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Jack Kimmel International Grant Application

Please note: This application may only be submitted July 1 - October 1.

If you have any questions, please email bduke@treefund.org or call 630-369-8300 x200.

Applicant

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Relevant citations authored	Ordóñez, C., Duinker, P., Sinclair, J., Beckley, T., Diduck, J. (2016) Determining public values of urban forests using a sidewalk interception survey in Fredericton, Halifax, and Winnipeg, Canada. Arboriculture & Urban Forestry 42 (1), 46-57. Ordóñez, C. (2015). Adopting public values and climate change adaptation strategies in urban forest management: a review and analysis of the relevant literature. Journal of Environmental Management 164, 215–221, http://dx.doi.org/10.1016/j.jenvman.2015.09.004. Ordóñez, C., Duinker, P. (2015). Climate change vulnerability assessment of the urban forest in three Canadian cities. Climatic Change 131 (4), 531-543, http://dx.doi.org/10.1007/s10584-015-1394-2. Duinker, P.; Ordóñez, C.; Steenberg, J.; Miller, K.; Sydney, T.; Nitoslawksi, S. (2015) Trees in Canadian cities: indispensable life form for urban sustainability. Sustainability 7 (6), 7379-7396, http://dx.doi.org/10.3390/su7067379. Ordóñez, C., Duinker, P. (2014) Urban forest values of the citizenry in three Colombian cities. Society & Natural Resources 27 (8), 834-849, http://dx.doi.org/10.1080/08941920.2014.90589 Ordóñez, C., Duinker, P. (2014) Assessing the vulnerability of urban forests to climate change. Environmental Reviews 22 (3), 311-321. http://dx.doi.org/10.1139/er-2013-0078. Duinker, P.N.; Steenberg, J.; Ordóñez, C.; Cushing, S.; Perfitt, K.R. (2014) Governance and urban forests in Canada: roles of non-government organisations. Proceedings of Trees, People, and the Built Environment II Conference, Birmingham, UK, 2-3 April 2014, 151-159. (Online: www.charteredforesters.org/resources/download-library/doc_download /320-tpbeii-conference-proceedings/) Ordóñez, C.; Duinker, P.N. (2014). Urban Forest Vulnerability to Climate Change: Research Synthesis Report for three Canadian cities (Halifax, London, and Saskatoon). School for Resource and Environmental Studies, Dalhousie University: Halifax, NS, Canada, 50 pp. Ordóñez, C., Duinker, P. (2013). An analysis of urban forest management plans in Canada: implications for urban forest management. Landscape and Urban Planning 116, 36–47, http://dx.doi.org/10.1016/j.landurbplan.2013.04.007. Peckham, S.C.; Duinker, P.; Ordóñez, C. (2013) Urban forest values in Canada: Views of citizens in Calgary and Halifax. Urban Forestry & Urban Greening 12 (2), 154–162, http://dx.doi.org/10.1016/j.ufug.2013.01.001. Duinker, P.; Ordóñez, C.; Steenberg, J.; Diduck, J.; Cushing, S.;

	Peckham, S.; Beckley, T.; Sinclair, J. (2013). What do Canadians value about urban trees? Article by the Canadian Urban Forestry Research Group (authors). Ontario Arborist 41 (3) (May/June 2013), 21-25. Ordóñez, C., Duinker, P. (2012) Ecological integrity and urban forests. Urban Ecosystems 15 (4), 863-877, http://dx.doi.org/10.1007/s11252-012-0235-6. Ordóñez, C; Duinker, P. (2010). Interpreting sustainability for urban forests. Sustainability 2 (6), 1510-1522, http://dx.doi.org/10.3390/su2061510 Pérez, M.; Rojas, J.; Ordóñez, C. (Editors) (2010). Sustainable Development: Principles, Applications and Guidelines of Policy for Colombia (Transl. original in Spanish: Desarrollo sostenible: Principios, aplicaciones y lineamientos de política para Colombia). Editorial Universidad del Valle, Cali, Colombia, 348 pp.
Has this investigator previously received funding from the TREE Fund?	No
If yes, was the funding for this project?	
Previous TREE Fund awards	

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	Bachelor of Science (Environmental), Faculty of Environmental Science,University of Guelph, Guelph, ON, Canada, 1991-1996
Relevant citations authored	Kershaw, S.E., Millward, A.A. (In Press) A spatio-temporal index for heat vulnerability assessment. Environmental Monitoring and Assessment. DOI: 10.1007/s10661-011-2502-z Millward, A.A., Paudel K., Briggs S.E. (2011) Naturalization as a strategy for improving soil physical characteristics in a forested urban park. Urban Ecosystems 14:261-278. Millward, A.A., Sabir, S. (2011) Benefits of a forested urban park: what is the value of Allan Gardens to the city of Toronto, Canada? Landscape and Urban Planning 100:177-188. Greene, C.S., Millward, A.A., Ceh, B. (2011) Who is likely to plant a tree? The use of public socio-demographic data to characterize client participants in a private urban forestation program. Urban Forestry & Urban Greening 10:29-38. Millward, A.A. (2011) Urbanisation viewed through a geostatistical lens applied to remote-sensing data. Area 43:53-66. Millward, A.A., Sabir, S. (2010) Structure of a forested urban park: implications for strategic management. Journal of Environmental Management 91:2215-2224. Millward, A.A., Kraft, C.E., Warren, D.R. (2010) Ice storm disturbance greater along terrestrial-aquatic interface in forested landscapes. Ecosystems 13:249–260. Millward, A.A., Piwowar, J.M., Howarth, P.J. (2006) Time-series analysis of medium-resolution, multisensory data for identifying landscape change. Photogrammetric Engineering and Remote Sensing 72:653-663. Millward, A.A., Kraft, C.E. (2004) Physical influences of landscape on a large-extent ecological disturbance: the northeastern North American ice storm of 1998. Landscape Ecology 19:99-111. Mersey, J.E., Millward, A.A., Martinez-R, L.M. (2002) Realizing the potential of GIS in community-based management of protected areas. International Journal of Sustainable Development and World Ecology 9:208-222. Millward, A.A., Mersey, J.E. (2001) A.A. Conservation strategies for effective land management of protected areas using an erosion prediction information system (EPIS). Journal of Environmental Management 61:329-343. Dr. Andrew Millward (2012) | Associate Professor of Geography | Principal Investigator, Urban Forest Research & Ecological Disturbance (UFRED) Group Millward, A.A. Mersey, J.E. (1999) Adapting the RUSLE to model soil erosion potential in a mountainous tropical watershed. Catena 38:109-129.
Has this investigator previously received funding from the TREE Fund?	No
If yes, was the funding for this project?	
Previous TREE Fund awards	

Students/Interns (if applicable)

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Department or major	Geography
Status	Intern

Student/Intern 2

Name	Mihai Grosu
Department or major	Geography
Status	Intern

Student/Intern 3

Name	
Department or major	
Status	

Project

Project title	Investigating Street Tree Decline and Mortality in Commercial Urban Spaces Revitalized with Structural Soil Cell Technology to Improve Planting and Maintenance Practices
Research area	Root and soil management Propagation, planting and establishment Plant health care Urban forestry
Project summary	The challenge of growing trees in commercial and highly-urbanized areas in cities will affect the success of the urban forest enhancement agenda, which is the focus of urban forest management across North America. Structural soil cell technology can improve habitat quality for trees in these spaces and was used most recently to plant trees as part of Toronto’s Bloor Street revitalization. These trees faced subsequent decline and high mortality. There is a lack of research on these landscapes and this technology, so it is unclear why these trees failed. Assessing the factors that contributed to their decline and mortality is necessary to guide future decisions about the use of this technology. This will ensure the success of the urban-forest enhancement agenda, reduce costs of tree planting and maintenance, and help companies and cities develop sound guidelines for street plantings in commercial

and highly-urbanized areas in cities. This research project will analyse already-existing soil and biophysical data from the Bloor Street trees and use multi-variate regression and contingency analysis techniques to elucidate the factors that have contributed the most to tree decline and mortality in Bloor Street. The information emanating form this project will be made accessible to urban forest managers and other stakeholders through research reports, academic publications, workshops, conference presentations, and webinars, and train one Canadian student in contemporary urban forest issues.

Statement of problem

North America is paying more attention to its urban forests. Municipalities are releasing first-ever management plans where they are committing to double or triple their tree planting goals (1). Enhancing the urban forest helps maximize quality of life since trees provide important ecosystem services, including regulation of urban heat and air quality (2). Economically, street trees attract shoppers to commercial areas by improving the aesthetic appeal of streets (3).

However, growing trees in the harsh environment of commercial, highly-urbanized city streets is difficult. A wide array of stressors can cause tree decline and premature mortality in these spaces (4). Urban streetscapes are commonly characterized by small, stressed, and short-lived trees (5). One technique that can improve growing conditions for street trees are underground structural soil cells, such as Silva Cells®. This technology was used in the Bloor Street Revitalization project, located in one of Toronto's main shopping districts. Despite significant forethought for street tree health, and substantial investment in underground infrastructure, many of the trees have not thrived or have died, requiring frequent re-plantings at increasing costs. There is not enough research on this technology today to provide a clear answer as to what happened. Therefore, it is essential that we understand the factors that contributed to the failure of the Bloor Street trees. This event may instigate municipal agencies, businesses, and other clients, to express reservation to proceed with future projects of a similar scope and scale. This will be an unfortunate outcome from a commercial standpoint, since companies leading the implementation of this technology may encounter resistance for their products. This is also unfortunate for the City's ambitious goals to increase urban-tree canopy (1).

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T.B.; Schipperijn, J.S. (ed.) Urban forest & trees. Berlin: Springer, 281-323.
5. Roman, L. A.; Scatena, F. N. (2011). Street tree survival rates: Meta-analysis of previous studies and application to a field survey in Philadelphia, PA, USA. Urban Forestry & Urban Greening, 10, 269-274.

Significance of your proposed project as it relates to the profession of arboriculture or urban forestry	This project will contribute to the Tree Fund's research priorities in propagation, planting, and establishment; risk assessment; and urban forestry management. I will develop an understanding on the abiotic factors influencing street tree decline and mortality in commercial urban spaces revitalized with structural soil cell technology. This will help me identify the most effective planting techniques that ensure the survival and vigorous growth of trees in commercial and highly-urbanized street settings. This understanding will be used to develop better planting and maintenance guidelines for new tree plantings in these spaces to ensure the success of the urban enhancement agenda in North America. Given my experience in urban forest management research in Canada, I have the connections needed to disseminate the results of my research to landscape architecture companies, urban forest managers, city planners, and practitioners, such as arborists and tree planting contractors. Finally, I want to expand my Canadian-based research into the US, and Tree Fund support is vital to give my research notoriety there.
Description of what is currently known about proposed project area	Research on urban forests has clearly established that urban trees help maximize quality of life through the provision of important ecosystem services, including regulation of urban heat (1), air quality (2), stormwater runoff (3), among many others. Besides providing important environmental services, urban trees contribute to the economic activity of urban areas. Street trees attract shoppers to commercial areas by improving the aesthetic appeal of streets (4,5). Given the ambitious urban-forest enhancement agendas of many North-American municipalities that are committing to double or triple their tree planting goals (6), the incorporation of trees into commercially-relevant urban landscapes is of growing importance. However, determining the most effective standards and practices for including trees in urban streetscapes is a difficult and multi-faceted technical challenge. Causes of the decline and mortality of street trees are numerous in heavily built-up areas, and trees are large, complex organisms that may exhibit multiple responses when stressed. Among the most important factors abiotic factors we find soils and water availability, damage, and light availability (7,8). Soil quantity and quality are important factors in urban tree decline. City streets, and their below-ground infrastructure, are highly engineered environments that are characterized by compacted, contaminated soils, with insufficient nutrient content, volume, and too dry or too saturated conditions (8,9). De-icing salts, in particular, contribute to the decline in newly planted city trees growing in northern climates (10). Although some information is known about damage to buds and roots system by sodium chloride (10,11), not a lot is known about magnesium- or calcium-based salts, although

they are increasingly being used as alternatives in urban landscapes (12). Healthy soils are essential to the lifecycle of trees, as they provide the rooting medium and essential nutrients for above-ground growth (13).

Damage and limited light availability may also contribute to tree decline and mortality. Trees are not immune to anthropogenic damage, which may include vandalism, mechanical damage, and improper handling and maintenance at the time of planting or pruning, all of which disproportionally affect street trees because of their exposed, high-traffic setting (9). Moreover, the geometry and density of buildings and other urban structures affects irradiation (i.e., sunlight available for photosynthesis and plant growth). Although this has been suggested as a factor in urban tree growth and mortality in general terms (14), the specifics of its effects in commercial and highly-urbanized areas is still unclear.

Beyond these physical stressors, other social factors, such as decision-making processes during design projects, including nursery stock selection, the timing of tree planting, among others, can also be major contributors to the decline and mortality of urban trees (9). However, investigations into the abiotic factors contributing to street tree decline are usually undertaken at a big spatial scale (14), making it difficult to know which factors contribute more to tree decline and mortality in specific tree-planting projects.

The factors above contribute to urban tree decline, resulting in the small, stressed, and short-lived trees that commonly characterize urban streetscapes (15). Street trees in commercial areas are the most vulnerable and suffer disproportionate rates of mortality among the young and newly-planted (14,15,16). In North America, such, trees in urban landscapes can last from 5 to 20 years (15,16), a considerable shortcoming given that trees can live to 75years or more. Short-lived trees not only provide less services and benefits (15), but ultimately cost more to maintain and replace. Urban-tree planting guidelines (17) are usually not specific enough to guide the planting of trees in these highly-engineered environments.

To maximize the benefits of city trees, the incorporation of greening objectives in the early stages of architectural design are required to grow large, healthy trees that provide maximal benefits. One increasingly used technique to improve growing conditions for street trees are the installation of underground structural soil cells, which can significantly improve growing conditions (18). This was the intent behind the installation of Silva Cell® structural soil cells in the Bloor Street Revitalization project, located in one of Toronto's main shopping districts. Despite significant forethought and planning for street tree health in this project, and substantial investment in underground infrastructure, many of the trees have not thrived or died, and have required frequent re-plantings at increasing costs. The Bloor Street corridor in Toronto is typical of streets in dense urban cores where tree establishment and growth is routinely difficult.

Silva Cells® are a relatively new technology and there is little academic research on best practices for their use in commercial streetscapes. There is also insufficient, site-focused research on potential causes of tree decline and mortality in commercial streetscapes. Research on these topics can enhance and refine innovative techniques and best management practices for designing, planting, and maintaining street trees and the physical environment necessary for their establishment and growth, specially in high-cost and high-profile design projects. This will help us avoid loss of resources on tree mortality and replacement, and ensure the long-term success and public approval of design projects. The scientific and technical advancements resulting from this project will contribute to the landscape architecture, arboriculture, and urban forestry industries that are growing in number and influence across North America.

1. Bowler, D.E.; Buyung-Ali, L.; Knight, T.M.; Pullin, A.S. (2010). Urban greening to cool towns and cities: A systematic review of the empirical evidence. Landscape Urban Plan 97 (3), 147-155.
2. Nowak, D.J.; Hirabayashi, S.; Bodine, A.; Greenfield, E.J. (2014). Tree and forest effects on air quality and human health in the United States. Environmental Pollution 193, 119-129.
3. Xiao, Q.; McPherson, E.G.; Ustin, S.L.; Grismer, M.E.; Simpson, J.R. (2000). Winter rainfall interception by two mature open-grown trees in Davis, California. Hydrol Process 14 (4), 763-784.
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5. Wolf, K. L. (2005). Business district streetscapes, trees, and consumer response. Journal of Forestry, 103, 396-400.
6. City of Toronto (2012). Sustaining and expanding the urban forest: Toronto's strategic forest management plan. Parks, Forestry and Recreation Division, City of Toronto: Toronto, ON, Canada.
7. Day, S.D.; Bassuk, N.L. (1994). A review of the effects of soil compaction and amelioration treatments on landscape trees. Journal of Arboriculture 20 (1), 9-17.
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9. Lu, J. W., Svendsen, S. E., Campbell, L. K., Greenfeld, J., Braden, J., King, K., & Falxa-Raymond, N. (2010). Biological, social, and urban design factors affecting young street tree mortality in New York City. Cities and the Environment 3, 1-15.
10. Cekstere, G., Nikodemus, O., & Osvalde, A. (2008). Toxic impact of the de-icing material to street greenery in Riga, Latvia. Urban for Urban Green 7, 207-217.
11. Zimmerman, E.M.; Jull, L.G. (2006). Sodium chloride injury on buds of acer platanoides, tilia cordata, and viburnum lantana. Arboriculture & Urban Forestry 32 (2), 45-53.
12. Cunningham, M.A.; Snyder, E.; Yonkin, D.; Ross, M.; Elsen, T.

(2008). Accumulation of deicing salts in soils in an urban environment. Urban Ecosystems 11 17-31.
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14. Jutras, P., Prasher, S. O., & Mehuys, G. R. (2010). Appraisal of key biotic parameters affecting street tree growth. Arboriculture& Urban Forestry 36 (1), 1-10.
15. Nowak, D.J.; Kuroda, M.; Crane, D.E. (2004). Tree mortality rates and tree population projections in Baltimore, Maryland, USA. Urban for Urban Green 2 (3), 139-147.
16. Roman, L. A., & Scatena, F. N. (2011). Street tree survival rates: Meta-analysis of previous studies and application to a field survey in Philadelphia, PA, USA. Urban for Urban Green, 10, 269-274.
17. Trowbridge, P.J.; Bassuk, N.L. (2004). Trees in the urban landscape – Site assessment, design, and installation. Hoboken, NJ: John Wiley & Sons, Inc.
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Summary of project goals

My research project will answer the following questions: 1) what are the factors influencing the decline and mortality of newly planted urban trees in Bloor Street, Toronto?; 2) what guidelines can be developed to reduce tree decline and mortality in commercial and highly-urbanized spaces revitalized with structural soil cells? My objectives are to: 1) analyse already-existing biophysical data from Bloor Street trees; 2) examine these analytical results to produce information on factors affecting tree decline and mortality in commercial and highly-urbanized spaces revitalized with structural soil cells; and 3) develop guidelines for the enhancement and refinement of tree planting in commercial and highly-urbanized spaces revitalized with structural soil cells.

Description of measurable outcomes expected

This research project will last for 8 months, although Tree Fund support is only requested for 3 months. The results of the project will be communicated to stakeholders of the Bloor Street revitalization project and the broader urban forestry industry through several deliverables, including a spatially-referenced database of biophysical information of Bloor Street trees, a final and detailed project report, two manuscripts for consideration in peer-reviewed academic journals (Arboriculture & Urban Forestry, Urban Forestry & Urban Greening), articles in industry and trade magazine publications, a conference presentation (International Society of Arboriculture), a workshop for researchers and practitioners, and a webinar (Urban Natural Resources Institute). A refined and improved best practices manual for tree planting in designed streets, with special attention to the use of structural soil cells in northern climates, will be a final and critical deliverable. Lastly, I will train one masters-level Canadian student in contemporary urban forest management issues, such as analysis of street tree data and tree-planting specifications, which can bring cutting-edge knowledge to their professional practice. The proposed study will lay a foundation for prospective future research in the next five years concerning ongoing tree-planting projects in Canadian cities. For instance, we expect to develop a second phase of investigation for the Queens Quay Revitalization project in Toronto. This project is similar to Bloor Street in species selection, soil volumes, and urban characteristics, and would offer a unique opportunity to apply the results of the proposed research study.

Project plan including design, hypotheses, methodology and analyses

My approach to the questions pertaining street tree decline and mortality in commercial urban spaces revitalized with structural soil cell technology is innovative, as I don't want to address decline and mortality at the city-wide scale, but focus on a representative, high-profile case study.

The purpose of the proposed project is to investigate and isolate the causes of decline and mortality of these street trees in the Bloor Street shopping district that were planted or replanted in between 2011 and 2015. The Bloor Street Revitalization project experienced high rates of tree mortality and decline, which were planted with Silva Cell® technology. Such a circumstance presents an opportune learning experience concerning approaches to maximizing street tree health and resilience, while, at the same time, is an opportunity to refine urban street tree planting methods that will result in new practices and associated productivity for the broader landscape architecture industry in Canada. Understanding exactly what went wrong in a scenario where such high levels of consideration and investment in street tree survival were present in the initial design process is critical.

Several hypotheses have been put forward as potential causes of decline and mortality among the Bloor Street trees. However, rarely does one stress agent kill a tree; rather, tree failure and death is usually the cumulative effect of several stressors over a period of time (1). Besides collecting soil and wood samples, reconstruction of possible causes of tree mortality along Bloor Street will necessitate forensically piecing together different physical and biological elements of site design, accounting for the influence of surrounding infrastructure and the built environment, the history of the planted stock, and project decision-making.

During the spring and summer of 2015, Ryerson University's Urban Forest Research and Ecological Disturbance (UFRED) Group collected soil and vegetation samples from the 133 London planetrees (Platanus x acerifolia) removed as part of the on-going streetscape revitalization. UFRED has also collected samples from the new trees (American elm, Ulmus Americana; Kentucky Cofee tree, Gymnocladus dioicus), to add to the available data. Soil texture analysis and the measurement of soluble salt concentrations (e.g. electrical conductivity or batch analysis), pH, and organic matter will be investigated as potential soil-related causes of decline and mortality. Trunk cross-sections from all removed trees will also be analyzed to measure tree age and tree response to growing conditions. Emergence of tree roots into the soil within the structural cells will be interpreted and analyzed using high-resolution imagery taken during the tree extraction process. Other information is being collected from archival records held by the City of Toronto and private contractors involved in the initial revitalization project, and through the Google Street View tool. These data include tree condition, location, distance to curb, nursery stock information, replanting information, and weather information (e.g. maximum and minimum temperatures and precipitation during 2011-2015). A shadow model is being built to extract light-availability data for each street tree in the heavily built-up environment of Bloor street. Multivariate regression analysis and contingency analysis (2) will be used to analyse the data and explore factors of influence that are statistically relevant.

Tree Fund support is requested for contracting labour from a commercial lab to process the soil samples for salts, nutrient content, and organic matter content, at an estimated cost of $39CAD/sample for a total of 130 soil samples. I will hire a student research assistant from Ryerson University's Urban Forest Research and Ecological Disturbance (UFRED) Group for the period Mar-May 2017 at a rate of $1,666/month, inclusive of benefits. The research assistant will assist me with: 1) data inputting and database management; 2) drafting of the texts to be included in future reports and publications; and 3) assistance in organizing workshops and webinars with practitioners and stakeholders. Other expenses of the project, such as attendance to conferences, workshop costs, transport, equipment, supplies, and software packages are included in the budget but will eventually be sourced from a research grant already in place at Ryerson University and from Ryerson's financial support mechanisms, which includes personal budget for conference travel, software packages, minor research expenses, and in-kind through Ryerson's on-site facilities.

Contact with stakeholders of the project, including the City of Toronto, the landscape architecture firm DTAH, the Bloor Improvement association, and James Urban – a respected expert in urban arboriculture and soils and senior advisor for the Bloor Revitalization project – has already been established.

This project is being co-led with Dr. Andrew Millward, Professor at Ryerson University, whose work has consistently upheld the goal of protecting and enhancing the urban forest through innovation, collaboration and excellence in engaging stakeholders on all levels. He is the recipient of the 2015 Ryerson University research award for Social Innovation and Action, which celebrates his accomplishments at the cutting edge of environmental public engagement with the goal of bolstering citizen interest in and protection of city trees. Dr. Millward is lead investigator for Ryerson University's Urban Forest Research and Ecological Disturbance (UFRED) Group.

As the principal investigator, I have the interdisciplinary background and research experience to complete this project. I co-launched an urban forest management research agenda at Dalhousie University and published eleven peer-reviewed journal articles. In my PhD dissertation I initiated research to develop an understanding of how urban forests are vulnerable to climate change (3,4). My research helped broaden the palette of ecological and social priorities for urban forest management (5,6,7) and helped understand it holistically (8). I will execute this project according to the highest standards based on my research qualifications. For instance, I have been dealing with urban forest issues for six years, and have a thoroughly grounded knowledge of the literature and the people behind it. I bring supervision skills to involve research assistants and students in my research. As the only PhD student in two research projects, I coordinated the activities of the research group and co-supervised five master theses and one bachelor thesis.

Finally, as a permanent resident in the process of becoming a Canadian citizen, I am committed to help Canada build a strong urban forest scholarship. Tree Fund funding will allow me to seed my research program, take my research to a broader audience, train Canadian students in urban forest management issues, and help me launch a successful research career that will have a significant impact in North America by influencing the community of practice. I look forward to becoming a research fellow and contributing to Tree Fund's research priorities.

1. Roman, L. A., & Scatena, F. N. (2011). Street tree survival rates: Meta-analysis of previous studies and application to a field survey in Philadelphia, PA, USA. Urban for Urban Green, 10, 269-274.
2. Jutras, P., Prasher, S. O., & Mehuys, G. R. (2010). Appraisal of key biotic parameters affecting street tree growth. Arboriculture& Urban Forestry 36 (1), 1-10.
3. Ordóñez, C.; Duinker, P.N. (2014). Assessing the vulnerability of urban forests to climate change. Environ Rev 22 (3), 311-321.
4. Ordóñez, C.; Duinker, P.N. (2015). Climate change vulnerability assessment of the urban forest in three Canadian cities. Clim.Change 131 (4), 531-543.
5. Ordóñez, C.; Duinker, P.N. (2012). Ecological integrity in urban forests. Urban Ecosystems 15 (4), 863-877.
6. Ordóñez, C., Duinker, P., Sinclair, J., Beckley, T., Diduck, J. (2016) Determining public values of urban forests using a sidewalk interception survey in Fredericton, Halifax, and Winnipeg, Canada. Arboriculture & Urban Forestry 42 (1), 46-57.
7. Peckham, S.; Duinker, P.N.; Ordóñez, C. (2013). Urban forest values in Canada: Views of citizens in Calgary and Halifax. Urban for Urban Green 12 (2), 154-162.
8. Ordóñez, C.; Duinker, P.N. (2013). An analysis of urban forest management plans in Canada: Implications for urban forest management. Landscape Urban Plan 116 36-47.

Description of plan for disseminating the results of this project

Besides the reports to the Tree Fund, the results of the project will be communicated to stakeholders of the Bloor Street revitalization project and the broader urban forestry industry through several deliverables, including a spatially-referenced database of biophysical information of Bloor Street trees, a final and detailed project report, two manuscripts for consideration in peer-reviewed academic journals (Arboriculture & Urban Forestry, Urban Forestry & Urban Greening), articles in industry and trade magazine publications, a conference presentation (International Society of Arboriculture), a workshop for researchers and practitioners, and a webinar (Urban Natural Resources Institute). A refined and improved best practices manual for tree planting in designed streets, with special attention to

	the use of structural soil cells in northern climates, will be a final and critical deliverable.
Project start date	03/01/2017
Project completion date	04/30/2017
Geographic range of project	USA & Canada

Budget

Compensation/Stipend

Proposed project budget	11910
Requesting from TREE Fund	0
Funding from other sources	11910
Value of in-kind support from other sources	0

Employee Benefits

Proposed project budget	4998.9
Requesting from TREE Fund	4998.9
Funding from other sources	0
Value of in-kind support from other sources	0

Travel (> 50 miles)

Proposed project budget	2500
Requesting from TREE Fund	0
Funding from other sources	2500
Value of in-kind support from other sources	0

Local Transportation (< 50 miles)

Proposed project budget	100
Requesting from TREE Fund	0
Funding from other sources	50
Value of in-kind support from other sources	50

Equipment (vehicles, growth chambers, etc.)

Proposed project budget	1000
Requesting from TREE Fund	0
Funding from other sources	500
Value of in-kind support from other sources	500

Supplies (paper, ink, toner, etc.)

Proposed project budget	1200
Requesting from TREE Fund	0
Funding from other sources	0
Value of in-kind support from other sources	1200

Contract Labor (contractor, speaker, etc.)

Proposed project budget	5070
Requesting from TREE Fund	5070
Funding from other sources	0
Value of in-kind support from other sources	0

Other/Misc.

Proposed project budget	1000
Requesting from TREE Fund	0
Funding from other sources	0
Value of in-kind support from other sources	1000
Description of other/misc. expenses	Software packages & licenses

Total

Proposed project budget	27778.9
Requesting from TREE Fund	10068.9

Funding from other sources	14960
Value of in-kind support from other sources	2750
Funds already received from other sources	0
Funds pending from other sources	14960
Value of in-kind support already received from other sources	0
Value of in-kind support pending from other sources	2750
How did you hear about this grant?	TREE Fund website

Applications will be scored on the following scale:

- Applicant is qualified (10 points)
- Applicant has experience (10 points)
- Project directly meets one or all TREE Fund priorities (10 points)
- Project has clearly stated need (10 points)
- Project is clearly linked to arboriculture and/or urban forestry (10 points)
- Research has practical application (10 points)
- Methods are clear (10 points)
- Objectives are achievable within proposed time frame (10 points)
- Objectives are achievable within proposed budget (10 points)
- Requested funds are matched with at least 10% cash or in-kind (10 points)

Your application will not be available for editing after it has been submitted.
Please review your application for completion before submission.