographic linearity between tree canopy variables and medium household income.

Potential methods of analysis were based on similar studies conducted in North American cities. In the Miami-Dade County study, Flocks et al., (2011) used random sampling design, Geographic Information System plots created from US Census block group data, and the geo-spatial statistical tool Kriging to study the equitable provision of canopy cover amongst three racially diverse neighbourhoods. They divided 1,273 km^2 of land into plots with different land uses such as residential, industrial, and parks, among other (Flocks et al., 2011). Similarly, this study created two study neighbourhoods that each included at least one park and one school.

The methods of analysis for social data used by Flocks et al. were similar to those used for this study. Data from a Canadian census long survey was plotted using a GIS software to indicate socio-economic indicators of affluence within the two study neighbourhoods. However, their measurement of biophysical data was more in depth. Flocks et al., (2011) measured species, number of stems, diameter at breast height, total height, crown diameter, and indicted whether the tree was publically or privately maintained. Land cover classifications and full tree inventories rare because they are expensive and time consuming (Schwarz et al., 2015). Therefore, Flocks et al. (2011) likely had more time and resources for this extensive analysis of tree canopy cover and other conditions. The benefit is that their results provide a more comprehensive picture of tree condition beyond canopy cover in Miami-Dade County.

Canopy cover was used in this study to determine levels of urban forestry in North End and South End Halifax. An important consideration in studies such as these are that canopy cover does not reflect quality and condition of trees (Berland et al., 2015). Species diversity is a desirable urban forest characteristic beyond canopy cover. An urban forest with good species diversity is often more resilient to extreme wind and weather events (Steenberg, Duinker, & Charles, 2013). Since certain trees species are more desirable than others, equal canopy cover across neighbourhoods with different socio-economic status does not always indicate environmental justice (Berland et al., 2015). Although there are other determinants of what makes a desirable urban forest, canopy cover is the most common.

3.5 Methods - ArcMap10.5

A variety of data sources and technologies were used to answer the research question. The Geographic Information System (GIS) software ArcMap10.5 was used to create three maps of the study area, canopy cover, and median household income in North End and South End Halifax (See Figure 1: Map 1: Study Area Map, Map 2: Median Household Income, Halifax, 2006, and Figure 3: Map 3: 2007 Canopy Cover in North End Halifax, 2007 Canopy Cover in South End, Halifax). Geographical boundaries, roads, buildings, and parks, are visible on the maps through the

ArcMap10.5 World Base Imagery. The projected coordinate system is WGS 1984 Web Mercator Auxiliary Sphere. The projection is Mercator Auxiliary Sphere and the datum is WGS 1984.

3.6 Methods - Social Data

Before indicators of socio-economic status of both neighbourhoods were determined, general population information was added to the base map. The Canadian Census Analyzer was used to analyze survey results from Halifax based on the 2006 long survey (CHASS, 2017). Information on male and female population was downloaded to a .csv file. In this file, total male and female population aged 18-75 was calculated. Then the .csv file joined the basemap so population information could be viewed in GIS.

Once population information based on Halifax dissemination areas was on the base map, information about median household income based on 2006 long-form Census results was downloaded (CHASS, 2017). Median household income was chosen as an indicator of affluence because it indicates general differences between neighbourhoods where one neighbourhood can be classified as higher income than the other. Using the "select by attribute" tool dissemination areas for the North End and the South End were selected. Dissemination areas used were within the neighbourhood boundaries set by the Halifax UFMP, and when joined they each have a park and a school within their boundaries. These dissemination areas were joined based on DUAID and exported to two new shapefiles. This way, the map viewer can see median household income classified in quintiles only in the neighbourhoods of interest (See Map 2: Median Household Income, Halifax, 2006).

3.7 Methods - High Resolution Tree Canopy

QuickBird Satellite Imagery of Halifax tree canopy cover was added to the base map. This layer was clipped based on the boundaries previously created for south_end.shp and north_end.shp. The percent of tree canopy cover for each neighbourhood was calculated based on the count from each neighbourhood clipping divided by the area. It was beneficial that the data was based on aerial imaging from 2007, because they two data sets used for this study were collected within one year of each other.

4.0 Results – Median Household Income

The median household incomes for the chosen study areas within North End and South End differed, as can be seen in the maps and tables (See Figure 2, Table 1, and Table 2). Based on the average of the five dissemination areas chosen to make up the North End study neighbourhood, North End had a lower median household income than South End (See Table 1 and Table 2).₩

Table 1: Median Household Incomes for North End

Dissemination Area	Area (m^2)	Median Household Income ($)
12090224	102,443.43	26,486
12090225	113,568.01	24,562
12090226	102,775.60	22,797
12090227	151,819.51	28,252
12090848	211,768.77	19,550
12090851	127,668.05	34,383
	Total area= 810,043.387 m^2 0.81 km^2	Average median income: 26,005

Table 2: Median Household Incomes for South End

Dissemination Area	Area (m^2)	Median Household Income ($)
12090292	270,051.818	No data
12090293	224,921.449	44,002
12090294	1,010,375.155	59,564
	Total area: 1,505,348.424 m^2 1.5053 km^2	Average Median income: 34,522

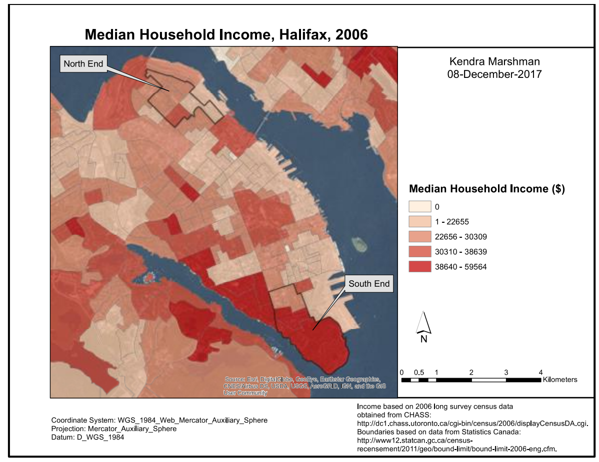

Figure 2. Map 2: Median Household Income, Halifax, 2006

4.1 Results – Canopy Cover Density

The findings of this study coincide with the Halifax UFMP report of identical canopy cover between North End and South End Halifax. The UFMP reported 27% canopy cover for both North End and South End Halifax in 2013 (HRM Urban Forest Planning Team). The HRM Urban Forest Planning Team (2013) measures and assesses all publically planted trees in Halifax yearly. Their reported canopy cover is likely more accurate than the count from the Quickbird Satellite Imagery because HRM puts ample time and resources into ensuring data accuracy by hiring Dalhousie students to undertake tree inventories every summer (HRM Urban Forest Planning Team, 2013). However, their data could not be used because its timing did not match up with the 2006 Canadian long survey results.

The results of this project show canopy cover density of 53s trees per hectare (ha) for North End Halifax and 766 trees per ha for South End Halifax (See Figure 3: Map 3: 2007 Canopy Cover in North End Halifax, 2007 Canopy Cover in South End, Halifax, Table 3 and Table 4). Canopy cover density was calculated based on total tree count of the Quickbird Satellite Imagery and total area of each study area.

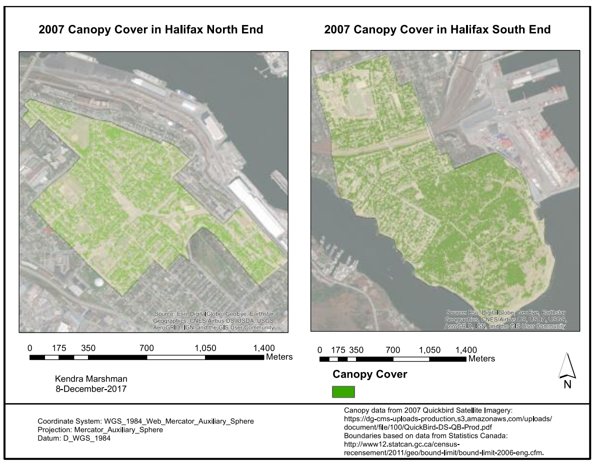

Figure 3. Map 3: 2007 Canopy Cover in North End Halifax, 2007 Canopy Cover in South End

Table 3: Canopy Cover for North End

Number of Trees	Area	Density (trees per ha)
44,801	81.00 ha 0.81 km^2	553

Table 4: Canopy Cover for South End

Number of Trees	Area	Density (trees per ha)
115,404	150.53 ha 1.51 km^2	766

5.0 Discussion & Recommendations

Higher canopy cover increases home property values. Schwarz et al., (2015) note a common feedback loop where this might result in individuals with higher incomes moving into neighbourhoods with higher tree canopy cover. An example of this within the South End study area is the high-income neighbourhood Marlborough Woods. On the other hand, neighbourhoods with low tree canopy cover are more likely to have lower housing prices and rents (Schwarz et al., 2015). Therefore, residents of these neighbourhoods may have less access to resources and fewer incentives to increase property value through planting trees (Schwarz et al., 2015). A few reasons for this could be that they are renters and have no interest in increasing property value, or their spending priorities are not focused on improving urban forest canopy (Schwarz et al., 2015). This feedback loop can partially account for why certain neighbourhoods have higher canopy cover than others.

Since many municipal governments have goals of enhancing urban canopy cover, lower-income neighbourhoods should receive assistance for planting projects. The residents of wealthy neighbourhoods have more time and resources to plant trees on their private property. For example, Harbord Village has a residents' association involved in community tree planting activities (Steenberg et al., 2017). The HRM

Urban Forest Planning Team (2013) has identified North End Halifax as a priority neighbourhood and has a goal of increasing its canopy cover. The UFMP indicates, "all HRM citizens deserve to enjoy a fulsome set of urban forest benefits in and near their residences and places of work and recreation" (2013, p. 38). The Halifax UFMP promotes partnerships between local government and North End community groups to achieve urban forest targets (HRM Urban Forest Planning Team, 2013). North American cities where positive correlation has been determined between urban canopy cover and affluence should follow Halifax's lead in creating targets to improve the canopy cover in lower-income neighbourhoods.

In Halifax, there are challenges for planting trees beyond economics and low citizen incentive. One challenge in the North End, which may account for the slightly lower canopy cover than South End, is the higher proportion of impervious surfaces which limit planting potential (HRM Urban Forest Planning Team, 2013). The HRM Urban Forest Planning Team (2013) has set a goal of increasing canopy cover in North End parks from 22% to 40%. Targeting parks as sites where canopy can be improved is a strategic step towards improving canopy cover in a lower-income neighbourhoods.

This study found slight differences in canopy density between two neighbourhoods. This might mean that Halifax has done a good job at ensuring equitable tree placement between neighbourhoods with varying levels of affluence. However, this study is limited in its generalizability because the study sites were restricted to two specific neighbourhoods in Halifax. A future research project should include a greater diversity of neighbourhoods beyond North End and South End. This would diversify the available data for analysis.

Correlation does not mean causation. In this study, I am making assumptions based on correlations of urban forest canopy cover and levels of affluence. If the findings had indicated a significantly lower canopy cover density in North End compared to South End and the paper reported that it was a result of varying median household incomes and population densities, this would be a generalization. This is due, in part, to not having preformed any cross tabulation to verify the results. A future research project should undertake qualitative research to determine what people think about canopy cover in their respective neighbourhoods. This is an important consideration because canopy cover does not consider access to natural sites and the quality of nature within those sites.

Berland et al., (2015) suggest further research into urban forest characteristics "beyond canopy cover" for ensuring environmental justice (Berland et al., 2015, p. 11). Berland et al., (2015) recommend consideration of quality of trees and species variation (Berland et al., 2015). Similar research should take place in Halifax to determine the just and equitable distribution of trees across neighbourhoods. If it is determined that species diversity is a better indicator of a healthy urban forest than canopy cover, urban foresters should encourage the public to plant diverse tree species. Furthermore, urban foresters should avoid even-aged plantings where trees mature and die at the same time (Steenberg, Duinker, & Charles, 2013). This will result in enhanced urban forest benefits.

6.0 Conclusion

This study suggests slight difference in canopy cover between a lower-income and higher-income neighbourhood in Halifax, Nova Scotia. Urban foresters understand and promote the many benefits provided by trees. It is important that they also understand the socio-economic forces that result in certain neighbourhoods having more canopy cover density than others. Understanding the environmental justice implications of urban forestry will help to inform management decisions that results in all neighbourhoods enjoying urban forest benefits.

References

Berland, A., Schwartz, K., & Herrmann. (2015). How environmental justice patterns are shaped by place: Terrain and tree canopy in Cincinnati, Ohio, USA. *Cities and the Environment*, *8*(1), 1-15. Retrieved October 06 2017 from http://digitalcommons.lmu.edu/cate/vol8/iss1/1.

CHASS. (2017). *Canadian census analyser: Profile of dissemination areas: 2006 census/cumulative profiles.* Retrieved November 24 2017 from http://dc1.chass.utoronto.ca/cgi-bin/census/2006/displayCensusDA.cgi.

DigitalGlobe. (n.d.). *QuickBird*. Retrieved December 01 2017 from https://dg-cms-uploads-production.s3.amazonaws.com/uploads/document/file/100/QuickBird-DS-QB-Prod.pdf.

Duinker, P. N., Ordóñez, C., Steenberg, J. W. N., Miller, K. H., Toni, S. A., Nitoslawski, S. A. (2015). Trees in Canadian cities: Indispensible life forms for urban sustainability. *Sustainaility*, *7*, 7379-7396. doi: 10.3390/su7067379.

Flocks, J., Escobedo, F., Wade, J., Varela, S., & Wald. (2011). Environmental justice implications of urban tree cover in Miami-Dade County. *Environmental Justice*, *4*(2), (125-134). doi: 10.1089/env.2010.0018.

Greene, C. S., Robinson, P. J. & Millward, A. A. (2018). Canopy of advantage: Who benefits most from city trees? *Journal of Environmental Management, 208*, 24-35.

Grove, J. M., Locke, D. H., & O'Neil-Dunne, J. (2014). An ecology of prestige in New York City: Examining the relationships among population density, socio-economic status, group identity, and residential canopy cover. *Environmental Management*, *54*, 402-419. doi: 10.1007/s00267-014-0310-2.

Holtan, M. T., Dieterlen, S. L., & Sullivan, W. C. (2015). Social life under cover: Tree canopy and social capital in Baltimore, Maryland. *Environment and Behavior*, 47(5), 502 – 525. doi: 10.1177/0013916513518064.

HRM Urban Forest Planning Team. (2013). *Halifax Regional Municipality Urban Forest Master Plan.* Halifax, NS: Halifax Regional Municipality.

Kedron, P. (2016). Identifying the geographic extent of environmental inequalities: A comparison of pattern detection methods. *The Canadian Geographer, 60*(4), 479-492. doi: 10.1111/cag.12297.

Million Trees NYC. (2015). *About million trees NYC.* Retrieved September 22 from http://www.milliontreesnyc.org/html/about/about.shtml.

Natural Resources Canada. (2016). *The state of Canada's forests Annual Report 2016*. Retrieved from https://cfs.nrcan.gc.ca/publications?id=37265.

NIPpaysage & Ekistics Planning and Design. (2008, October). Point Pleasant Park: Comprehensive Plan. Halifax, NS: Canada.

Ordóñez, C., Duinker, P. N., Sinclair, A. J., Beckley, T., & Diduck, J. (2016, January). Determining public values of urban forests using a sidewalk inception survey in Fredericton, Halifax, and Winnipeg, Canada. *Arboriculture & Urban Forestry, 42*(1), 46-57.

Patterson, S. (2009). Eighteenth-Century Treaties: The Mi'kmaq, Maliseet, and Passamaquoddy experience. *Native Studies Reviews*, *18*(1), 25-52. Retrieved from http://preserve.lib.unb.ca/wayback/20141205151655mp_/http://contestedterrain.lib.unb.ca/sites/default/files/patterson_nsr_2009.pdf.

Schwarz, K., Fragkias, M., Boone, C., Zhou, W., McHale, M., Grove, J., O'Neil-Dunne, J., McFadden, J., Buckley, G., Childers, D., Ogden, L., Pincetl, S., Pataki, D., Whitmer, A., & Cadensso. (2015). Trees grow on money: Urban tree canopy cover and environmental justice. *PLoS ONE, 10*(4), 1-17. doi: 10.1371/journal.pone.0122051.

Statistics Canada. (2017a). *Canada goes urban*. Retrieved September 26, 2017 from http://www.statcan.gc.ca/pub/11-630-x/11-630-x2015004-eng.htm.

Statistics Canada. (2017, August 25b). *Census profile, 2016 census, Halifax [census metropolitan area], Nova Scotia and Nova Scotia [province].* Retrieved October 9 2017 from http://www12.statcan.gc.ca/census-recensement/2016/dp-pd/prof/details/page.cfm?Lang=E&Geo1=CMACA&Code1=205&Geo2=PR&Code2=12&Data=Count&SearchText=Halifax&SearchType=Begins&SearchPR=01&B1=All.

Statistics Canada. (2016, November 25). *2006 census – boundary files*. Retrieved November 24, 2017 from http://www12.statcan.gc.ca/census-recensement/2011/geo/bound-limit/bound-limit-2006-eng.cfm.

Steenberg, J. W. N., Duinker, P. N., & Charles, J. (2013). The neighbourhood approach to urban forest management: The case of Halifax, Canada. *Landscape and Urban Planning, 117,* 135-144. doi: dx.doi.org/10.1016/j.landurbplan.2013.04.003.

Steenberg, J. W. N., Robinson, P. J., & Millward, A. A. (2017). The influence of building renovation and rental housing on urban trees. *Journal of Environmental Planning and Management*, 1-15. doi: http://dx.doi.org/10.1080/09640568.2017.1326883.

van Wassenaer, P. J. E., Schaeffer, L., & Kenney, W. A. (2000). Strategic planning in urban forestry: A 21st Century paradigm shift for small town Canada. *The Forestry Chronicle, 76*(2), 241-245.