# Urban Forest Management and Research in Halifax, NS

## Contributions from the School for Resource and Environmental Studies, Dalhousie University

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**Foreword and Acknowledgements**

My involvement with HRM in urban-forest affairs began in earnest with my membership on the Point Pleasant Park Recovery Task Force following Hurricane Juan in September 2003. That engagement led eventually to membership on the consulting team that prepared the Point Pleasant Park Comprehensive Plan in 2006-2008 (NIPpaysage et al., 2008). I joined the Steering Committee for the HRM Urban Forest Master Plan in 2007, and in 2010 assumed a leadership role alongside planner John Charles to prepare that plan. Meanwhile, I had gone to the Social Sciences and Humanities Research Council with a proposal to study urban-forest values and won a substantial grant for this research.

Since that exciting beginning, I have had the honour and pleasure to be engaged in a wide variety of research and planning projects associated with trees in the city. Collaborations with my academic and practitioner colleagues and my numerous students and research associates have been formative and deeply rewarding experiences. Clearly, many people and organizations have been pivotal in their contributions to the success of urban-forest management and research in our Dalhousie-HRM collaborations. With sincerest gratitude, I acknowledge their contributions as follows. For funding, I am indebted to HRM (contracts), SSHRC (grants and scholarships), NSERC (scholarships), the Ufor CREATE Network at UQO (scholarships), the Government of Nova Scotia (scholarships), Mitacs (internship funding), and Dalhousie University (student support). I thank Dalhousie's Office of Research Services, along with other administrative offices, for facilitating my grants and contracts. My collaborators at HRM have been vital partners in the work: John Charles, Planner; John Simmons, HRM Urban Forester; Kevin Osmond, HRM Urban Forestry Supervisor; Shilo Gempton, HRM Planner; Crispin Wood, HRM Manager of Urban Forestry; and Natalie Secen, Supervisor of Contracts, HRM Urban Forestry. My academic collaborators have been John Sinclair at University of Manitoba and Tom Beckley at University of New Brunswick.

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I acknowledge the immense contributions to urban-forest scholarship made by my research students Camilo Ordóñez, Shawna Peckham, James Steenberg, Sophie Nitoslawski, Bimal Aryal, Maliheh Rostami, Alison Walsh, Stephen Cushing, Paul Singh, Wendy Margetts, Jessica Quinton, Heba Jarrar, Anna Irwin-Borg, Jordan Haughn, Levyn Radomske, and Tyler Doucet.

I apologize deeply to any people and organizations who have been erroneously missed from these thankyous. I also apologize in advance if any important documents and accomplishments

have been missed in this report - please bring them to my attention so I can include them appropriately.

Finally, I inform readers that this is the last version of this report that I will write. I will continue to engage with some graduate students at Dalhousie and will associate with the School for Resource and Environmental Studies on future scholarly writings, but I am no longer leading a research program on urban forests at Dalhousie. From here on, my urban-forest energies will be devoted to nurturing the website www.halifaxtreeproject.com, and other miscellaneous pursuits including consulting through my firm Sylveritas Ltd.

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## 1. Introduction

Collaboration is a hallmark of contemporary applied scholarship. The mutual learning emanating from successful collaborations in resource and environmental management benefits the management organizations as they strive to reduce uncertainties associated with major funding initiatives as well as the scholars who gain insights at the time and space dimensions of real management problems.

Staff of Halifax Regional Municipality and scholars at Dalhousie University's School for Resource and Environmental Studies decided in 2008 to become embedded in each other's work associated with urban forest management and research in Halifax. Embeddedness is the style of collaboration we sought to implement (Van Damme et al., 2008). In embedded relationships, HRM staff have become integral members of the scholarly enterprise of the professor and students, and the Dalhousie scholars have become integral members of the management enterprise associated with the city's trees. When the personalities of the major participants are such that working relationships become friendship relationships, the synergies are palpable and the results striking.

The centrepiece of the collaborative relationship is the HRM Urban Forest Master Plan (UFMP) (HRM Urban Forest Planning Team, 2013). However, the participants have engaged in a wide range of supporting work that finds its record in a host of other documents. In this report, my aim is to catalogue the entire spectrum of work associated with Halifax's urban forests that has been done either independently by HRM staff or Dalhousie scholars, or jointly by the two organizations.

Please note that HRM now refers to the municipal government and Halifax refers to the entire territory of the municipality. This change became effective in 2014 and has led to some confusion about what is meant by Halifax in contemporary parlance.

## 2. Overview of Events, 2000-2023

Here is a point-form list of relevant events and processes:

- Sep 2001 - first discussion at HRM Council about the need for a UFMP
- Sep 2003 - Hurricane Juan visited Halifax; severe tree blowdown in Point Pleasant Park; about one week passed before the city has completely mobile and all electrical service restored
- Sep 2006 - commitment to developing a UFMP was made in the Regional Planning Strategy
- 2007-2008 - forest inventory completed for the Urban Forest Effects (UFORE) model
- May 2010 - UFMP planning activities begin in earnest in the first year of formal collaboration between HRM Urban Forestry and SRES (at this time of writing, we have concluded our 7th year of collaboration under a research contract between HRM and Dalhousie)
- Sep 2012 - draft UFMP endorsed by HRM Regional Council
- Spring 2013 - first contracted street-tree plantings in spring/summer
- July 2013 - final revised version of the UFMP published
- Fall 2013 - first contracted street-tree plantings in autumn

- Winter 2014 - first contracted street-tree prunings
- Spring/Summer/Fall 2014 - second year of contracted street-tree plantings
- Summer 2014 - special initiative on fruit trees in community gardens
- Aug 2014 - publication of the UFMP Digest
- Winter 2015 - second season of contracted street-tree prunings
- Spring/Summer/Fall 2015 - third year of contracted street-tree plantings
- Spring/Summer/Fall 2016 - fourth year of contracted street-tree plantings
- Summer 2016 - forest inventory completed for i-Tree Eco model (formerly UFORE)
- Summer 2016 - first inventory of damage to young street trees from grass-cutting equipment
- Fall 2016 - beginning of third season of contracted street-tree prunings
- Fall 2016 - analysis and reporting to HRM on the results of the iTree Eco study
- Spring/Summer/Fall 2017 - fifth year of contracted street-tree plantings
- Fall 2017 - beginning of third season of contracted street-tree prunings
- Winter 2018 - recommendations from Dalhousie to HRM on program renewal
- Spring/Summer/Fall 2018 - sixth year of contracted street-tree plantings
- Winter 2019 - fourth season of contracted street-tree prunings
- Spring/Summer/Fall 2019 - seventh year of contracted street-tree plantings
- Winter 2020 - fifth season of contracted street-tree prunings
- Spring/Summer/Fall 2020 - no tree plantings due to the COVID-19 pandemic
- Winter 2021 – contracted street-tree prunings
- Spring/Summer/Fall 2021 – eighth year of contracted street-tree plantings
- Winter 2022 – contracted street-tree prunings
- Spring/Summer 2022 – ninth year of contracted street-tree plantings
- Winter 2023 – contracted street-tree prunings

## 3. The Urban Forest Master Plan

### 3.1 Planning

After an initial series of meetings in the period 2007-2009, the UFMP planning process began in earnest in summer 2010. Details of the process are well described in the UFMP itself (HRM Urban Forest Planning Team, 2013); here we summarize the major sets of planning activities up to 2013.

Community Engagement - media events and releases began in summer 2010 and have continued since. Several focus groups and open houses were held in 2010-2012 to set the UFMP scope, identify priorities among urban-forest values, review progress with the plan, and discuss implementation issues. Team leaders also hosted frequent urban-forest walkabouts to help participants understand better the opportunities and issues associated with managing trees in the city.

Neighbourhood Analysis - to account for the significant variation of urban-forest quantity and quality across the diverse expanse of HRM's serviced core, the planning team divided the UFMP service area into 111 neighbourhoods. Using several sets of data, including remotely sensed imagery, we analyzed the canopy and then prepared neighbourhood-specific prescriptions for

ongoing development of the urban forest. Five neighbourhoods - Quinpool-Connaught, Halifax North End, Fairview, Eastern Passage, and Colby Village - were singled out for priority in street-tree plantings for the first years of contract planting.

Values, Objectives, Indicators, and Targets - to set the UFMP on a solid foundation of the public's values associated with trees in the city, we followed the lead of the Canadian Standards Association (2009) in establishing a systematic framework for translating values into practical targets for managers to try to achieve.

Principles - the plan contains both guiding (numbering four) and operational principles (numbering 15) to guide overall management of the HRM urban forest.

Actions and Implementation - the plan establishes 32 action sets for delivery against the plan's goals and objectives. An implementation schedule, complete with estimated costs and responsibility assignments, rounds out the plan.

Research and Monitoring - planning for any large system, including urban forests, is beset with considerable, and sometime enormous, uncertainty. Monitoring is used to track key indicators to determine the degree to which they are behaving as predicted in the plan. Research is performed in specific issue areas to shed light on important management questions. The plan contains specific directives on the research and monitoring required for successful plan implementation.

## 3.2 Implementation

With the HRM Council endorsement of the Plan in September 2012, formal implementation commenced in April 2013. This means that, at this time of writing, we are in the midst of the 11th year of implementation.

### 3.2.1 Planting

Prior to plan implementation, the majority of street trees planted in Halifax were installed by city staff or planted by contractors as part of new developments or re-construction of roads and sidewalks. There is no precise estimate of the number of trees thus planted each year, but urban-forest staff with the city estimate the number to have been 1000-1500 per year for many years.

The plan calls for a significant increase in the number of trees to be planted in the city streets. To pursue this objective, HRM engaged private companies, through contract, to plant most of the new trees. All contracts were competitively awarded through a public bidding process.

Contracting out large street-tree plantings was a new venture for city staff, and a range of issues arose during the contract planting programs of 2013, 2014, and 2015. As a result, MREM student Katherine Witherspoon (2015) was asked to undertake an analysis of the experiences and learnings of those three years and recommend improvements in the contracting process. For 2016 and beyond, city staff have implemented many of those improvements. Experience with the 2016 contract tree planting showed that several issues remain to be resolved before full confidence in

the success of street-tree planting is warranted. A standing order was implemented with a tree-planting firm to plant the entire suite of trees for three years running – 2020, 2021, 2022. We are now back to annual contracts for 2023.

A major part of the ongoing collaborative process between HRM and Dalhousie University since the Plan was finished has been research and monitoring associated with Plan implementation. The core monitoring project is to establish an inventory of as many of the new trees as possible, focussing mainly on the contract-planted trees but also trees planted by city staff and under other contracts. The inventory includes a spatial registration for each new tree and measurements of its height, diameter, and condition. The data, held in electronic form in a database and linked to a geographic information system, are used to track the early development of the new trees as they move through the vulnerable first few years of establishment and growth and become long-term residents of the street environment. Because each tree represents a capital investment by the city, the data will also become part of the city's asset database.

### 3.2.2 Pruning

Besides improving the street-tree canopy through planting, another key management need is to maintain the existing street trees. Until the Plan was adopted, street-tree maintenance - mainly through pruning but also removals where necessary - was accomplished either by the city in response to requests through the 311 facility or by Nova Scotia Power as part of its program of keeping electricity wires clear of tree crowns. Urban forest managers have long preferred to put their street trees onto a cyclical pruning schedule so that each tree is visited by a pruning crew at fixed intervals, perhaps as frequent as every seven years. Cyclical pruning helps shape young trees so that structural problems in later life are minimized and helps keep older trees in healthy condition by removing deadwood.

In an effort to move toward a cyclical pruning program, HRM implemented contract pruning programs in the winters of 2014, 2015, 2017, 2018, 2019, 2020, 2021, 2022, 2023.

### 3.2.3 Public Outreach and Education

The Plan calls for ongoing public outreach and education associated with its implementation. The urban-forest collaborative group has designed and implemented the following activities to try to help citizens learn about the trees in the city.

Fruit Trees in the City (Urban Orchards)

Following the Mayor's Conversation on a Healthy and Liveable Community in autumn 2013, HRM Regional Council passed a motion for staff to develop an urban-orchard program for the city. Our team held two public consultations on this topic, in June 2014 and February 2015. Two documents were associated with the June-2014 workshop: a discussion paper in advance of the workshop (Lesko et al., 2014a), and a report to HRM outlining the workshop's findings (Lesko et al., 2014b). As a consequence of the team's work, an urban-orchard pilot project was implemented in 2014 in the Dartmouth Common, and several community gardens planted fruit

trees in 2015.

<u>Digest</u>

The UFMP is a daunting document of 440 pages. On the assumption that HRM citizens would prefer a more-accessible summary of the plan, we produced a digest version of 42 pages (Charles and Duinker, 2014) that one can download from the HRM website (see immediately below).

<u>Social Media</u>

The HRM Urban Forest Planning Team actively maintains a presence on the HRM website ([www.halifax.ca/property/ufmp](www.halifax.ca/property/ufmp)) as well as Facebook ([https://www.facebook.com/HRMUFMP/)](https://www.facebook.com/HRMUFMP/)) and Twitter ([https://twitter.com/HalifaxUFMP)](https://twitter.com/HalifaxUFMP)).

Urban-Forest Walkabouts

Each year, members of the team lead walkabouts, of 1.5 to 2.0 hours in length, in various parts of the city. Citizen attendance ranges from a handful of people up to many dozens of participants. The point of a walkabout, which is designed as a learning exercise, is to discuss with citizens a range of issues related to trees in the city while viewing those very issues in the streets or in city parks. Sometimes the team takes initiative to offer walkabouts in specific areas of the city, but team members also accept invitations from various organizations to lead a walkabout. A rough estimate of the number of walkabouts led by team members is about 10 events each year. I intend to continue offering to lead urban-forest walkabouts, and extend an open invitation to any individuals or organizations to engage me in leading a walkabout.

### 3.2.4 Regulation Development

Three major initiatives have been undertaken in relation to the theme of regulations associated with urban forests in Halifax. One is a review by Dalhousie planning students on a suite of regulatory tools recommended for development in the HRM context (Ashe et al., 2013). Second, HRM staff members are leading the development of a "Tree Technical Manual: Halifax Regional Municipality Standards and Specifications" (HRM, 2017). Members of our urban-forest team at Dalhousie have been contributing to the specs and standards document through background research and reviews of drafts. The document was expected to be brought before HRM Council for approval in 2018; however, it is still in development and consideration at the staff level.

### 3.2.5 Community Tree Plants

The UFMP encourages HRM citizens to become engaged in hands-on projects associated with the urban forest. The most satisfying such projects, and those most amenable to citizen participation, are plantings of tree seedlings. HRM frequently receives requests from local groups to assist in facilitating such projects by providing leadership and planting sites. Since the UFMP was published, many such projects have taken place around the city. Both the HRM urban-forest leaders and the Dalhousie team are enthusiastic about the prospect that a new or

existing non-government organization might take up the challenge of facilitating such community tree plants.

## 4. The State of the Halifax Urban Forest

An original intention for this document was to summarize the state of the Halifax urban forest with comprehensive information derived from various datasets assembled mainly by our Dalhousie group. Over time it became clear that this is a much greater task than this report was able to accommodate. Therefore, two additional documents were planned to fill the void. One is is the report of the iTree Eco project of 2016 (Foster and Duinker, 2017). The second is a journal manuscript (Duinker et al., 2022) that will summarize what we know about the HRM urban forest from all the datasets assembled since the 1970s, by both us and others.

## 5. Research and Planning Support at the School for Resource and Environmental Studies

Research and planning support at SRES on sustainable urban forests has been vigorously pursued for more than a decade. Major funding agencies have been the Social Sciences and Humanities Research Council (grants and scholarships), the Natural Sciences and Engineering Research Council (scholarships), the Halifax Regional Municipality (through research and development contracts), Mitacs, and SRES itself (scholarships). A wide variety of topics has been addressed across both social and biophysical themes using a range of methods and implementation approaches. What follows is a comprehensive listing of all the projects we have undertaken, and their associated publications.

### 5.1 Research Project Summaries

### 5.1.1 Undergraduate Thesis Research

Shortly after the devastation of Point Pleasant Park by Hurricane Juan in September 2003, we started a series of undergraduate research projects undertaken by students seeking an honours degree. The nine projects I supervised are these:

Kalkreuth, J.M. 2006. Characterizing Post-hurricane Coarse Woody Debris and Overstorey in Point Pleasant Park, Halifax, NS. Unpublished Honours Thesis, Environmental Science Program, Dalhousie University, Halifax, NS. 55 pp.

Three growing seasons after Hurricane Juan, Johanna collected data on downed woody debris and overstorey surviving trees at four sites chosen to represent the full range from lowest hurricane damage to virtually complete hurricane damage. The least-damaged site had very little downed woody debris (owing to the regular cleaning of such material by park staff up to the end of the twentieth century) and over a thousand trees per hectare. The most damaged site, now designated as tour stop #6 on the self-guided tour of the park, had just 17 trees per hectare but over two hundred cubic metres of downed wood on the ground. At this time of writing (2015), much of that downed wood is well rotted and close to the ground (lower than one metre), whereas in 2006 is was still hard with much of it perched up to three metres above the ground.

Steenberg, J.W.N. 2007. Post-Hurricane Coniferous Regeneration in Point Pleasant Park. Unpublished Honours Thesis, Environmental Science Program, Dalhousie University, Halifax, NS. 64 pp.

James measured the abundance of conifer seedlings across the entire southern half of the park. He found as few as under a thousand conifer seedlings per hectare in some areas to as high as five thousand seedlings per hectare in other areas. Most seedlings were red spruce. James' work was published in 2010 in the Proceedings of the Nova Scotian Institute of Science (see Appendix 9.1).

d'Entremont, N. 2010. Snags in Point Pleasant Park. Unpublished Honours Thesis, Environmental Science Program, Dalhousie University, Halifax, NS.

Nicole quantified the snag population in Point Pleasant Park. Snags are unusually abundant in the Park because of Hurricane Juan - it not only killed many trees during the event without knocking the trees down, but it also weakened many surviving trees to such an extent that they have been dying steadily during the past dozen years since the hurricane. Nicole found snags to be in high abundance in the park, particularly snags of white pine and red spruce.

Kerr, H. 2013. A First-Approximation Windthrow Risk Index for Street Trees on the Halifax Peninsula. Unpublished Honours Thesis, Environmental Science Program, Dalhousie University, Halifax, NS. 61 pp.

In this study, Heather aimed to create a vulnerability index to determine the susceptibility of individual trees and neighbourhoods to wind events in the future on the Halifax Peninsula. Trees were analyzed based on specific characteristics: species, height, diameter at breast height, distance from nearest building, height of nearest building, pruning, site conditions, distance from coast and elevation, Data from one hundred trees across the Halifax Peninsula were used to demonstrate the utility of the index. It was determined that the most susceptible trees were scattered across the Peninsula. However, the most vulnerable neighbourhood was located on the southwest coast, in the direction of the prevailing winds that pass through in the summer.

Margetts, W. 2015. Old Growth among Us: A Characterization of Urban Old-Growth Forests in Halifax. Unpublished Honours Thesis, Environmental Science Program, Dalhousie University, Halifax, NS. 44 pp.

Wendy's objective was to determine whether old-growth forest stands inside the city of Halifax were of similar characteristics to old-growth stands in the province's hinterland. She measured the overstorey's and downed woody debris in six stands in the city and two outside. She also used data collected by the province to characterize the province's best old-growth stands. Overall, Wendy found that old-growth within the city was surprisingly close in old-growthness - based on the overstorey and downed deadwood - to the hinterland stands. This means that the city administration could feature these six stands, all of which are in municipal parks, and encourage citizens to visit and learn about old-growth forests right in their neighbourhoods.

Wendy's work is being prepared for publication (see Appendix 9.5).

Marshman, K. 2015. The Fruits of Nature: Investigating the Prospects for Fruit Trees on Halifax School Grounds. Unpublished Honours Thesis, Programs in Canadian Studies, and Environment, Sustainability, and Society, Dalhousie University, Halifax, NS. 62 pp.

By interviewing staff and parents at elementary schools in Halifax, Kendra tried to find out whether there is both biophysical and social capacity to grow more fruit trees on school grounds. Both questions were answered in the affirmative. Having small orchards on school grounds serves both an environmental-education function and a nutrition function.

Jarrar, H. 2018. Assessing the Vulnerability of the HRM Urban and Rural Canopy to the Potential Arrival of the Emerald Ash Borer. Unpublished Honours Thesis, Environmental Science Program, Dalhousie University, Halifax, NS. 40 pp.

Abstract: "Invasive species are an ever-increasing problem in urban and rural forests, and have the potential to severely decimate tree populations. The Emerald Ash Borer (EAB) is one such invasive species, which targets ash trees. Ash trees are ecologically, socially, and economically valuable trees. The EAB is predicted to move into the Halifax Regional Municipality (HRM), and this of concern to many forest managers. In this study, I assessed the vulnerability of ash trees in the urban and rural HRM to the potential arrival of the EAB. This assessment was conducted using spatial data compiled from different studies and sources. The locations of ash trees were extracted from these datasets to get a spatial distribution of the ash trees in the HRM. An assessment of the distribution was then conducted using the tree metrics provided in the data (e.g. diameter at breast height (DBH), stem count/plot), the spatial distribution of ash trees, and the existing literature on EAB dispersal. The objective of the study was to show how the urban and rural forest will be affected by the EAB. It was found that 2.54% of the trees found in the urban forest were ash trees, and that in the rural forest, 0.02% of the trees in the FRI data, as well 0.14% of trees found in the UFORE and PSP data, were ash. The urban forest may be more susceptible to the EAB given the shorter distances between ash trees, compared to the longer distances between ash trees and groves in the rural forest. However, given the overall low density of ash trees found in the datasets, the movement of EAB into the HRM may not affect the overall canopy cover to a high degree. The spatial distribution will provide forest managers with a clear depiction of which areas may be affected the most. It will also aid in deciding which mitigation practices can be put in place to contain the spread of EAB should it arrive into the HRM."

Irwin-Borg, A. 2019. Potential Effects of Climate Change on Survival of the Invasive Hemlock Woolly Adelgid (Adelges tsugae (Annand)) in Nova Scotia, Canada. Unpublished Honours Thesis, Environmental Science Program, Dalhousie University, Halifax, NS. 47 pp.

Abstract: "Hemlock woolly adelgid (HWA) kills hemlock trees by injecting poison into their stems as the feed on sap, defoliating the trees. This insect has caused widespread eastern hemlock death across the northeastern United States (US) and its presence was confirmed in Nova Scotia in 2017. Eastern hemlock trees are foundation species, creating unique ecosystem

dynamics in their habitats, and they are also a defining species of tolerant coniferous old-growth Acadian forests, which are valuable biodiversity hubs in Nova Scotia. HWA mortality after exposure to extreme low winter temperatures has been well studied, and 91% mortality has been found to keep HWA populations under control. This study used an equation developed for northeast US forests to determine theoretical HWA mortality using mean winter temperatures for a past (1981-2010) scenario and representative concertation pathway (RCP) 2.6, 4.5, and 8.5 scenarios for the near future (2041-2070) and distant future (2071-2100). Stands containing hemlock are also shown in the maps to depict areas of concern. It was found that some high-elevation, northern regions of Nova Scotia would have kept HWA populations under control, causing >90% HWA mortality, but stands containing hemlock are generally not present in these areas. Areas with >90% mortality were not found in any of the future scenarios. The differences between the near future and distant future scenarios were lowest for RCP 2.6 and highest for RCP 8.5, with RCP 4.5 falling in the middle. Because this study used equations developed for the northeastern US, future research should focus on developing HWA mortality equations for Nova Scotia. Future studies should also consider more variables that have been linked to HWA population distributions."

Haughn, J. 2020. The Implications of the Emerald Ash Borer (*Agrilus planipennis*) on Riparian Canopy Cover in Three Halifax Regional Municipality Parks. Unpublished Honours Thesis, Environmental Science Program, Dalhousie University, Halifax, NS. 52 pp.

"Invasive species are posing an increasingly large threat to Canada's urban forest. The Emerald Ash Borer (EAB) is an invasive pest with the potential to eliminate entire ash stands. The EAB was discovered in Nova Scotia in 2018. In this study I aimed to address the research question "what are the implications of the EAB on short-term riparian zone canopy cover in three Halifax Regional Municipality (HRM) parks?". Both census and cruise-transect-sampling methods were exercised to determine ash proportions and distribution in each park. For the census method, all trees within the park were measured (diameter at breast height (DBH), crown condition, crown position) and digitally geo-positioned to determine distribution. Using an equation derived from existing ash data, ash crown projections were then calculated for each ash tree based on DBH. The cruise method was conducted using plots dispersed along a transect line stretching the length of the stream. It was found in the park undergoing census method (Fish Hatchery Park) that ash accounted for approximately 30% of total canopy cover within the assessed park. Analysis of plot data demonstrated ash presence in 41% of all plots sampled, only five of which were projected to fall below Nova Scotia's riparian-zone regulatory basal area as a result of ash removal. In Moirs Mill Park, ash accounted for 20% of all trees measured, and were present in eight of the 11 plots. In Sir Sandford Fleming Park, ash accounted for 5.5% of all trees measured and were present in eight of the 20 plots. Overall, the arrival of EAB will have a modest impact on riparian canopy cover in the HRM parks sampled. The visual distribution and location-specific data along the riparian zone will help forest managers and planners understand areas of highest risk."

Radomske, L. 2023. Characterizing the Conifer Density Gradient from the Halifax Peninsula to the Hinterlands of the Halifax Regional Municipality. Unpublished Honours Thesis, Environmental Science Program, Dalhousie University, Halifax, NS. 61 pp.

"The urban-forest tree-species composition is influenced by the urban environment and thus by daily anthropogenic activity. However, in the naturalized woodlands, species composition is primarily influenced by natural disturbances. In moving away from the urban setting to the naturalized forest, there is a shift in the environment leading to a transition of dominant species, ultimately creating a species composition gradient. This study characterized the conifer gradient through assessing the Halifax Peninsula, surrounding communities, and the hinterlands of the HRM. The assessment of the conifer density on the Halifax Peninsula followed a probabilistic sampling technique in which ocular estimates were conducted to produce a conifer inventory for the study area. To assess the conifer density in the other study areas, two independent datasets were analyzed. Further analyses on other cities' conifer densities were conducted to develop benchmark values for the HRM. Through these assessments, it became apparent that there is a steep conifer gradient in the transition from the urban environment to the naturalized environment. These data can be used to question the lack of conifers in the urban forest despite their prominence in the naturalized setting and in other cities."

Two additional undergraduate thesis projects were undertaken in 2015-16. While they relate to urban forests and urban greening, they were not specifically about trees in Halifax.

Singh, P. 2016. The Implementation of Lawn Alternatives on Front Yards in Halifax, Nova Scotia. Unpublished Honours Thesis, Environmental Science Program, Dalhousie University, Halifax, NS. 82 pp.

Paul surveyed the front yards of some three thousand homes in ten Halifax neighbourhoods to document the amount and type of lawn decommissioning occurring in the city. Lawn decommissioning is indeed occurring, but at a modest rate. Most of it occurs in older neighbourhoods with small front yards.

Pilkington, C. 2016. Deconstructing the Modern Research Paper: A Case Study. Unpublished Honours Thesis, Program in Environment, Sustainability, and Society, Dalhousie University, Halifax, NS. 48 pp.

Caitrin examined a 2015 paper by Linda Chalker-Scott in which the author promotes the use of non-native tree species in urban-forest plantings purportedly on the basis of scientific evidence. Caitrin shows that the evidence is largely not scientific but rather laden with the author's personal values in relation to native and non-native tree species.

### 5.1.2 Master's Thesis Research

The centrepiece of research-based educational programming at the School is the Master of Environmental Studies. Eleven students have completed master's theses on urban forests.

MacKenzie, T. 2005. Ecological Effects of Development in Urban Forests: The Case of Hemlock Ravine Park in Nova Scotia. Unpublished Master's Thesis, School for Resource and Environmental Studies, Dalhousie University, Halifax, NS.

Tracey undertook an analysis of Hemlock Ravine Park using software called CITYgreen, a product of American Forests. He showed the enormous benefits, in terms of ecosystem services, provided by the Park, and how further erosion of the Park as a consequence of expansion of urban infrastructure is detrimental to environmental quality.

Steenberg, J.W.N. 2010. Climate Change Impacts and Adaptations in the Forests of Central Nova Scotia. Unpublished Master's Thesis, School for Resource and Environmental Studies, Dalhousie University, Halifax, NS.

"Global climate change is at the forefront of issues in forest management. Forest managers are now faced with the challenge of incorporating climate change into their forest management values and objectives, as existing paradigms may be invalidated by the changing climate. The exploration of climate change impacts and formulation of potential management strategies will be necessary to reduce the vulnerability of forests. Halifax Water manages forest watersheds for the purpose of supplying clean water to much of the Halifax Regional Municipality. The purpose of this study is to characterize the future forest structure of the two principal watersheds supplying the Halifax Regional Municipality and to evaluate different adaptations incorporated into forest management using a modelling approach. The landscape disturbance model LANDIS-II and ecosystem process model PnET-II were used to simulate the forest response to climate change and adaptive measures in timber harvesting. Several impacts of climate change were examined in the study area. The most drastic effect of climate change in the watersheds was considerable change in forest composition, with a sharp decline in the abundance of boreal species, such as balsam fir and black spruce, and an aggressive increase in some temperate and pioneer species, such as red maple and aspens. Incorporating climate change adaptation into timber harvesting scenarios was found to be effective in minimizing trade-offs between timber supply and forest ecosystem integrity in the face of climate change. The watersheds managed by Halifax Water represent a situation where the principal objective is the maintenance of water quality as opposed to timber production, and therefore offer a unique opportunity to implement cutting-edge practices and adaptive forest management focused on climate change resilience and resistance while also facilitating transition to the changing climate."

Peckham, SC. 2010. Nature in the City: Ecological Consciousness Development Associated with Naturalized Urban Spaces and Urban Forest Values in Calgary, AB and Halifax, NS. Unpublished Master's Thesis, School for Resource and Environmental Studies, Dalhousie University, Halifax, NS. 131 pp.

To collect her data, Shawna used focus groups and field tours with diaries. Here is her abstract: "In an increasingly urbanized world, how cities are designed and built affect how urbanites connect to the natural world and develop an ecological consciousness. Findings indicate that people value different urban landscapes for unique reasons but that urban trees provide numerous aesthetic, psychological, social, educational, ecological, moral and economic benefits. Many urban forest values are interwoven across these value categories. How people defined nature, what emotional states the landscape engendered and how they were able to actively engage with natural elements within urban landscapes all influenced participants' sense of belonging to a

broader natural community. Overall, findings support the notion that naturalized spaces, even small spaces, can invoke a sense of connectedness with nature within participants. Yet, many respondents suggest that urban nature experiences may not be enough for the general population to develop an ecological consciousness, rather that they require additional educational support." This research was published in 2013 (see Appendix 9.1).

Rostami, M. 2011. Tree Species Selection for the Halifax Urban Forest under a Changing Climate. Unpublished Master's Thesis, School for Resource and Environmental Studies, Dalhousie University, Halifax, NS. 119 pp.

"Tree selection is critical to ensuring that urban forests are diverse, healthy, and adapted to the urban environment. Climate is one of the main controllers of plant distribution around the world, so tree species are expected to redistribute as a result of climate change. This research aimed to identify which eastern North American tree species should be most suited for planting in urban areas in Halifax given impending climate change. A database was developed for 57 tree species and 95 tree characteristics to enable analysis of tree species native to eastern North America. The results of previous climate envelope research and the database were used to identify the tree species most suitable for planting in Halifax. Of the 57 tree species examined, 16 were identified as most suited for the Halifax urban forest of the 21st century." (Maliheh's database is available by request from me).

Walsh, A. 2012. Potential Urban Forest Carbon Sequestration and Storage Capacities in Burnside Industrial Park, Nova Scotia. Unpublished Master's Thesis, School for Resource and Environmental Studies, Dalhousie University, Halifax, NS. 119 pp.

"Urban and industrial settings represent potential areas for increased carbon (C) sequestration and storage through intensified tree growth. Consisting of an estimated 1270 ha of land once entirely forested, Burnside Industrial Park (BIP) in Dartmouth, Nova Scotia. Our study examines the degree to which intensified urban tree planting within the BIP ecosystem could enhance C sequestration and storage. This was achieved by conducting a geospatial analysis in combination with construction of a C model. Three scenarios urban forest development were examined. If all potential planting spots are filled with trees by 2020, an estimated 26,368 tC, at a sequestration rate of 635 tC/yr, could be achieved by 2050. Next, we explored the challenges and opportunities associated with pursuing C offset markets as a means for funding urban forest development within BIP. A basic framework from which a community based C offset market could potentially be established was recommended."

Toni, S.A. 2015. A Framework for Urban Forest Naturalization. Unpublished Master's Thesis, School for Resource and Environmental Studies, Dalhousie University, Halifax, NS. 138 pp.

"The way we design and manage cities directly impacts our quality of life. Urban ecosystems differ markedly from their rural surroundings due to the high density of built infrastructure, and are considered 'unnatural'. Naturalization is the process of altering the characteristics of urban greenspaces so that they resemble nearby ecosystems. Increasing naturalness has social, ecological, and economic benefits. The two objectives of this thesis were to create a conceptual

framework for urban forest naturalization and test its use in guiding management decision-making. Thirty-eight framework dimensions were determined from a literature review on naturalness assessments and urban ecology, and using professional judgment. Sixteen urban sites in Halifax, Nova Scotia, and Winnipeg, Manitoba were visited that represented a broad range of urban settings, from an untreed roadside field to old-growth portions of parks. Each site received a score from 0 to 1 on each of sixteen naturalness dimensions. Applications of the framework to the sites demonstrated that management activities typically fell into one of three categories: stand initiation, site transformation, or monitoring. Within individual sites, the actions to achieve these goals differed. For instance, some 'transformation' sites require the introduction of native ground flora coupled with the removal of invasive species, while others require an increase in canopy differentiation and species composition. The framework thus helped pinpoint individual actions or goals that could be targeted to increase overall naturalness. Future research should consider how urban residents perceive different scores along the various framework dimensions, as psychological benefits may relate to perceived rather than ecological naturalness. Some dimensions may contribute to perceived but not ecological naturalness, or vice versa. It is important for managers to understand how their activities impact the experience of urban residents in greenspaces as well as non-human species."

Sydney's framework is already published (Appendix 9.1).

Nitoslawski, S. 2016. Managing and Enhancing Urban Tree Diversity: a Comparison of Suburban Development in Two Canadian Cities. Unpublished Master's Thesis, School for Resource and Environmental Studies, Dalhousie University, Halifax, NS. 138 pp.

"Significant losses in biodiversity occurring worldwide have prompted researchers, practitioners, and policy-makers to explore strategies for protecting and enhancing biodiversity in urban areas. Urban forests, or trees found within the city, are integral components of green infrastructure and provide numerous ecological services. Given the widespread suburbanization of Canadian cities, it is crucial to explore the mechanisms by which subdivision development influences forest composition. This study assessed whether suburban neighbourhoods with contrasting pre-urbanized landscapes exhibited differences in tree diversity losses or gains due to development. Two cities were chosen based on the landscape present prior to urbanization: Halifax, developed onto woodlands, and London, developed onto farm fields. Trees in four neighbourhoods were sampled, representing two development decades and three land types: remnant woodland, streetscapes, and residential properties. The land types examined reflect differences in tree establishment, ownership, planting preferences, and administration. Changes in policies and species-selection decisions likely explain diversification in newer streetscapes in both cities. Older residential properties located adjacent to remnant forest stands were dominated by native trees, alluding to species dispersal across green spaces over time. These results emphasize the importance of considering both spatial and temporal contexts when managing and enhancing urban forest diversity. Instead of simply aiming to maximize biodiversity in suburban areas, practitioners and stewards should acknowledge differences in forest composition based on land use and tenure, and embrace flexibility and adaptation when shaping and managing tree-species diversity."

Aryal, B. 2017.  Economic and Biophysical Implications of Alternative Street-tree Spacings in Halifax, Canada. Unpublished Master's Thesis, School for Resource and Environmental Studies, Dalhousie University, Halifax, NS. 153 pp.

"Municipalities establish, maintain, and administer trees on the rights of way along streets. In spite of the many benefits trees provide, they are often planted far apart. The overall objective of this study was to explore the optimal spacing of street trees in Halifax. Altogether 2,162 trees were measured with an average spacing of 15.4 metres (m) and standard deviation (SD) of 10.5 m. Regression equations were developed for three-dominant species to predict crown diameter from diameter at breast height (DBH) and used in the simulation to calculate crown coverage over 60 years, at spacings from 5 to 20 m in a 1 hectare (ha) area. A row of street trees at close spacing delivers a greater canopy coverage per unit area. I recommend street-tree spacing between 5 and 10 m. It is important to find an affordable way to plant trees closer together in streets to maximise ecosystem services."

Liu, X. 2018. GIS-based Multi-criteria Decision Analysis (MCDA) for Prioritizing Tree-planting Sites in Halifax Urban Parks. Unpublished Master's Thesis, School for Resource and Environmental Studies, Dalhousie University, Halifax, NS. 106 pp.

"In Halifax, the lack of canopy cover and urges for better management of urban forests stimulated the Urban Forest Master Plan (UFMP), which was adopted by council in 2012. One goal of the UFMP is to increase the canopy cover in Halifax peninsula to 40% in parks. To achieve this goal, two questions need to be solved: where to plant trees and where to plant first. Thus, this research provided a two-phase solution by incorporating GIS-based Multi-criteria Decision Analysis (MCDA). The first phase selected candidate parks by setting limitations on park location, management authority, area, and a ground survey. This phase resulted in identification of 28 candidate urban parks in the Halifax peninsula. The second phase included eight criteria to feature benefits brought by urban trees. These criteria were weighted by experts through consultations and then used to calculate the ranking of the 28 parks."

Quinton, J. 2019. The Living Amongst the Dead: The Role of Halifax Cemeteries as Greenspace and Their Potential for Expansion of the Urban Forest. Parks. Unpublished Master's Thesis, School for Resource and Environmental Studies, Dalhousie University, Halifax, NS. 109 pp.

"Urban forests provide cities with a multitude of benefits but face many survival challenges. This thesis sought to determine the potential for cemeteries to expand the urban forest in Halifax, Nova Scotia through tree planting. Inventories of existing cemetery trees and potential plantable spots were conducted. Interception surveys with cemetery users and interviews with cemetery managers were used to determine the importance of cemetery trees and identify concerns and barriers to planting trees in cemeteries. The results indicate that Halifax cemeteries have relatively high canopy covers primarily composed of older non-native trees, and that the number of cemetery trees could be nearly doubled. Cemetery users highly value cemetery trees and have very few concerns about them. Cemetery managers also value cemetery trees but cited barriers to planting such as a lack of space, financial constraints, and potential for damage. For current canopy cover to be maintained (and expanded), these barriers need to be addressed."

Doucet, T. 2023. The Role of NGOs in Urban Forest Governance. Unpublished Master's Thesis, School for Resource and Environmental Studies, Dalhousie University, Halifax, NS.

To be defended and submitted in August 2023. Here are the abstracts of the two submitted journal manuscripts.

#1 – "Urban forests are being threatened by rapid urbanization, biodiversity crises, and climate variability. In response, governments are increasingly collaborating with the public for solutions to these mounting challenges. Non-governmental organizations (NGOs) are dominant players in these collaborations because of their ability to deliver on communities' environmental and social issues. Despite their growing visibility in urban forest management, research in this domain is nascent. There is a lack of attention directed to the structure of non-governmental relationships and the range of collaborative activities. This study focuses on addressing these gaps and examining collaborations between local governments and NGOs in Canadian urban forest programming by characterizing their components including mandates, relationship ties, accountability, resource exchange, and power dynamics. We collected data using semi-structured interviews with three groups: leaders of NGOs, municipal government officials in urban forest, parks, or public works departments, and urban-forest experts who have observed how NGOs and governments interact. The participants represent 32 individuals in nine Canadian cities. Our results indicate that NGO-government collaborations have relational ties and accountability processes that are both formal and informal in nature; however, formality in collaborations is associated with the amount of funding, proximity to government, or size of the NGO. Additionally, our findings suggest that given adequate support, NGOs present an opportunity to local governments to supplement their resources and capacity. As such, while the strength and formality of collaborations may be a product of NGO size and budgets, public servants should not be hesitant to engage smaller, grassroots NGOs to realize their public service mandates. Characterizing the components of these governance processes provides a benchmark for practitioners participating in similar public-civic interactions. This research has the capacity to arm all governance actors with the tools and knowledge to navigate these collaborative actions and streamline urban greening efforts."

#2 – "Local governments are increasingly collaborating with citizenry and nongovernment organizations (NGOs) in urban forest management because of the underlying belief that these groups contribute to the quality of urban environmental services. However, in practice, the successes, challenges, and outcomes vary drastically by collaborative arrangement; solely documenting positive outcomes in NGO-government collaborations may hinder the ability to mitigate their associated downsides rather than biasing collaborative behaviours towards success. This study draws on the experiences of urban forest professionals across nine Canadian cities who have participated in or observed NGOs and local governments engage in collaborative urban forest management. We employed semi-structured interviews with 32 participants from three groups: leaders of NGOs, municipal government officials, and urban forest experts who have observed the two parties interact. Our results demonstrate that the addition of NGOs in municipal forest management is associated with positive outcomes and the characteristics of relationships, individual personnel, and community support contribute to their success. We also

characterize the barriers that collaborators are tasked with navigating in order to achieve positive outcomes, including high employee turnover, siloed departments, competing priorities, shifting politics, and precarious funding and contracts. Our recommendations for successful NGO-government collaborations include arming stakeholders with a thorough knowledge of civic processes, diversifying political relationships, fostering "champions" among a greater number of involved parties, and participating in longer-term contracts and funding agreements. Further, involved parties should ensure they are working towards the equitable distribution of the benefits and outputs of urban forest collaborations. Moving forward, because of the insular nature of NGO-government collaborations and a low capacity among NGOs to share the ouputs of these collaborations, we recommend researchers continue to study success under varying governance arrangements so that groups may benchmark their collaborative activities against others and determine the most effective means of participating in co-management."

**5.1.3 PhD Thesis Research**

The highest earned degree awarded by universities is the doctorate. We have been fortunate to have Camilo Ordóñez with us from 2009 through 2015. His PhD thesis was defended in May 2014. Camilo's thesis chapters have been published in journals (see Appendix 9.1).

Ordóñez, Camilo. 2014. Managing Urban Forest Public Values in a Changing Climate. Unpublished PhD Thesis, Interdisciplinary PhD Program, Dalhousie University, Halifax, NS. 239 pp.

With more than half of the world's population concentrated in urban areas, urban services are crucial for people's lives. Some of these services are provided by urban trees, which are valued positively by most people. However, urban forest management (UFM) today faces a number of challenges, including accounting for the values of the public and climate change. These two are connected, since climate-driven biophysical changes will affect value provision and people's urban forest values will determine the management direction by which we address the climate challenge. This study aims to understand how to incorporate public values and climate change in UFM by examining how people value the urban forest, how these values are managed, how urban forests are vulnerable to climate change, and how this vulnerability affects value provision. To address these questions, I review the urban forest values literature and reveal opportunities for research. Later I examine the content of 14 Canadian urban forest management plans and reveal that UFM today lacks detail in ecological and social themes. I argue that a management paradigm based on what the citizens consider important about urban forests may help deal with these shortcomings. I present urban forest values research from three Colombian cities (Bogotá, Cali, Pereira) using field tours, personal diaries, and focus groups. I then integrate this research with similar research in Canada to build a values typology that portrays how the public values the urban forest. I then review climate change in UFM and argue that climate change vulnerability assessments (CCVAs) are crucial for embracing climate adaptation in UFM. I present CCVA research in three Canadian urban forests (Halifax, London, Saskatoon) using an exploratory and expertbased method. I demonstrate that the survival of young trees and mal-adapted tree species are important sensitivity factors in urban forests. By mapping how urban forest vulnerability to climate change will affect value provision I argue that climate change is

both a threat and an opportunity to bring specificity to ecological and social themes in UFM and to veer towards a UFM style that: plants more trees close to infrastructure and people; ensures tree survival by experimenting with different planting techniques and more-natural arrangements; embraces adaptive management and public engagement; and facilitates ecosystem transition without reducing values satisfaction.

### 5.1.4 MREM Project Reports

Alongside the MES graduate program at the School is the Master of Resource and Environmental Management. Candidates in the MREM must complete a project report in the final semester. About twenty such reports have been produced in association with our research on urban forests. Most of the students were employed under the auspices of a research and planning support contract between the School and HRM.

Ross, J.S. 2010. Success Stories: Engaging Citizens in Canada's Urban Forests. Unpublished MREM Project Report, School for Resource and Environmental Studies, Dalhousie University, Halifax, NS. 28 pp.

One of the best ways for citizens to become actively engaged appears to be by participating in experiential learning programs. Since the 1990s in Canada, environmental non-governmental organizations (ENGOs) and government agencies alike have taken special interest in preserving their communities' urban forests. This report showcases ENGOs and municipalities that have developed successful programs to engage citizens actively in urban forest management. By considering the factors that make these community engagement programs successful, one can bias for success in one's own community programming to enhance the vitality of urban forests. We urge the Halifax Regional Municipality to consider adopting strong programs of active citizen engagement in sustaining its urban forest.

Hack, J. 2011. Policy Tools and the Halifax Urban Forest. Unpublished MREM Project Report, School for Resource and Environmental Studies, Dalhousie University, Halifax, NS. 30 pp.

The Halifax urban forest plays a significant role economically, ecologically, and socially within the Halifax region. The current policy tools in place, including the forthcoming Urban Forest Master Plan and the extant public tree bylaws and planning regulations, are insufficient to properly protect all aspects of the urban forest within the Halifax Regional Municipality. This paper highlights that a private-tree bylaw is the missing tool that can, with the other tools, provide adequate and sustainable protection. Recommendations for a private tree bylaw were developed from those of four other cities in Canada: Ottawa, Richmond Hill, Vancouver and Victoria.

Gazibara, N. 2011. The Case for Fruit Trees in the City. Unpublished MREM Project Report, School for Resource and Environmental Studies, Dalhousie University, Halifax, NS. 57 pp.

This report assesses the importance of integrating urban forestry with urban fruit production, the potential for urban fruit production within cities, and potential barriers and benefits. A fruit-tree

planting study was completed to assess potential planting and fruit production capacity in an urban residential neighbourhood in Halifax, Nova Scotia. Further feasibility and potential opportunities for fruit-tree integration are analyzed with existing urban fruit tree and urban fruit orchard case studies around the world. Overall, the analysis points to high potential for fruit tree integration within urban environments. The report addresses some of the existing barriers to this integration, and provides recommendations for further research, municipal programs, bylaws, and incentive programs that can overcome these identified drawbacks and barriers.

O'Reilly, P. 2013. Monitoring Guide for Halifax Regional Municipality's Urban Forest and Urban Forest Master Plan. Unpublished MREM Project Report, School for Resource and Environmental Studies, Dalhousie University, Halifax, NS. 33 pp.

The purpose of this document is to guide the monitoring efforts of HRM with respect to the urban forest and the Urban Forest Master Plan. This document was written shortly after the UFMP was approved by city council and is intended to guide monitoring efforts for the next 10 years after which the Plan will be up for review.

Ashbourne, K. 2013. An Urban Forestry Approach to American Chestnut Recovery in the Regional Municipality of Halton. Unpublished MREM Project Report, School for Resource and Environmental Studies, Dalhousie University, Halifax, NS. xy pp.

This report was developed to guide policy-makers and practitioners in the Regional Municipality of Halton (the Region) in their efforts to restore American chestnut (*Castanea dentata*), a species at risk (*Endangered Species Act,* 2007). It is intended to provide the research necessary to move forward with recovery in the Region and to be a preliminary, high-level assessment of recovery potential within the Regional Municipality. Along with analysis of planting potential, the report sets out a practical framework for implementing American chestnut recovery in an atypical recovery setting - the urban forest. To companion this, recommended objectives and strategies are presented as a starting point for the development of an urban forestry approach to regional recovery. The recommendations and strategies focus on the practical restoration of American chestnut, while recognizing the complex interrelationship between humans and the environment in the urban landscape.

Shi, C. 2013. Planted-Tree Inventory Protocol for Halifax Regional Municipality's Urban Forest. Unpublished MREM Project Report, School for Resource and Environmental Studies, Dalhousie University, Halifax, NS. 30 pp.

The purpose of this document is to provide a step-by-step guide for Halifax Regional Municipality (HRM) staff, tree-planting organizations and public citizens on how to assess and record planted-urban tree survival and mortality. The impetus for this protocol is the HRM pilot tree-planting program initiated in this summer (May, 2013), which roughly 1000 new trees were planted in the selected five urban forest neighborhood (Colby Village, Connaught/Quinpool, Eastern Passage, Fairview and North End Halifax) and measured by Dalhousie University Urban Forest Team. This protocol includes 27 variables that need to be recorded for a tree, on-site data worksheet sample and some ideas about data analysis.

Perfitt, K.R. 2014. An Urban Forest Implementation Strategy: Advancing Education, Stewardship and Public Participation to Sustain HRM's Urban Forest. Unpublished MREM Project Report, School for Resource and Environmental Studies, Dalhousie University, Halifax, NS. 19 pp.

The purpose of this report is to provide direction for implementing urban forest education and stewardship, integral to implementation of the Urban Forest Master Plan. The need to promote urban forest citizen stewardship and to develop educational programs for the public was identified through public engagement sessions in 2012. The need to consider how to increase public participation in the urban forest planning process is also discussed. Through three short discussion papers, opportunities related to these themes will be explored.

Lesko, M. 2014. Managing Extreme Wind-Events in Halifax's Urban Forest. Unpublished MREM Project Report, School for Resource and Environmental Studies, Dalhousie University, Halifax, NS. 38 pp.

With an increase in the intensity and frequency of hurricanes expected for Halifax, the city has employed management strategies to adapt its urban forest to future climatic conditions. One such method is through species selection. Maliheh Rostami (2011) produced a list of 27 tree species that would be suitable for urban planting in Halifax's urban forest under a changing climate. These 27 tree species were analyzed for their wind-tolerance using a species-specific framework pertaining to wind-tolerance. As a result of the analysis, six tree species were highly wind-tolerant, eight were moderately wind-tolerant, and 13 were of low wind tolerance. These results were verified by comparing the wind-tolerance of the tree species to a planting design manual as well as through expert consultation. Limitations and information gaps regarding the framework and results were discussed, providing opportunities for future research. Lastly, recommendations as to how to better adapt Halifax's urban forest to extreme wind events are offered.

Slapcoff, L. 2014. An Analysis of Naturalization-related Content in Canadian Urban Forest Management Plans. Unpublished MREM Project Report, School for Resource and Environmental Studies, Dalhousie University, Halifax, NS. 27 pp.

The objective of this report is to provide a detailed overview of naturalization agendas in UFMPs across Canada. This report examines content relating to urban forest naturalness and naturalization against the aforementioned steps of the urban forest planning process. The goal of this approach is to identify at which planning stages naturalization information is featured, and at which steps it is lacking. Furthermore, this report points out outstanding examples of naturalization planning that currently feature in Canadian UFMPs. Finally, the general trends, strengths and weaknesses, and outstanding examples presented in this report will serve as a basis for naturalization planning recommendations and research opportunities targeting urban forest managers and scholars.

Foster, D.E. 2016. Location Matters: The Importance of Tree Placement to Urban Forest Values. Unpublished MREM Project Report, School for Resource and Environmental Studies, Dalhousie

University, Halifax, NS. 69 pp.

Urban forests are arguably an indispensable resource for urban environments. The benefits of trees in cities are numerous and range from financial savings to better human health. However, they also introduce some tangible costs and potential risks into an often risk-adverse environment. To better understand the benefits and disamenities of urban trees, it is important to consider tree location as an important contributing variable. I developed a classification scheme for urban tree habitats and applied it to 25 benefits and 11 disamenities of trees found in the literature. The contribution of trees to satisfying the values and exacerbating the disamenities are rated on a -3 to +3 scale based on severity and type of impact. Comparative analysis suggests that trees growing next to roads provide the most substantial suite of benefits in urban environments, but incur the greatest costs for management and potential risk for conflict with, and damage to, infrastructure and the built environment. Tree location is an important consideration for urban forest managers. The broad approach of this paper provides a greater understanding of the general trends in the relationship between tree location and a tree's ability to provide benefits and cause disamenities in urban environments.

Witherspoon, K. 2016. Street-Tree Planting Contracts: Lessons Learned from Three Years of Experience in Halifax. Unpublished MREM Project Report, School for Resource and Environmental Studies, Dalhousie University, Halifax, NS. 33 pp.

Katherine examined the Halifax tree-plant contracting experiences of 2013, 2014, and 2015, and made recommendations to the city for improvements.

Hayden, K. 2016. Protecting HRM Trees: A Look into Mechanical Damage. Unpublished MREM Project Report, School for Resource and Environmental Studies, Dalhousie University, Halifax, NS. 30 pp.

Urban trees are also vulnerable because of many threats, including mechanical damage from grass maintenance equipment. Mechanical damage is poorly understood and researched. This report takes a close look at the issue of mechanical damage, specifically in HRM. The effects of mechanical damage are explored, and then an HRM case study is presented. The case study consisted of routinely checking 844 trees in five urban forest neighbourhoods in HRM for signs of recent mechanical damage. When damage was visible, additional information was recorded including the size and type of damage and the location of the tree. Although data from only one grass-cutting season does not provide enough information to make any grand conclusions, several patterns were identified and discussed. In future years, this protocol should be repeated to see if the same patterns, or new ones, emerge. The results of this research can then be used in HRM urban forest managers to better protect trees from the preventable threat of mechanical damage.

Recommendations outline three areas in which HRM should focus its efforts: prevention, protection, and accountability. The most important of these is prevention in the form of education. Mandatory education regarding mechanical damage should be written into future grass-cutting tenders to ensure everyone is on the same page regarding expectations. Second, the

current protection measures used by HRM (trunk guards and mulching) should be continued and special attention should be paid to "problem areas" identified through inspections. Increasing the protection in these areas could reduce the instances of mechanical damage. Lastly, in cases where damage has already occurred, HRM should use the penalties already outlined in the tenders to their fullest extent ($100 per 2.5 cm square of damage) to encourage better compliance.

Secen, N. 2016. Making Sense of 311 Request Data to Learn about and Contribute to Halifax's Urban Forest. Unpublished MREM Project Report, School for Resource and Environmental Studies, Dalhousie University, Halifax, NS. 57 pp.

HRM's 311 municipal request system acts as a liaison between the public and the Transportation and Public Works Department (which manages the urban forest in HRM based on the Urban Forest Master Plan). This study used 311 municipal data pertaining to street trees in HRM to fulfill the following four objectives: (1) Indirectly evaluate the public's perception of Halifax's urban forest, (2) Make recommendations to the future implementation of Halifax's Urban Forest Master Plan, (3) Make recommendations to improve the effectiveness and efficiency of the 311-style municipal request system, and (4) Through these recommendations, reduce the influx of 311 requests pertaining to street trees. Between April 1st 2016 and September 24th 2016, a total of 1,836 311 requests were made pertaining to street trees. Of these requests, 779 were related to general pruning. 156 of these reported a tree that was dead, dying, or had deadbranches, and 115 pertained to a tree that was blocking a sign or a streetlight. 122 were repeat callers. Since general pruning requests were the dominant category, this was targeted for UFMP implementation improvement recommendations so that the influx of 311 requests may eventually be reduced. It is important to reduce this influx because as of October 3rd 2016, 826 out of 1836 requests were still open (ie yet to be addressed by HRM).

The UFMP outlines the necessity for a 7-year pruning cycle, and this data may justify the need for increased funding in order to implement it. A review of pruning program best practices revealed that upon implementation, younger trees should be put on a shorter pruning cycle than the older trees (being inspected 3 times before 10 years of age). This would help to promote good structural growth and strength, which would help to decrease the influx of 311 street tree requests in the long term. Other aspects of implementation that would help to make the pruning cycle more effective/efficient include coordination of pruning schedules with utility companies, and a pruning agreement (which would allow property owners to pay for pruning of public trees).

Doll, S. 2017. Golf Courses are Better than Parking Lots: An Investigation into the Ecological Sustainability of Institutionalized Greenspaces. Unpublished MREM Project Report, School for Resource and Environmental Studies, Dalhousie University, Halifax, NS. 55 pp.

This Nova Scotian case study explored the ecological integrity of institutionalized greenspace using an urban forestry lens. Approaching the investigation through a triple-bottom-line analysis, in combination with a comparative study between the tree population found on an inner-city Halifax golf course and "naturalized" ingrowth areas around the municipality, provides insight into the ecosystem services these greenspaces can provide, despite (or because of?) intensive

anthropogenic intervention. Despite common perceptions that golf courses are environmentally detrimental and socially exclusive developments, arguments are made for the ecological and social integrity of these spaces under appropriate management regimes.

Ristow, M. 2017. Online Mapping Applications for Urban Forest Management: An Open Data Approach Unpublished MREM Project Report, School for Resource and Environmental Studies, Dalhousie University, Halifax, NS. 41 pp.

Urban forests provide a plethora of benefits to the environment and to human health, and their management is essential for maintaining these benefits. However, it is evident that municipal governments in Canada may not have the financial resources, technical resources, or the time to do so effectively. This report presents the use of online mapping applications enabling Volunteered Geographic Information (VGI) to address some of these limitations and assist with building larger tree inventories for management purposes. It outlines VGI concepts as well as the opportunities and benefits associated with VGI for urban forest management. A review of existing online mapping applications is presented. Six applications enabling VGI are compared against 14 criteria. It was found that most programs are using OpenTreeMap; therefore, a brief analysis of this program is provided. An example of how to implement an online mapping application is presented for Halifax, Nova Scotia using tree inventory data-sets available to the School for Resource and Environmental Management. Finally, the report returns to the three main challenges (the digital divide, environmental justice issues, data integrity) to discuss how to address these issues. There is very little research on VGI online mapping applications for tree inventories in Canada. This report is meant to provide a review of the opportunities for implementation, while also acknowledging and making recommendations for some of the main limitations.

Thavarajah, V. 2018. Urban Forest Carbon Offsetting Programs in US and Canada and Their Applicability to HRM's Urban Forests. Unpublished MREM Project Report, School for Resource and Environmental Studies, Dalhousie University, Halifax, NS. 61 pp.

Carbon offsetting and generating marketable carbon credits from urban forests and urban tree planting programs have captured the attention of researchers and local authorities lately. At present, there are several standard protocols developed by numerous carbon registries for urban tree planting projects. Halifax Regional Municipality is blessed with a rich 43% of canopy cover, and as a recommendation of the Urban Forestry Master Plan, an Annual Tree Planting (ATP) program is carried out since 2013. This study has focused on reviewing the possibility of improving this ATP program into a tree planting project that can generate marketable carbon offsets. For the above purpose, nine urban forest carbon offset protocols from United States and Canada were thoroughly reviewed and their applicability in for an improved ATP program was assessed. The results indicate that the Urban Forestry Carbon Offsets Protocol by Duke Carbon Offsets Initiative is readily applicable for HRM's ATP program, with only slight alterations to the current operational framework. It is recommended that HRM should take an initiative towards developing its ATP program to a carbon offsetting project as it would generate revenue for the preservation of urban tree canopy in Halifax. With the information presented in the study, developing a new urban forest carbon offsetting protocol for Nova Scotia is also suggested.

Sorensen Kass, J. 2019. Text-A-Tree: Mapping relationships with urban trees in Halifax. Unpublished MREM Project Report, School for Resource and Environmental Studies, Dalhousie University, Halifax, NS.

Increasingly over the last 20 years, prominent works such as Richard Louv's Last Child in the Woods have called for reform and reconnection with the natural world. 81.2% of Canadians now live in urban areas, where access is limited to what are traditionally considered wild and natural spaces. While cities can contain an abundance of life and play host to a myriad of ecosystem services, research suggests that modern people are more disconnected from nature than previous generations. Yet there is growing evidence to suggest that while the technologies used by humans are changing, the desire to connect with nature is not. Most prominent of these examples is the 2013 phenomenon of Melbourne Australia, in which a tree-maintenance program morphed into an opportunity for the public to send personal messages to trees in the city. Inspired by this organic engagement, we sought to create an initiative in which people could connect with urban trees using modern technology.

Text-A-Tree was created as a two-month engagement project in which visitors to the Halifax Public Gardens (Nova Scotia, Canada) could send text-messages to 15 selected trees and have their messages answered by volunteer "tree speakers" Communications were managed through a web based customer-service platform called Zendesk. Between July 7 and Aug 31 2019, a total of 10,805 messages were received from 2,905 unique phone numbers. A grounded theory approach was taken to analyzing a randomized subset of these messages, which were coded and processed using AtlasTi. Analysis sought to understand what participants valued about urban trees and the project itself, following the argument that understanding public values and testing engagement strategies is vital to urban-forest management. The coding process centred on the apparent purpose or intent of participant messages, resulting in the emergence of three major themes: sharing personal experience, sharing in other' experience, and social norms.

Text-A-Tree was the first known example of an experience in which participants could engage with trees in the real-world using text-messaging. Unlike the commonly cited utilitarian benefits of urban trees (e.g. carbon sequestration, shade, aesthetics, pollution abatement), analysis indicated that the meaning created by participants was one of relationships. I propose that participants of Text-A-Tree used the project as an opportunity to engage in relationship-building rather than as a source of information or receptacle of opinions as was initially hypothesized. The model explored in this paper is as yet the unpolished first attempt at what appears to be a promising tool for engaging the public with urban nature. Text-A-Tree demonstrated that the integration of nature need not, and perhaps should not, be limited to inclusion in our physical lives, but should extend into our emotional and perhaps technological lives as well.

Machat, H. 2021. Characterization and Abundance of Eastern Hemlocks in Five Major Wooded Parks of the Halifax Regional Municipality. Unpublished MREM Project Report, School for Resource and Environmental Studies, Dalhousie University, Halifax, NS.

Invasive pests are increasingly being considered a significant threat to Canada's urban forest. The Hemlock Woolly Adelgid (HWA) is an invasive pest that kills eastern hemlocks by eating their nutrient and water storage cells at the base of needles, thus causing death of the tree. HWA has caused widespread mortality across northeastern parts of the United States and its presence was first confirmed in southwestern Nova Scotia in 2017. Eastern hemlocks are considered a foundational species, as they disproportionately influence the surrounding environment by creating unique ecosystem dynamics. This report outlines an exploratory study that was conducted on five major parks of the Halifax Regional Municipality (Admiral Cove, Hemlock Ravine, Shubie, Sir Sandford Fleming and Point Pleasant Park) to characterize the abundance and distribution of eastern hemlocks. Urban parks that have higher abundance of eastern hemlocks may be at a greater risk of HWA invasion and subsequent loss of overall canopy. Cruise-transect-sampling methods were utilized to determine the distribution and proportion of eastern hemlock to non-hemlock species, while also observing for the presence of eastern hemlock regeneration.  The findings suggest that some parks may need more targeted management efforts considering their high proportion of eastern hemlocks occurrence – namely Hemlock Ravine. Other parks such as Admiral Cove or Shubie may require less interventions by HRM due to minimal occurrence of eastern hemlocks. The collection of this data will give HRM some baseline information that may be used to inform targeted future monitoring protocols, concentrate their efforts to priority areas, and consider the potential ways that risk management techniques could be used. Further, this data may be used to help increase knowledge about eastern hemlocks distribution throughout Nova Scotia, which will help with the province's overall management of HWA.

Niesink, C. 2022. A Review of Best Management Practices for Urban Birds in the Tree Care Industry: Is More Research Needed? Unpublished MREM Project Report, School for Resource and Environmental Studies, Dalhousie University, Halifax, NS.

While urbanization can have several negative impacts on birds, key components of urban environments are urban forests. When managed appropriately, urban forests can provide several benefits to birds, which involves protecting migratory birds, their nests, and eggs during tree work. To help protect birds and to minimize the risk that arborists can pose to birds during tree work, a set of guidelines specific to Halifax Regional Municipality (HRM) were created. However, throughout this process, few peer-reviewed sources were found, therefore, this study aims to characterize the literature that was obtained, analyze this data, and identify potential research gaps. A data extraction form was used to screen all 81 sources found, resulting in 44 sources being characterized. These sources were characterized using the same data extraction form and results were quantitatively analyzed using descriptive statistics in Microsoft Excel. Results show that 66% of grey literature sources did not have a reference section or in-text citations, the highest target audience was the public, governmental bodies and cities/municipalities were the most common publisher of information, and finally, 8 sources did not include a publication date. These findings suggest that more research is needed on this topic, and more cities and municipalities should consider creating guidelines for the protection and conservation of birds, their nests, and eggs during tree work. Future studies should consider the impacts of tree work on urban birds, how often birds and nests are impacted, which practices are most effective in creating and preserving bird habitat, and if current recommendations are

effective. While these results highlight the lack of knowledge on the subject, these guidelines can help HRM in becoming a better bird-friendly city and will hopefully encourage other cities and municipalities to do the same.

Hutchison, C. 2023. WindSmart: Increasing the Resilience of the Halifax Regional Municipality's Urban Forest to Wind Damage. Unpublished MREM Project Report, School for Resource and Environmental Studies, Dalhousie University, Halifax, NS.

Urban forests are a part of the broad urban ecosystem that cities rely on to reduce the effects of climate change. Yet urban forests can be some of the most neglected regions of a city due to the maintenance costs associated with planting site locations and characteristics, and available tree species. There are numerous benefits that urban trees have on cities, especially in coastal regions, which experience increased susceptibility to damaging wind events due to the ongoing effects of climate change. Along the Atlantic Coast, Halifax, NS, has experienced numerous hurricanes and post-tropical storms that have altered both rural and urban forests. The WindSmart Program proposed here is an adaptation plan for the Halifax Regional Municipality. The Program emulates the nationally, and internationally, recognized FireSmart Program. The purpose of the program is to raise public awareness towards protecting the urban forest, encouraging community stewardship and education, and adapting it to become more wind firm through multiple initiatives.

### 5.1.5 Other Academic Projects

### Interception Surveys - Halifax Streets and Point Pleasant Park

As part of a class project a few years ago, we implemented a project whereby students interviewed passers-by on the sidewalks of Halifax, Fredericton, and Winnipeg. The data have been published by Arboriculture and Urban Forestry in a recent paper led by Camilo Ordóñez (see Appendix 9.1). The findings show that the interviewees very strongly appreciate trees in the city, and the principal values associated with those trees were psycho-social values such as sense of place and feeling of well-being.

In a winter-2015 undergraduate class, students collected data from just more than 260 passers-by in Point Pleasant Park. This work is ongoing to try to increase the sample size. So far we have learned that park visitors overwhelmingly appreciated the condition of the forest before Hurricane Juan in 2003, and while that appreciation was still substantial for today's forests, it was significantly reduced. Participants admitted to having little knowledge about the tree species in the Park. The report from the winter survey has the following citation:

Andrade, M., E. Bethune, C. Cardella, JJ. Klimek, K. Mitukiewicz, and J. Smith. 2015. User Viewpoints on Point Pleasant Park. Group Final Research Summary Report, MGMT 3701. Unpublished Report, School for Resource and Environmental Studies, Dalhousie University, Halifax, NS. 49 pp.

### Street-Tree Survey in the Allan-Lawrence-Duncan Neighbourhood

To begin the process of sharing tree-related information with residents in various neighbourhoods, in 2015 I measured all the streets trees in the Allan-Lawrence-Duncan neighbourhood of central Halifax. Of the 248 trees, over a third are elms, and the great size of most of the elms means that their share of the canopy in the streets is over half. Generally speaking, the trees in the streets of this neighbourhood are in good condition. In 2020, my students and I remeasured all the trees along the streets. The data spreadsheet is available upon request.

Duinker, P.N. 2020. Street-Tree Data for Allan/Lawrence/Duncan Streets. Unpublished Dataset, School for Resource and Environmental Studies, Dalhousie University, Halifax, NS.

**Student Projects, Sustainable Urban Forests (ENVI 5051) and Directed Readings**

Starting in autumn 2013 and ending 2018, I instructed an annual fall course entitled "Sustainable Urban Forests". Among other assignments, students - singly or in groups - engaged in small research projects aimed to sharpen their research skills and potentially produce useful information for urban-forest managers. In addition, students occasionally undertook directed-studies courses on topics related to urban forests. Here are citations for some projects written up in 2014-2016. Note that these are original manuscripts and most have not been edited by me.

Slapcoff, L. and J. Fraser. 2014. A Critical Analysis of Indicators in the Halifax Urban Forest Master Plan. Unpublished manuscript, School for Resource and Environmental Studies, Dalhousie University, Halifax, NS.

Foster, D., W. Margetts, and S. Saunders. 2014. At the Water's Edge: An Inventory of Trees on the Halifax Waterfront. Unpublished manuscript, School for Resource and Environmental Studies, Dalhousie University, Halifax, NS.

Miller, S. 2014. Urbanization and Homogenization: Native Species Richness in Urban Forests. Unpublished manuscript, School for Resource and Environmental Studies, Dalhousie University, Halifax, NS.

Lesko, M., S. Nitoslawski, and K. Witherspoon. 2014. When Trees and Utility Lines Intersect. Unpublished manuscript, School for Resource and Environmental Studies, Dalhousie University, Halifax, NS.

Aryal, B. 2015. The Big-Tree Argument in Urban Forestry: Valid or Misguided. Unpublished manuscript, School for Resource and Environmental Studies, Dalhousie University, Halifax, NS.

Kent, C., S. Maasik, J. Bell, and P.N. Duinker. 2015. Old-Growth Forests in HRM. Unpublished manuscript, School for Resource and Environmental Studies, Dalhousie University, Halifax, NS.

McFadden, C. 2015. Urban Forest Values: A Sidewalk Interception Survey of Off-Peninsula Halifax. Unpublished manuscript, School for Resource and Environmental Studies, Dalhousie

University, Halifax, NS.

Bell, T.J. 2015. Public Street Tree Protection Standards and Guidelines. Unpublished manuscript, School for Resource and Environmental Studies, Dalhousie University, Halifax, NS.

Hayden, K., E. Jessome, M. Lamarque, K. Noonan, and N. Secen. 2016. Composition and Structure of the Tree Canopy in Selected Halifax Cemeteries. Unpublished manuscript, School for Resource and Environmental Studies, Dalhousie University, Halifax, NS.

Noonan, K. 2016. Composition of the Tree Canopy of the Barrington Street Active Transportation Greenway. Unpublished manuscript, School for Resource and Environmental Studies, Dalhousie University, Halifax, NS.

Jessome, E. and M. Lamarque. 2016. Prioritizing the Needs of Green Infrastructure: Street Tree Spacing in Halifax, Nova Scotia. Unpublished manuscript, School for Resource and Environmental Studies, Dalhousie University, Halifax, NS.

**Envirothon 2015**

Envirothon is a North-America-wide highschool-level knowledge contest focusing on forests, water, wildlife, and soils. Each year there is a special theme on which student teams need to make an oral presentation. The special theme needs both a study guide and a scenario. With the assistance of three students, I prepared these items for the NS Forestry Association, which is the organizing body for Envirothon in this province. The study guide was prepared as an interactive .pdf and will be further developed as a tool for public education about urban forests. The current version is available as follows:

Duinker, P.N., D. Foster, K. Witherspoon, and R. Zimmerman. 2015. Urban Forests: Learning Materials for Nova Scotia Envirothon 2015 Participants. School for Resource and Environmental Studies, Dalhousie University, Halifax, NS. 138 pp. Available at: http://www.nsfa.ca/learning-outcomes-guides/

**5.2 Street-Tree Inventory and Database**

Each summer, under contract with HRM Urban Forestry, we have implemented an inventory of all the contract-planted trees along streets (and sometimes in parks). At this time of writing, we have measured thousands trees planted during the springs and autumns of 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2021, and 2022. The objective with this measurement program is to develop a baseline dataset of as many new streets trees as possible (we don't get them all because of the difficulty of getting records of the plantings implemented by HRM staff and contractors engaged by developers to plant trees along new streets). All the measured trees are assessed for trunk diameter, total height, crown condition, distance to curb, and precise location (with a high-resolution GPS). The data are stored in a GIS data management system and provided to HRM for inclusion in its asset databases.

Of particular interest to us as researchers is the 2018, 2019, 2020, 2021, and 2022 remeasurement of as many of the 2013, 2014, 2015, 2016, and 2017 planted trees as we can find. The data are being analyzed now and a journal paper will be submitted during 2023. We are keen to examine mortality and growth rates.

### 5.3 Publications

The SRES group of urban-forest researchers has been active in publishing written works associated with trees in the city (see Appendix). To date, members of the group have written 31 journal papers and book chapters, three conference papers in proceedings, 12 reviewed papers, 23 reports, and three plan documents. Members of the group have also written a suite of short articles about trees in the city, articles that are profiled on the website www.halifaxtreeproject.com.

### 5.4 Presentations

The UFMP team has made numerous presentations, in the form of both formal conference papers and posters, for which there is a written record, to less-formal conference presentations as well as participation in various professional, academic, and public meetings. Since 2007, team members have made well over fifty conference and workshop presentations, both across Canada and in Europe and the USA.

### 5.5 Awards

In 2014, the Canadian Institute of Planners gave its annual "Planning Excellence Merit Award" to HRM and the School for Resource and Environmental Studies in recognition of the quality of the HRM Urban Forest Master Plan. In 2020, I was given the Royal Galipeau Award of Distinction, Tree Canada.

### 5.6 Development of Young Scholars and Practitioners

Beginning in 2006, emphasis in the partnership between Dalhousie and HRM has been placed on mentoring Dalhousie students in scholarship and practice associated with sustainable urban-forest management. That mentoring, led both by HRM staff and Dalhousie professors, extends across undergraduate theses, master's (MES) theses, PhD theses, master's (MREM) project reports, and course projects. In the course, which was mounted for the seventh and last time in autumn 2019, about fifty students have participated in a variety of project experiences related to urban forests. If these counts are correct, and in consideration of some double-counting, somewhere around 70-80 students have been mentored in scholarship and practice of sustainable urban-forest management.

### 5.7 National and International Exposure

Most of the journals in which we publish our urban-forest research findings are read around the globe. In addition, we have been active in presenting our work at national conferences (e.g., the

Canadian Urban Forest Conferences of 2010 in Truro, 2012 in London, 2014 in Victoria, 2016 in Laval, and 2022 in Charlottetown; Canadian Association of Geographers, 2016 in Halifax; Canadian Psychological Association, 2012 in Halifax; Livable Cities Forum, 2016 in Halifax; ON Urban Forest Summit, 2021) as well as international meetings (e.g., European Forum on Urban Forests of 2013 in Leipzig, 2014 in Milan, 2015 in Lausanne, and 2019 in Cologne; Urban Tree Diversity conferences of 2014 in Alnarp (SE) and 2016 in Melbourne; International Symposium on Society and Natural Resources of 2014 in Hamburg; Ecological Society of America in Florida, 2016; International Society of Arboriculture, Texas, 2016; American Association of Geographers, 2018 and 2019; Conferences on Trees, People, and the Built Environment, Birmingham, UK, in 2014 and 2017; Trees and Society Conference, UK, 2021; International Urban Forest Congress, Vancouver, 2018). We plan presentations at several conferences in 2023, and beyond. HRM and Halifax are becoming well known across the global urban-forest community because we have taken initiative to communicate the results of our work broadly.

## 6. Media Coverage Associated with the HRM Urban Forest Master Plan

(note: some items may have been missed in the web-based search)

http://www.cbc.ca/news/canada/nova-scotia/halifax-s-urban-forest-to-grow-under-new-plan-1.1291722
Halifax's Urban Forest to grow under new plan
CBC News
Sep 9, 2012

http://www.metronews.ca/news/halifax/2013/06/11/be-leaf-it-or-not-trees-could-be-coming-to-your-neck-of-the-woods-in-hrm.html
Be-leaf it or not: Trees could be coming to your neck of the woods in HRM
Haley Ryan, Metro News
Jan 11, 2013

http://thechronicleherald.ca/novascotia/1083222-benefits-of-urban-forests-touted
Benefits of urban forests touted
Michael Gorman, The Chronicle Herald
Mar 21, 2013

http://www.metronews.ca/news/halifax/2013/10/30/new-trees-added-to-africville-others-parts-of-hrm-after-first-year-of-urban-forest-plan.html
New trees added to Africville, other parts of HRM after first year of Urban Forest plan
Ruth Davenport, Halifax Metro News
Oct 20, 2013

http://www.dal.ca/news/2013/12/11/urban-forest-master-plan-takes-root-at-dalhousie.html
Urban Forest Master Plan takes root at Dalhousie
Clark Jang, Dal News

Dec 11, 2013

http://www.cbc.ca/informationmorningns/2013/12/19/halifaxs-tree-trimming-underway/
Halifax's Tree Trimming Underway
CBC News
Dec 19, 2013

http://www.thecoast.ca/RealityBites/archives/2014/02/13/halifaxs-urban-forest-plan-moves-forward
Halifax's urban forest plan moves forward
Alana Westwood, The Coast
Feb 13, 2014

http://www.thecoast.ca/halifax/norway-maples-should-make-like-a-tree-and-leave-halifax/Content?oid=4796198
Norway maples should make like a tree and leave Halifax
Planifax/The Coast
Jul 17, 2015

http://globalnews.ca/video/2120265/urban-forest-master-plan
Urban Forest Master Plan
Global News
Jul 20, 2015

http://www.metronews.ca/news/halifax/2015/07/24/new-walking-tour-series-aims-to-grow-residents-knowledge-of-halifaxs-urban-forest.html
Walking tours aim to grow residents' knowledge of Halifax's urban forest
Steohanie Taylor, Metro News
Jul 24, 2015

http://thechronicleherald.ca/opinion/1316382-stop-the-reckless-tree-abuse-in-halifax
Stop the reckless tree abuse in Halifax
Peter Duinker, The Chronicle Herald
Oct 13, 2015

http://halifaxcitizen.ca/2015/11/09/greener-neighbourhoods/
Greener Neighbourhoods
Chris Mune, Halifax Citizen
Oct 9, 2015

http://thechronicleherald.ca/novascotia/1347921-green-streets-program-to-fund-halifax-projects
Green Streets program to fund Halifax projects
The Chronicle Herald
Mar 9, 2016

## 7. Conclusion

It is safe to say that, during the past 15+ years at SRES, a considerable amount of scholarly work has been accomplished on urban forests. The trees of Halifax, in all their diversity, have served as a most fascinating research resource for so many of us at the School. I look forward to continuing to create interesting, useful, and defensible knowledge about our local urban forest and its role as green infrastructure supporting a good human environment in Halifax.

## 8. References

(Note: papers cited in the text that are included in the Appendix are not included here)

Van Damme, L., P.N. Duinker and D. Quintilio. 2008. Embedding science and innovation in forest management: recent experiences at Millar Western in west-central Alberta. Forestry Chronicle 84:301-306.

## 9. Appendix: Publications and Presentations

(Note: most of these publications are available digitally from me by request)

### 9.1 Journal Papers and Book Chapters

### 9.1.1 Refereed

Steenberg, J.W.N., M. Ristow, P.N. Duinker, L. Lapointe-Elmrabti, J.D. MacDonald, D.J. Nowak, J. Pasher, C. Flemming, and C. Samson. 2023. A national assessment of urban forest carbon storage and sequestration in Canada. Carbon Balance and Management 18:11. https://doi.org/10.1186/s13021-023-00230-4.

Duinker, P.N. and J.W.N. Steenberg. 2023. Urban Forestry Ecology. In: Oxford Bibliographies in Ecology (D. Gibson, editor). Oxford University Press, New York, NY.

Ordonez, C., J.W.N. Steenberg, and P.N. Duinker. 2021. Vulnerability of urban nature to climate change: an overview of impacts and assessment approaches, with examples from urban forests. Chapter 16 of "Routledge Handbook of Urban Ecology", Second Edition. Editors: Ian Douglas, Pippin Anderson, David Goode, Mike Houck, David Maddox, Harini Nagendra, and Tan Puay Yok. Routledge, Abingdon, Oxon.

Aryal, B, J.W.N. Steenberg, and P.N. Duinker. 2021. The effects of street tree spacing and crown interactions on crown dimensions and canopy cover. Arboriculture and Urban Forestry: 47(5):183–195. doi.org/1048044/jauf.2021.017

Sorensen, J.K., P.N. Duinker, M. Zurba, M. Smit. 2021. Testing a novel human-nature connection model with Halifax's urban forest using a text-messaging engagement strategy. Urban Forestry and Urban Greening: 65:online. doi.org/10.1016/j.ufug.2021.127350

Thompson, K., P.N. Duinker, and K. Sherren. 2020. Ecosystem services: A new framework for old ideas, or advancing environmental decision-making? Learning from Canadian forerunners to the ES concept. Canadian Geographer: in press. doi: 10.1111/cag.12670

Doll, S.M. and P.N. Duinker. 2020. Characterization and justification of trees on an inner-city golf course in Halifax, Canada: an investigation into the ecological integrity of institutional greenspace.  Forests 11(1): 96. doi:10.3390/f11010096

Quinton, J., J. Ostberg, and P.N. Duinker. 2020. The importance of multi-scale temporal and spatial management for cemetery trees in Malmö, Sweden. Forests 11: 78. doi:10.3390f11010078

Quinton, J, P.N. Duinker, J.W.N. Steenberg, and J. Charles. 2020. The living among the dead: cemeteries as urban forests, now and in the future. Urban Forestry and Urban Greening: 48. doi.org/10.1016/j.ufug.2019.126564

Quinton, J., J. Ostberg, and P.N. Duinker. 2020. The influence of cemetery governance on tree management in urban cemeteries: A case study of Halifax, Canada and Malmö, Sweden. Landscape and Urban Planning 194. https://doi.org/10.1016/j.landurbplan.2019.103699

Thompson, K., K. Sherren, and P.N. Duinker. 2019. The use of ecosystem services concepts in Canadian municipal plans. Ecosystem Services 38: online. doi.org/10.1016/j.ecoser.2019.100950

Quinton, J. and P.N. Duinker. 2019. Beyond burial: Researching and managing cemeteries as urban green spaces, with examples from Canada. Environmental Reviews 27(2):252-262. doi: 10.1139/er-2018-0060

Quinton, J, P.N. Duinker, K.A. Gallant, J.W.N. Steenberg, and J. Charles. 2019. To tree or not to tree: user and management perspectives of cemetery trees. Urban Forestry and Urban Greening 43: 126385. doi.org/10.1016/j.ufug.2019.126385

Steenberg, J.W.N., P.N. Duinker, and S.A. Nitoslawski. 2019. Ecosystem-based management revisited: updating the concepts for urban forests. Landscape and Urban Planning 186:24-35. doi.org/10.1016/j.landurbplan.2019.02.006

Steenberg, J.W.N., P. Robinson, and P.N. Duinker. 2018. Counter-intuitive relationships between housing renovation, socioeconomic status, and urban forest ecosystems. Environment and Planning B: Urban Analytics and City Science: published online 2018_01_12. doi/pdf/10.1177/2399808317752927.

Nitoslawski, S., J.W.N. Steenberg, P.N. Duinker, and P.G. Bush. 2017. Assessing the influence of environmental attributes on urban forest species composition in suburban neighbourhoods. Urban Forestry and Urban Greening 27:187-195. doi.org/10.1016/j.ufug.2017.08.002

Ordóñez, C., T. Beckley, P.N. Duinker, and A.J. Sinclair. 2017. Public values associated with urban forests: synthesis of findings and lessons learned from emerging methods and cross-cultural case studies. Urban Forestry and Urban Greening 25:74-84. doi.org/10.1016/j.ufug.2017.05.002

Duinker, P.N., S. Lehvävirta, A. Busse Nielsen, and S. Toni. 2017. Managing Urban Woodlands. In press as Chapter 34 in "Routledge Handbook of Urban Forestry", edited by F. Ferrini, C. Konijnendijk van den Bosch, and A. Fini.

Nitoslawski, S.A., P.N. Duinker, and P.G. Bush. 2016. A review of drivers of tree diversity in suburban areas: research needs and recommendations for Canadian cities. Environmental Reviews: 24(4):471-483. doi: 10.1139/er-2016-0027

Nitoslawski, S.A., and P.N. Duinker. 2016. Managing tree diversity: a comparison of suburban development in two Canadian cities. Forests 7:119. doi:10.3390

Ordóñez, C., P.N. Duinker, A.J. Sinclair, T. Beckley, and J. Diduck. 2016. Public values of urban forests in Canada using a sidewalk-interception survey: results for Fredericton, Halifax, and Winnipeg. Arboriculture and Urban Forestry 42(1):46–57.

Duinker, P.N., C. Ordóñez, J.W.N. Steenberg, K.H. Miller, S.A. Toni, and S.A. Nitoslawski. 2015. Trees in Canadian cities: indispensable life form for urban sustainability. Sustainability 7:7379-7396. doi:10.3390/su7067379

Toni, S.A. and P.N. Duinker. 2015. A framework for urban-woodland naturalization in Canada. Environmental Reviews 23. dx.doi.org/10.1139/er-2015-0003

Ordóñez, C. and P.N. Duinker. 2015. Climate change vulnerability assessment for urban forests in three Canadian cities. Climatic Change: online. doi:10.1007/s10584-015-1394-2
Ordóñez, C. and P.N. Duinker. 2014. Assessing the vulnerability of urban forests to climate change. Environmental Reviews: doi: 10.1139/er-2013-0078.

Duinker, P.N., C. Ordóñez, J. Steenberg, J. Diduck, S. Cushing, S. Peckham, T. Beckley, and J. Sinclair (Canadian Urban Forest Research Group). 2013. What do Canadians value about urban trees? Ontario Arborist 41(3):20-23, 25.

Ordóñez, C. and P.N. Duinker. 2013. An analysis of urban forest management plans in Canada: implications for urban forest management. Landscape and Urban Planning 116:36-47. doi: 10.1016/j.landurbplan.2013.04.007

Peckham, S.C., P.N. Duinker, and C. Ordóñez. 2013. Urban forest values in Canada: views of citizens in Calgary and Halifax. Urban Forestry and Urban Greening 12(2):154-162. http://dx.doi.org/10.1016/j.ufug.2013.01.001.

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

Ordóñez, C. and P.N. Duinker. 2012. Ecological integrity in urban forests. Urban Ecosystems 15:863-877. DOI: 10.1007/s11252-012-0235-6

Ordóñez, C. and P.N. Duinker. 2010. Interpreting sustainability for urban forests. Sustainability 2:1510-1522. doi:10.3390/su2061510

Steenberg, J.W.N. and P.N. Duinker. 2010. Post-hurricane coniferous regeneration in Point Pleasant Park. Proceedings of the NS Institute of Science 45 (Part 2):26-54.

**9.1.2 Reviewed**

Duinker, P.N. 2019. The blind men and the trees: diverse perspectives on the species composition of Halifax's urban forest. Atlantic Forestry Review 25(4):16-17.

Charles, J. 2017. The Halifax experience: public engagement was key to ramping up HRM's urban forest plan. Atlantic Forestry Review 23(6):14-16.

Steenberg, J. 2017. In an arboreal state of mind: The psychological benefits of urban trees are well documented but undervalued. Atlantic Forestry Review 23(6):17-19.

Foster, D. 2017. Location, location, location: street trees are most subject to conflict, but they provide the greatest benefits. Atlantic Forestry Review 23(6):26-27.

Duinker, P.N. 2017. Silviculture vs. arboriculture: management practices in rural and urban forests reflect different objectives. Atlantic Forestry Review 23(6):32-33.

Aryal, B. 2017. What's the sweet spot for spacing? Street trees planted tighter will deliver ecosystem services sooner. Atlantic Forestry Review 23(6):34-35.

Duinker, P.N. 2017. Guest Editorial: Why Care about Urban Forests? Atlantic Forestry Review 23(6):6-7.

Duinker, P.N. 2017. Silviculture vs. Arboriculture: The Same or Different? Atlantic Forestry Review 23(6):32-33.

Duinker, P.N. 2017. Guest Editor. Atlantic Forestry Review 23(6):6-35.

Duinker, P. 2017. Trees in the city: why trees in cities are phenomenal investments in urban infrastructure.  Municipal World 127(1):3-5.

Leahey, M. and P. Duinker.  2016. Things you never knew about trees … and how Pugwash learned them.  Municipal World 126(8):25-26.

Duinker, P.N., C.  Ordóñez, J. Steenberg, J. Diduck, S. Cushing, S. Peckham, T. Beckley, and J. Sinclair (Canadian Urban Forest Research Group).  2013.  What do Canadians value about urban trees?  Ontario Arborist 41(3):20-23, 25.

**9.2 Conference Papers Published**

Duinker, P.N., J.W.N. Steenberg, S.A. Nitoslawski, B. Aryal, D.E. Foster, and K. Hayden. 2017. The Conundrum of Roadside Trees: Joy for the People, but Plight for the Trees. Review Paper for the Conference "Trees, People and the Built Environment 3", Birmingham University, 2017-04-05.
https://www.charteredforesters.org/wp-content/uploads/2019/01/Duinker-et-al-The-Conundrum-of-Roadside-Trees.pdf

Duinker, P.N., J. Steenberg, C. Ordóñez, S. Cushing, and K.R. Perfitt. 2015. Governance and

urban forests in Canada: roles of non-government organisations. Paper presented at "Trees, People, and the Built Environment II", held 02-03 April 2014 in Birmingham, UK. 15 pp. http://www.charteredforesters.org/icf-events/national-conference/tpbeii-resources/

Ordóñez, C., P.N. Duinker, and J.W.N. Steenberg. 2010. Climate change mitigation and adaptation in urban forests: a framework for sustainable urban forest management. Paper presented at the 18th Commonwealth Forestry Conference, Edinburgh, June-July 2010. http://www.cfc2010.org/papers/session7/Ordóñez-s7.pdf

## 9.3 Reports

Hutchison, C. and P. Duinker. 2022. Improving Attention to Climate Change in HRM's Urban Forest Master Plan 2.0. Unpublished Report to Halifax Regional Municipality. School for Resource and Environmental Studies, Dalhousie University, Halifax, NS.

Niesink, C. and P. Duinker. 2022. Protecting Migratory Birds in the Urban Core of Halifax Regional Municipality: Best Management Practices for Tree Work. Unpublished Report to Halifax Regional Municipality. School for Resource and Environmental Studies, Dalhousie University, Halifax, NS.

Machat, H., and P. Duinker. 2022. Distribution and Abundance of Eastern Hemlocks in Five Major Wooded Parks of the Halifax Regional Municipality. Unpublished Report to Halifax Regional Municipality. School for Resource and Environmental Studies, Dalhousie University, Halifax, NS.

Secen, N., J. Haughn, and P. Duinker. 2020. 311 Analysis: Methods & Results. Draft Report to HRM. School for Resource and Environmental Studies, Dalhousie University, Halifax, NS.

Haughn, J., N. Secen, and P. Duinker. 2020. Quantitative Assessment of Plantable Spots in the Tree Lawns of the Halifax Peninsula. Draft Report to HRM. School for Resource and Environmental Studies, Dalhousie University, Halifax, NS.

Secen, N., J. Haughn, and P. Duinker. 2020. Planning for Citizen Engagement for the HRM Urban Forest. Draft Report to HRM. School for Resource and Environmental Studies, Dalhousie University, Halifax, NS.

Ristow, M., J.W.N. Steenberg, and P.N. Duinker. 2019. An Updated Approach for Assessing Canada's Urban Forestcarbon Storage and Sequestration. Final Report to Environment and Climate Change Canada. School for Resource and Environmental Studies, Dalhousie University, Halifax, NS.

KBM Resources Group, Lallemand inc./BioForest, Dillon Consulting Limited (with special advisors Peter Duinker and James Steenberg). 2019. Toronto Canopy Study 2018. Report for the City of Toronto. 287 pp.

Sorensen Kass, J., F. Stevens, and P.N. Duinker. 2019. The Street Trees of Bridgewater, Nova Scotia: Follow-up Inventory and Recommendations. Report to the Council of the Town of Bridgewater. School for Resource and Environmental Studies, Dalhousie University, Halifax, NS.

Quinton, J. and P. Duinker. 2019. The Trees of Old Burial Ground Cemetery. School for Resource and Environmental Studies, Dalhousie University, Halifax, NS.

Quinton, J. and P. Duinker. 2019. The Trees of Fort Massey Cemetery. School for Resource and Environmental Studies, Dalhousie University, Halifax, NS.

Quinton, J. and P. Duinker. 2019. The Trees of Camp Hill and Fairview Lawn Cemeteries. School for Resource and Environmental Studies, Dalhousie University, Halifax, NS.

Quinton, J. and P. Duinker. 2019. The Trees of Mount Olivet and Holy Cross Cemeteries. School for Resource and Environmental Studies, Dalhousie University, Halifax, NS.

Jones, J. A., Wei, X., van Noordwijk, M., Creed, I. F., Gush, M., Ellison, D., Blanco, J. A., Bishop, K., McNulty, S. G., Archer, E., Bargués Tobella, A., Bruijnzeel, L. A., Duinker, P. N., Foster, D., Gebrekirstos, A., Giles-Hansen, K., Hacket-Pain, A., Harper, R. J., Ilstedt, U., Li, Q., Liao, Y., Malmer, A., Mwangi, H., Orland, C., Steenberg, J. W. N., Wang, Y., Worthy, F., Xu, J., & Zhang, M. (2018). Forest landscape hydrology in a 'new normal' era of climate and land use change. In I. F. Creed & M. van Noordwijk (eds.), *Forests and Water on a Changing Planet: Vulnerability, Adaptation, and Governance Opportunities. A Global Assessment Report* (pp. 81-99). International Union of Forest Research Organizations (IUFRO),Vienna, Austria.

Doll, S. and P. Duinker. 2018. The Trees of Old Ashburn Golf Course: Inventory and Management Recommencations. Report to the Managers of Old Ashburn Golf Club. School for Resource and Environmental Studies, Dalhousie University, Halifax, NS.

Doll, S., M. Ristow, J. Quinton, and P. Duinker. 2018. The Street Trees of Bridgewater, Nova Scotia: Inventory and Recommendations for Improvement. Report to the Council of the Town of Bridgewater. School for Resource and Environmental Studies, Dalhousie University, Halifax, NS.

Duinker, P. and J. Charles. 2018. Growing together in Halifax, Canada: A productive partnership helped create a strong master plan for forests in this Nova Scotian city. In "Forests and Sustainable Cities: Inspiring Stories from around the World", pp. 29-34. Food and Agriculture Organization of the United Nations, Rome, IT.

Foster, D. and P. Duinker. 2017. The HRM Urban Forest in 2016. Report to HRM. School for Resource and Environmental Studies, Dalhousie University, Halifax, NS.

Hayden, N., N. Secen, and P.N. Duinker. 2016. Tree Planting Tips &Tricks. School for Resource and Environmental Studies, Dalhousie University, Halifax, NS.

Duinker, P.N. and C. Pilkington.  2016.  The Trees of Pugwash, Nova Scotia: Inventory and Recommendations for Improvement.  School for Resource and Environmental Studies, Dalhousie University, Halifax, NS.

Andrade, M., E. Bethune, C. Cardella, JJ. Klimek, K. Mitukiewicz, and J. Smith. 2015. User Viewpoints on Point Pleasant Park. Group Final Research Summary Report, MGMT 3701. Unpublished Report, School for Resource and Environmental Studies, Dalhousie University, Halifax, NS. 49 pp.

Lesko, M., L. Slapcoff, K. Marshman, B. Roach, and P. Duinker. 2014b. Urban Orchards in Halifax: Results of a Consultation Workshop in Halifax, June 2014. School for Resource and Environmental Studies, Dalhousie University, Halifax, NS. 26 pp.

Lesko, M., B. Roach, and L. Slapcoff. 2014a. Urban Orchards in Halifax: A Discussion Paper. School for Resource and Environmental Studies, Dalhousie University, Halifax, NS. 16 pp.

Ordóñez, C. and P.N. Duinker. 2013. Urban Forest Vulnerability to Climate Change: Background Document. School for Resource and Environmental Studies, Dalhousie University, Halifax, NS. 11 pp.

Canadian Urban Forest Research Group. 2013. In Support of Trees in the City: A Message for Municipal Councillors, Developers, and NGOs. CUFRG, School for Resource and Environmental Studies, Dalhousie University, Halifax, Canada. Available at: www.canadianurbanforest.ca.

**9.4 Plan Documents**

Charles, J. and P.N. Duinker (editors). 2014. Urban Forest Master Plan Digest. Halifax Regional Municipality, Halifax, NS. 42 pp.

HRM Urban Forest Planning Team. 2013. Halifax Regional Municipality Urban Forest Master Plan. Halifax Regional Municipality, Halifax, NS. 441 pp.

NIPpaysage Landscape Architects, Ekistics Planning and Design, P.N. Duinker, Black Spruce Heritage Services, Form:Media, and LandDesign Engineering Services. 2008. Point Pleasant Park Comprehensive Plan. Halifax Regional Municipality, Halifax, NS.

**9.5 Papers Submitted**

Doucet, T.C., P.N. Duinker, J.D. Charles, J.W.N. Steenberg, and M. Zurba. 2023. Characterizing non-governmental organizations and local government collaborations in urban forest management across Canada. Journal of Environmental Management: submitted.

Doucet, T.C., P.N. Duinker, M. Zurba, J.W.N. Steenberg, and J.D. Charles. 2023. Perspectives of

successes and challenges in collaborations between non-governmental organization and local government on urban forest management. Urban Forestry and Urban Greening: submitted.

**9.6 WWW Articles**

2023

A series of articles on "So, You Want to Plant a Tree! Things to Think About Beforehand and in the Early Years"
https://www.halifaxtreeproject.com/why-did-that-tree-die

What Kind of Tree Should I Choose?
Where Should I Get the Tree?
How Big a Tree Should I Plant?
Where and When Should I Plant My New Tree?
How Do I Plant the Tree?
What Does My New Tree Need in the Early Years?

2021

Commentary: Should we lose trees to bike lanes? That's 100% stupid!
https://www.halifaxtreeproject.com/treesforbikelanes

A series of short articles on "why did that tree die?":
https://www.halifaxtreeproject.com/why-did-that-tree-die

Why did that tree die? Was it just old age?
Windthrow as an agent of tree death
Storm damage as an agent of tree death
Why did that tree die? Blame it on the insects
Building renovations as a cause of tree mortality
Mammals as agents of tree death
Role of nutrient deficiencies in urban tree death

A series of short articles on downsides of urban trees:
https://www.halifaxtreeproject.com/new-page-45

Tree damage to grey infrastructure: curbs and sidewalks
Infrastructure damage: power lines & buildings during storms
Tree allergies
Nuisance litter from urban trees
Nuisance shade
Urban trees and feelings of safety and danger
Habitat for annoying wildlife
Green gentrification: can urban greening displace residents?

Wildfires and risk to infrastructure
Potential to introduce invasive trees and insects

2020 (and 2021)

A series of short articles on urban-forest values in Halifax:
https://www.halifaxtreeproject.com/urbantreevalues

A full sensory experience: aesthetics of the urban forest
Urban trees help conserve fuel in parked cars
Urban trees can prolong the life of things manufactured & built
Urban trees help reduce home energy costs
City trees enhance community safety
Seeking shelter from the sun: the importance of shade provision by trees
Urban trees enhance business sustainability and opportunities
Urban trees help attract tourists
Urban trees provide diverse foods
Trees foster health and healing: a conversation
Urban trees enhance recreation opportunities
Trees help to cool the city environment
Urban trees capture and store carbon
Urban trees slow down stormwater flow
Potential career pathways in urban forestry
Urban trees can increase property values
Trees help to clean the air around us
Urban trees can help improve water quality
Urban biodiversity: reframing green space in Canadian cities
Trees in the city provide learning opportunities
Attachment to the city: the role of trees in creating a sense of place
Trees and happiness

A series of short articles on street trees of Halifax:
https://www.halifaxtreeproject.com/street-tree-blog

The Norway maple
The American elm
The little-leaf linden
The red oak
The silver maple
The serviceberry
The green ash
The pin oak
The ginkgo
The Japanese lilac
The sugar maple

The European beech
The black locust
The basswood
The red maple
The black walnut
The tulip tree
The hackberry
The London plane
The Freeman maple

## 9.6 Presentations

### Papers, Posters and Abstracts Presented

Radomske, L. and P. Duinker. 2023. Characterizing the Conifer Density Gradient from the Halifax Peninsula to the Hinterlands of the Halifax Regional Municipality. Poster presented at Science Atlantic Environment Conference (2023; online). Winner, K.C. Irving Environmental Science Centre Award.

Doucet, T., P.N. Duinker, and J.W.N. Steenberg. 2022. Assessing Juvenile Street Tree Sensitivity to Drought in Halifax, Nova Scotia. Poster presented at Canadian Urban Forest Conference, Charlottetown, PE. 2022-10-03-05.

Doucet, T., P.N. Duinker, and J.W.N. Steenberg. 2022. Why Do Trees Die Young in the Streetscape? The case of Halifax, Canada. Presented at International Society of Arboriculture Conference, Malmö, Sweden. 2022-09-12-14.

Doucet, T. and P.N. Duinker. 2022. Characterizing non-governmental organizations (NGOs) and municipal government collaborations in urban-forest programming. Presented at Canadian Association of Geographers Conference, Toronto Metropolitan University, Toronto, ON. 2022-05-30 to 2022-06-03.

Duinker, P.N. 2022. Practical Aspects of Tree-Planting Programs in a Changing Climate: Experiences in Halifax. Presented at HortEast Conference and Trade Show, Moncton, NB. 2022-11-16.

Duinker, P.N. 2022. Where a Tree Could Grow But Doesn't, Why Not? Arguments for way more trees in towns and cities and how we might accomplish that. Presented at HortEast Conference and Trade Show, Moncton, NB. 2022-11-16.

Duinker, P.N. 2022. Strategic Thinking for Urban-Forest Policy, Planning, and Programming: Key ingredients for fostering resilience in a changing climate. Presented at Canadian Urban Forest Conference, Charlottetown, PE. 2022-10-03.

Duinker, P.N. 2022. Fostering Stronger Relationships Between Urban People and Their Trees. Presented at the 2022 Conference of ISA-Ontario. ISA-Ontario, Milton, ON. 2022-03-03.

Duinker, P.N. 2021. Fostering Stronger Relationships Between Urban People and Their Trees. Presented at the 2021 Ontario Urban Forest Summit Virtual Conference on "Essential Nature: Reimagining The Urban Forest In A Post Covid World". Ontario Urban Forest Council, Toronto, ON. 2021-11-24.

Duinker, P.N. 2021. The Value of Valuing Trees: Don't Ignore the Incalculable! Presented at the Trees and Society Conference of the Arboricultural Association, Loughborough UK, 2021-09-06.

Duinker, P.N. 2019. What does success look like? a personal take on promising advances in sustainable urban forest management. Invited presentation, Atlantic Urban Forest Conference, Halifax, NS. 2019-11-14.

Quinton, J., and P.N. Duinker. 2019. The role of cemetery management in maintaining the urban forest of Halifax, Nova Scotia (Canada). European Forum on Urban Forestry, Cologne, DE. 2019-05-24.

Quinton, J., Duinker, P., Steenberg, J., Gallant, K., and Charles, J. 2019. Sociocultural values ascribed to trees in urban cemeteries in Halifax, Nova Scotia. Oral presentation at the American Association of Geographers Annual Meeting, Washington, DC, 2019-04-03.

Duinker, Peter, James Steenberg, David Foster, Sophie Nitoslawski, Bimal Aryal, Shauna Doll, Sydney Toni, Wendy Margetts, Katherine Witherspoon. 2018. Diverse perspectives on the trees of Halifax: the value of diverse datasets. Paper presented at International Urban Forest Congress, Vancouver, 2018-10-03.

Quinton, J., P. Duinker, J. Steenberg, K. Gallant, and J. Charles. 2018. Potentials for canopy improvement in Halifax cemeteries: (or) The argument for retaining trees in cemeteries. Poster presented at International Urban Forest Congress, Vancouver, 2018-10-01. Winner of Best Poster Award.

Steenberg, JWN, D. Rainham, and PN Duinker. 2018. The Role of Trees and Greenspace in Healthy Urban Living. Workshop presented at Healthy Living, Healthy Lives Conference, Dalhousie University, Halifax, NS. 2018-09-21.

Duinker, Peter N., James WN Steenberg, David E Foster, Emilie English, Simone Charron, John Simmons, and Shilo Gempton. 2018. Plans require implementation to achieve management: how we did it for urban forests in Halifax, Canada. Presented at AAG 2018, New Orleans, 2018-04-12.

Duinker, P.N. 2017. Plans require implementation to achieve management: how we did it for urban forests in Halifax, Canada. Paper presented at Atlantic Urban Forest Conference,

Fredericton, NB, 2017-11-07/08

Foster, D.E., and P.N. Duinker. 2017. A century of land-cover change at the Deanery Project, Lower Ship Harbour, NS. Poster prepared for the Deanery Project, Lower Ship Harbour, NS.

Steenberg J.W.N., P.J. Robinson, and P.N. Duinker. 2017. Counter-intuitive relationships between housing renovation, socioeconomic status, and urban forest ecosystems. Paper presented at Association of American Geographers Annual Meeting, 2017-04-05/09, Boston, MA.

Duinker, P.N., J.W.N. Steenberg, S.A. Nitoslawski, B. Aryal, D.E. Foster, and K. Hayden. 2017. The Conundrum of Roadside Trees: Joy for the People, but Plight for the Trees. Review Paper for the Conference "Trees, People and the Built Environment 3", Birmingham University, 2017-04-05.

Duinker, P. 2016. Implementing Halifax's Urban Forest Master Plan: Joys and Sorrows, Trials and Tribulations. Keynote Presentation, Canadian Urban Forest Conference 12, Laval, QC, September 2016.

Duinker, P., C. Ordóñez, J. Steenberg, and J. Charles. 2016. Trees: An Indispensable Tool for Livable and Resilient Cities in a Changing Climate. Livable Cities Forum, Halifax, NS, September 2016.

Nitoslawski, S.A., Duinker, P.N, and Bush, P.G. 2016. Managing and enhancing suburban tree diversity in Canadian neighbourhoods. Presentation for the International Society of Arboriculture (ISA) Conference and Trade Show. August 17, 2016. Fort Worth, Texas, USA.

Nitoslawski, S.A., Duinker, P.N, Bush, P.G, and Steenberg, J.W. 2016. Suburban woodland ecosystems as biodiverse forests in Canadian cities . Presentation for the Ecological Society of America (ESA) Conference. August 11, 2016. Fort Lauderdale, Florida, USA.

Sinclair, J, P. Duinker, C. Ordonez, T. Beckley, and J. Diduck. 2016. Public values and urban forests: Findings from Fredericton, Halifax, and Winnipeg. Paper presented at CAG 2016 (Canadian Association of Geographers), Halifax, NS, May 2016.

Foster, D. and P. Duinker. 2016. Location matters: The importance of tree placement to urban forest values. Paper presented at CAG 2016 (Canadian Association of Geographers), Halifax, NS, May 2016.

Nitoslawski, S., P. Duinker, and P. Bush. 2016. The influence of temporal and spatial contexts on urban tree diversity: A case study of two Canadian cities. Paper presented at CAG 2016 (Canadian Association of Geographers), Halifax, NS, May 2016.

Duinker, P.N. and S. Toni. 2016. Naturalization of Urban Forests in Canada: Opportunities and Challenges.  Paper presented at the Second Urban Tree Conference, Melbourne, Australia, February 2016.

Nitoslawski, S. and P.N. Duinker. 2016. Managing Urban Forests to Enhance Tree Diversity: a Comparison of Landscape Conversion and Subdivision Development in Two Canadian Cities. Paper presented at the Second Urban Tree Conference, Melbourne, Australia, February 2016.

Marshman, K. and P.N. Duinker. 2015. The fruits of nature: investigating the prospects for fruit trees on Halifax school grounds. Poster presented at the Elizabeth May Symposium, Halifax, 2015-03-10.

Margetts, W. and P.N. Duinker. 2015. Old growth among us: a characterization of urban old-growth forests in Halifax. Poster presented at the Elizabeth May Symposium, Halifax, 2015-03-10.

Duinker, P.N. J. Steenberg, C. Ordonez, S. Toni, X. Liu, S. Cushing, and L. Slapcoff. 2014. Native and natural: naive or noteworthy? A hard look at naturalization of urban forests. Presented at Canadian Urban Forest Conference, Victoria, BC, 2014-09-29.

Duinker, P.N., J. Steenberg, J. Charles, and S. Cushing. 2014. Making the Halifax treescape more native: initiatives in planting native tree species in parks, streets, and institutional lands. Presented at International Conference on Urban Tree Diversity, Alnarp, Sweden, 2014-06-17.

Duinker, P.N. and C. Ordóñez. 2014. Managing urban forest values in a changing climate. Presented at ISSRM 2014, Hannover, Germany, 2014-06-12.

Duinker, P.N. and C. Ordóñez. 2014. Human dimensions of sustainable urban forests: focussing the research agenda. Workshop presented at ISSRM 2014, Hannover, Germany, 2014-06-12.

Beckley, T., P. Duinker, J. Sinclair, C. Ordóñez, A. Kekacs, S. Cushing, J. Diduck, and R. Owen. 2014. Talking about the trees among the trees: in-situ methods for forest-values elicitation. Presented at ISSRM 2014, Hannover, Germany, 2014-06-10.

Duinker, P.N., J. Steenberg, J. Charles, R. LeBlanc, and S. Cushing. 2014. Toward naturalization of urban green space: new directions for Halifax and Charlottetown, Canada. Presented at European Forum on Urban Forestry (CUFC 17), Lausanne, CH.

Duinker, P.N., J. Steenberg, C. Ordóñez, S. Cushing, and K.R. Perfitt. 2014. Governance and urban forests in Canada: roles of non-government organisations. Paper presented at "Trees, People, and the Built Environment II", held 02-03 April 2014 in Birmingham, UK. 15 pp. http://www.charteredforesters.org/icf-events/national-conference/tpbeii-resources/

Duinker, P.N. C. Ordóñez, J. Steenberg, J. Diduck, S. Cushing, J. Sinclair, T. Beckley, and J. Charles. 2013. When Citizens Have Their Say: Adjusting Urban Forest Management to Account for the Public's Values. Paper presented at 15th European Forum on Urban Forests, Milan, Italy, May 2013.

Steenberg, J.W.N. and P.N. Duinker. 2013. Redefining the Neighbourhood: Addressing Social and Biophysical Processes in Urban Forests to Foster Identity. Paper presented at "Urban Forests and Political Ecologies: Celebrating Transdisciplinarity", Toronto, ON, April 2013.

Ordóñez, C. and P. Duinker. 2012. Urban forest values in Colombia and implications for urban forest management. Paper presented at International Symposium on Society and Resource Management, Edmonton, AB, June 2012.

Duinker, P.N. 2012. What Canadians value about urban forests, and why that matters. Keynote paper presented to the Environmental Psychology Section, Canadian Psychological Association 2012 Convention, Halifax, NS, June 2012.

Rostami, M., P.N. Duinker, and E. Rapoport. 2012. Incorporating Climate Change into Urban Tree-Species Selection: The Case of Halifax, Canada. Poster presented at 15th European Forum on Urban Forests, Leipzig, Germany, May 2012.

Walsh, A., P.N. Duinker, and M. Adams. 2012. Aggressive Urban Tree Planting for Carbon Sequestration: The Case of Burnside Industrial Park. Poster presented at 15th European Forum on Urban Forests, Leipzig, Germany, May 2012.

Duinker, P.N. 2012. Restoration of a Damaged Urban Forest Park: The Case of Point Pleasant Park, Halifax, Canada. Paper presented at 15th European Forum on Urban Forests, Leipzig, Germany, May 2012.

Ordóñez, C., P.N. Duinker, and S. Peckham. 2011. Urban forest values in Canada: advances in preliminary understandings. Paper presented at International Symposium on Society and Resource Management, Madison, WI, June 2011.

Ordóñez, C., P.N. Duinker, and S. Peckham. 2011. Urban forest values in Canada: advances in preliminary understandings. Paper presented at Canadian Sociological Association Annual Meeting, Fredericton, NB, June 2011.

Hack, J. and P. Duinker. 2010. A Values-Objectives-Indicators-Targets Approach to Urban Sustainable Forest Management in Halifax. Poster presented at Canadian Urban Forest Conference 9, October 2010, Truro, Nova Scotia.

Ross, J. and P. Duinker. 2010. Success Stories: ENGOs Engaging Citizens in North America's Urban Forests. Poster presented at Canadian Urban Forest Conference 9, October 2010, Truro, Nova Scotia.

Walsh, A. and P. Duinker. 2010. Greening greyscapes: carbon sequestration potential of the future urban forest of Burnside Industrial Park in Halifax, Nova Scotia. Poster presented at Canadian Urban Forest Conference 9, October 2010, Truro, Nova Scotia.

Peckham, S., K. Beazley and P. Duinker. 2010. A need for nature in the city? Eco-consciousness

development associated with naturalized urban spaces. Poster presented at Canadian Urban Forest Conference 9, October 2010, Truro, Nova Scotia.

Rostami, M. and P. Duinker. 2010. Tree Species Selection for the Halifax Urban Forest under a Changing Climate. Poster presented at Canadian Urban Forest Conference 9, October 2010, Truro, Nova Scotia.

Peckham, S., P. Duinker and K. Beazley. 2010. Urban Forest Values in Canada: Views of Citizens in Calgary and Halifax. Paper presented at Canadian Urban Forest Conference 9, October 2010, Truro, Nova Scotia.

Ordóñez, C. and P.N. Duinker. 2010. Ecological Integrity and Urban Forests. Paper presented at Canadian Urban Forest Conference 9, October 2010, Truro, Nova Scotia.

Duinker, P.N., R. LeBlanc, J. Simmons and P. Bigelow. 2010. Restoration of a damaged urban forest park in Halifax, Canada. Poster presented at the Commonwealth Forestry Conference, June 2010, Edinburgh, UK.

Duinker, P.N. 2007. Forests in settled landscapes: more trees, please!  Presentation in the final session, CIF 2007 AGM on "Forests in Settled Landscapes", Toronto, ON, August 2007.

**Other Presentations and Participations by Peter Duinker**

Moderator, Jarvis-lecture Panel on "As They Stand: The Trees of The Halifax Public Gardens", for The Friends of the Public Gardens; Saint Mary University, June 2023

Presentation on "Tips and Pointers on Planning for Urban-Forest Sustainability in Mahone Bay", for the Town of Mahone Bay, May 2023

For the UFor (Urban Forest) NSERC CREATE Network, designed and implemented the second annual UFor Summer Field School, Charlottetown, October 2022

Seminar on "Why I Hug Trees", to the Halifax Humanities class, October 2022

Online seminar presentation entitled "Strategic Thinking for Urban-Forest Policy, Planning, and Programming: Key ingredients for fostering resilience in a changing climate", for Canadian Institute of Forestry and Tree Canada, 2022-11-23 (http://cif-ifc.adobeconnect.com/pfoqgfalyjc4/)

Four urban-forest walkabouts led in cooperation with HRM Councillors, Aug-Oct 2022

Class seminar on "Making Forest Policy the Nova Scotia Way", Lakehead University, September 2022

Seminar on "Talking Trees in Wolfville", presented to the Wolfville Town Council, June 2022

Six urban-forest walkabouts led in cooperation with HRM Councillors, June and July 2022

Class seminar on "Adaptive Management: How Might It Work for Urban Forests?", for UBC Master of Urban Forest Leadership Program, March 2022

Seminar on "What Future for Forests and Forest Management in Central Nova Scotia?", for the Environmental Liaison Committee of Pictou, County, March 2022

Seminar on "Unintended Consequences of Renewable Energy Tech and How They Are Addressed" for the Dalhousie CREATE on Leadership in Energy Sustainability, January 2022

For the UFor (Urban Forest) NSERC CREATE Network, designed and implemented the first annual UFor Summer Field School, with participants in Vancouver, Toronto, Montreal, and Halifax, August 2021

With Crispin Wood, Invited Online Seminar on "Applied Urban-Forest Research through a University-Municipality Partnership:The Case of Dalhousie University and Halifax Regional Municipality", for the National Electronic Lecture Series on "Research in Urban Forestry in Canada", co-sponsored by the Canadian Institute of Forestry and Tree Canada, June 2021

Invited Online Seminar on "How Halifax Did It: Adventures in Getting and Implementing an Urban Forest Plan", for Trees Matter Fredericton, March 2021

Chair, Atlantic Urban Forest Conference, Halifax, November 2019

Urban-forest Walkabouts in Halifax, August 2019

Walkabout and Presentation on "Urban Forests in HRM (and What Can the Gardeners Do to Help)" to the Dartmouth Horticultural Society, Dartmouth, June 2019

Presentation on "Talking Trees in Mahone Bay", Mahone Bay, May 2019

Leadership of a field tour on urban forests, organized by Halifax Tree Project, October 2018

Leadership of a field tour on "Climate Change and Resilience of Urban Ecosystems", for the Shad Program hosted at Dalhousie University, July 2018

Presentation on "HRM's Urban Forest Master Plan: Improving Tree Canopy over the Long Term", to the Friends of the Public Gardens AGM, Halifax, June 2018

Presentation on "Old trees, old forest, old growth, old professor . . . A Look at Nova Scotia", and field-tour leadership to Hemlock Ravine Park, for the Halifax Field Naturalists, June 2018

Leadership of one field tour for Canadian Capital Cities Organization Annual Conference, and

four field tours for Federation of Canadian Municipalities Annual Conference, in Point Pleasant Park, June 2018

Presentation on "The Street Trees of Bridgewater: Inventory and Recommendations for Improvement", to the Council of the Town of Bridgewater, March 2018

Presentation on "Nine Things You Might Not Know about Trees in Nova Scotia", to the Town of Bridgewater, October 2017

Organized four special sessions on "Geography of Trees in the City", at CAG 2016 (Canadian Association of Geographers), Halifax, May 2016

Presentation on "How, When, and Where to Plant a Tree", to the Pugwash Communities in Bloom Committee, May 2016

Presentation on "Nine Things You Never Knew about Trees", to the Pugwash Communities in Bloom Committee, October 2015

Participation as Chief Judge, Oral Presentations on Urban Forests, at Envirothon 2015 Nova Scotia Championships, Aylesford, NS, May 2015

Presentations on "Urban Forests" at Envirothon workshops, Wolfville, NS, November 2014, and Lawrencetown, NS, April 2015

Presentation on "HRM Urban Forest Master Plan", to the Halifax Rotary Club, March 2015

Presentation on "Trees and Forests: World's Best Sources of Vitamin N", at "Why Forests Matter", a public forum organized by the Nature Conservancy of Canada, Halifax, September 2014

Presentation on "A Walk in the Coastal Woods: The Past, Present, and Future of Point Pleasant Park", at an In-Service Day of the Halifax Branch of the Atlantic Coalition of Independent Schools, at Sacred Heart School of Halifax, January 2014

Organized and facilitated three workshops on "Vulnerability Assessment for Urban Forests under a Changing Climate", London, Saskatoon, and Halifax, June-August 2013

Invited seminar on "In Search of Sustainable (Urban) Forest Management in Canada: Guidance from Citizens' Values", UK Forestry Commission Central Belt, Scotland, November 2012

Invited presentation on "Research on Urban Forests in Halifax, Canada", to the Scottish Tree Officers Group, Balloch, Scotland, October 2012

Invited seminar on "In Search of Sustainable (Urban) Forest Management in Canada: Guidance from Citizens' Values", UK Forest Research, Roslin, Scotland, September 2012

Leader, workshops on "Urban Forest Values", in Halifax, Toronto, Fredericton, and London, summer/fall, 2012

Keynote presentation on "The Point Pleasant Park Comprehensive Plan, HRM's Urban Forest Master Plan, & Dalhousie University's Campus Tree Plan: Some New Directions for Halifax Forests", at the International Society of Arborists Atlantic Chapter Annual Educational Conference, Windsor, NS, September 2011

Presentation on "Urban Forests" at First Annual Urban Forestry and Master Planning Workshop, sponsored by APALA and LPPANS. Halifax, October 2010

Seminar presentation - first in the series entitled "Future Forests Presents" - on "Restoration of a Damaged Forest Park in Halifax, Canada", at Swedish University of Agricultural Sciences, Umea, November 2009