



Volunteering for Forest Health: A Public-Private Partnership in Oakville, Ontario, Canada

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Abstract. The Forest Health Ambassador Program, a joint public-private initiative in Oakville, Ontario, Canada, recruits volunteers from the community to assess municipal street trees for health issues and signs of invasive insects. In partnership with municipal employees, staff from BioForest, a private consultant, trains volunteers to inspect trees for a suite of structural and foliar conditions, as well as for signs and symptoms of infestation by emerald ash borer, gypsy moth, and Asian longhorned beetle. Since 2014, 4,871 street trees have been assessed by a growing base of volunteers. The program effectively increases the number of participants involved in the early detection of invasive pests, beyond what government resources typically allow. Thus, the program entails a low-cost investment that provides multiple ancillary benefits and channels community efforts into a cohesive product. The results provide data with direct implications for municipal forestry operations and help identify trends in urban forest health over time. For example, detections of relatively high numbers of gypsy moth egg masses were reported by volunteers, allowing the municipality to take remedial action and mitigate damage. A variety of media are used to advertise the program, including community newspapers and social media, as well as communications in local schools and at community events. The program is well-suited to high school students, who are able to complete curriculum-mandated volunteer hours through the program, while simultaneously gaining environmental knowledge. The program allows for the proliferation of awareness and education pertaining to municipal urban forest issues, particularly those related to invasive species and urban tree health.

Key Words. Canada; Citizen Science; Community Engagement; Environmental Awareness; Invasive Species; Monitoring; Ontario; Urban Trees.

Citizen science volunteer programs engage individuals with a personal appreciation for urban forests, while harnessing individual data collection efforts into cohesive research initiatives that can support urban forest conservation and management (Cooper et al. 2007; McKinley et al. 2017). Effective citizen science programs can have many positive results, including useful, high-quality data that may be used for management purposes (Roman et al. 2017), public sharing of scientific knowledge (Bonney et al. 2009), empowerment of practitioners and other social benefits (Westphal 2003), and improvements to the urban environment (Jack-Scott et al. 2013). Municipalities can use a citizen science program as an affordable way of gathering data on their urban forests while simultaneously expanding the public's knowledge of urban forest issues.

Citizen science programs can provide valuable resources in the face of municipal budgetary restrictions. Municipal forestry budgets may be incapable of addressing all urban forest management issues, and the added financial burdens imposed by invasive species, such as emerald ash borer (*Agrilus planipennis*), can amount to a crisis for municipalities. In instances when municipal government spending on urban forest management is constrained, the use of citizen science volunteers can expand capabilities for urban forest health monitoring with comparatively minor financial costs.

This paper presents a historic case study of one municipality's use of citizen science in a volunteer program to increase public awareness of urban forest health issues and to gather data on tree health and invasive insect activity from 2014

to 2017. The Forest Health Ambassador Program is a collaboration between the Town of Oakville, Ontario, Canada, and BioForest, a private forest health and pest management company based in Ontario. Oakville has a comprehensive urban forest management program, and local residents are generally invested in the urban forest and are supportive of management activities. Oakville was an early adopter of the UFORE (now i-Tree Eco) forestry benefits software, having completed its first study in 2005, and it was the first municipality to resurvey its UFORE plots, using i-Tree Eco, in 2015. Like many urban areas in eastern North America, Oakville is infested by

emerald ash borer (*Agrilus planipennis*) and experiences fluctuating populations of the resident European gypsy moth (*Lymantria dispar dispar*). Oakville is also a neighbor of the City of Mississauga, which is the location of the only area in Canada that is currently under quarantine due to Asian longhorned beetle (*Anoplophora glabripennis*), a highly invasive insect most recently detected in 2013 (CFIA 2013) (Figure 1).

In response to these threats, Oakville initiated a comprehensive urban forest health monitoring program and strengthened existing forest management strategies. In 2014, the Town contracted BioForest to develop and implement the



Figure 1. Oakville, Ontario, Canada, and surrounding area.

monitoring program. To inform program development, BioForest and Oakville held a workshop with regional stakeholders and other land managers aimed at gathering information on active urban forest health monitoring programs. One outcome of this workshop was Oakville's decision to develop a volunteer program as part of its urban forest health monitoring program.

PROGRAM DEVELOPMENT

The Forest Health Ambassador Program was designed to achieve three primary goals: increase the capacity for early detection of invasive species, track forest health trends over time, and foster public awareness of invasive species and urban forest health. The program was focused on street trees, a portion of the urban forest not covered by the other two components of the urban forest health monitoring program, which monitor wooded areas.

BioForest bridged a gap between the community and the municipal forestry department. BioForest staff trained volunteers, produced survey materials, and acted as the primary point of contact for volunteers. The local forestry department's use of a consultant for the volunteer program made hiring a full-time municipal staff person unnecessary and required a smaller financial investment.

In order to build a network of volunteers from scratch, Oakville employed a variety of advertising and outreach strategies. Initially, advertising was conducted primarily through the Oakville Canopy Club, a Town of Oakville initiative aimed at educating the public about emerald ash borer and the threat it posed to Oakville's urban forest. Information was distributed through the Canopy Club's social media accounts and at community events. In the latter case, BioForest and Town of Oakville staff handed out flyers and conducted in-person outreach at Arbor Day celebrations, public "open house" events, community tree-planting events, and local environmental fairs. Oakville also used the results of a telephone survey to compile a list of residents interested in participating in the program. Advertisements for volunteer opportunities were posted in the local newspaper and on community center message boards. BioForest and Oakville staff also delivered leaflets to local high schools for display in guidance counselors' offices.

BioForest and Oakville staff developed the Forest Health Ambassador Program protocol, which focused only on street trees located in the municipal right-of-way. The protocol was designed to strike a balance between gathering operationally useful data and ensuring that expectations of the volunteers were reasonable. The development of a standardized protocol ensured that the data generated by the surveys were consistent and useful for management purposes.

The protocol required volunteers to measure tree diameter at breast height (DBH) and to assess trees for conditions that represent a tree's general state of health (Table 1). Volunteers assessed stem and crown condition and recorded the presence or absence of a dead top. Crown conditions were ranked based on severity—from 1, which indicates 0%–5% damage, to 5, which indicates >75% damage. Volunteers also assessed each tree for the presence of any sign or symptom of emerald ash borer, European gypsy moth, and Asian longhorned beetle. If volunteers suspected that they observed evidence of any of these insects, they recorded the signs or symptoms. Given the implications invasive insect pests have for the management of Oakville's urban forest, it was considered crucial that volunteers be able to report on signs and symptoms of insect infestation. While Oakville currently funds regular monitoring activities focused on these three major invasive pests, the volunteer surveys further enhanced early detection capability by reporting on areas that were largely excluded from formal annual monitoring surveys.

Table 1. Stem and crown condition attributes in Forest Health Ambassador Program Assessment Protocol.

Stem condition (presence/absence)	Crown condition (ranked 1–5)
Broken main stem	Canopy decline
Wound	Defoliation
Woodpecker holes	Discoloration
Cracks	Dead branches present

PROGRAM IMPLEMENTATION

The town's annual data collection period ran from early June to the end of August. BioForest delivered mandatory training sessions in early June. Each session lasted two hours and included an indoor presentation on the protocol, followed by an outdoor exercise in which volunteers practiced the protocol on live trees.

The outdoor component also included a visit to a nearby park where the Canadian Food Inspection Agency has simulated the signs of Asian longhorned beetle activity on live maple trees, for educational purposes. Each volunteer received a package containing paper maps and data sheets, writing instruments, a measuring tape, and a reference booklet containing visual examples of stem and crown conditions and invasive insects. Volunteers were assigned a survey area near their place of residence in Oakville measuring 0.25 km². This area was further subdivided into a grid of 25 cells, with a map provided for each 10,000 m² grid cell. Each of these grid cell maps was populated with Oakville's tree inventory data and used high-quality aerial imagery, resulting in clear, accessible maps for volunteers to reference. Data sheets were prefilled with tree species and address information corresponding to the tree inventory data points on the grid cell maps. Volunteers submitted their completed data sheets either by dropping them off at Oakville's municipal forestry offices or by scanning and emailing their forms to BioForest staff.

Roman et al. (2017) recommend that citizen science programs include the use of data quality checking procedures to ensure high quality results, and the design of the Forest Health Ambassador Program was aligned with this approach. Because Oakville used data collected by volunteers to support management objectives, data quality and accuracy were integral to the goals of the program. During the data collection period, volunteers were encouraged to submit questions and concerns to BioForest staff, who replied within 24 hours, and to meet with the volunteer, if necessary, to provide additional guidance. After submitting data, each volunteer was subject to an audit by BioForest staff in order to verify that the submitted data were accurate and complete. In the case of experienced volunteers, BioForest staff conducted visual inspections on a minimum of three trees and verified all invasive insect reports. If a volunteer was new to the program, BioForest staff audited one full map grid cell, in order to ensure that the protocols were well understood. If a volunteer's data appeared to be highly inaccurate, BioForest staff met with the volunteer to provide additional training and to correct any issues.

Volunteers contacted BioForest staff while performing surveys if they observed a condition of concern, such as a potentially hazardous tree. BioForest staff conducted a follow-up inspection and referred the tree to Oakville forestry staff, if necessary. BioForest staff immediately performed a follow-up inspection of any tree suspected of being infested by Asian longhorned beetle, due to the serious repercussions of an infestation of that pest.

In addition to providing high quality volunteer data, the program's long-term viability was contingent on volunteers enjoying their experience. Simple expressions of thanks and appreciation are considered effective components of volunteer management that make volunteers' experiences more meaningful and may help retain volunteers (Wolcott et al. 2008; York 2017). The Forest Health Ambassador Program highlighted volunteers' accomplishments by holding a volunteer appreciation night after the data collection season ends. The Town of Oakville hosted the appreciation night, which included a presentation of the trends in the volunteers' data and examples of direct management actions taken by Oakville staff as a result of the program. In 2016 and 2017, the appreciation night event included a tree planting to commemorate the volunteers' contribution to urban forest health. The 2017 appreciation night also included a tree identification exercise, a topic in which volunteers had previously expressed interest.

PROGRAM GROWTH AND EVOLUTION

From 2014 to 2017, there was an increase in participation and in the number of annual data submissions (Table 2). Increases in participation aligned with diversification of advertising methods and dedicated efforts to recruit high school students. The number of actual annual participants was greater than the number tallied from submitted data forms, as some volunteers participated in small groups, for example, with family members or fellow volunteers. As of 2017, volunteers had assessed a total of 4,871 street trees in Oakville, equivalent to about 5% of the Town's street tree population.

The data submitted by volunteers have benefited municipal operations in Oakville. For example, in 2015 and 2017, volunteers reported high

levels of European gypsy moth activity in neighborhoods that had not been included in the Town's formal annual gypsy moth monitoring surveys. As a result of these reports, the newly detected pockets of gypsy moth activity were added to the annual monitoring surveys, and selective treatments were applied to high-value trees that may otherwise have gone untreated. Each year, volunteers also reported potentially hazardous trees that may have posed a risk to public safety. These reports led to immediate corrective action by municipal forestry crews, who were able to mitigate the risks by pruning or removing the trees.

Program organizers used volunteer feedback to gauge the strengths of the program and identify areas that require improvement. At each volunteer appreciation night, volunteers were given a brief questionnaire so that organizers can capture feedback on how they may improve volunteers' experience of the program. Each year, 100% of the volunteers who provided feedback indicated that they enjoyed the experience. Volunteers also consistently cited their gain of environmental knowledge as one of the program's strengths.

Through this feedback process, some lessons were learned that were incorporated into later efforts to improve the experiences of the volunteers. For example, in 2015, the protocol was modified to include two assessments per tree, in order to capture any seasonal variability of insects or diseases. Feedback gathered from volunteers indicated that while they understood the reason for the dual assessments, they preferred to survey each tree once, in order to survey more trees each year. The protocol was subsequently modified to reinstate single tree assessments. Other improvements made to the program include redesigning data sheets to be more user friendly and extending the length of the data collection period.

MOVING FORWARD

The Forest Health Ambassador Program continued in 2018 with a similar level of participation to the numbers seen in 2017. A total of 47 volunteers attended training in 2018, 32 of whom had submitted data by late August. The survey season was also shortened by approximately two weeks, due to the staff resources required for the coordination and execution of an aerial spray program for the control of gypsy moth in the Town of Oakville. In 2018, the program coordinators added to the training manual a simple, illustrated identification guide to common street tree species. The protocol remained the same in 2018, and the program coordinators made no major changes to the structure of the program.

It has become clear that youth represent a vital component of the past and future demographics of the Forest Health Ambassador Program. The number of high school students has increased from 2014 to 2017 and remained high in 2018. The ongoing enrollment of these students is key to growing the program in future years. Under the Ontario provincial education curriculum, high school students are required to complete a total of at least 40 hours of volunteer work before graduation (Ontario Ministry of Education 2016). The Forest Health Ambassador Program is well positioned as a means for students to fulfill this requirement, while transferring environmental knowledge and promoting outdoor physical activity. Connecting with the educational sector and reaching a young audience may also have the added benefit of contributing momentum to general advocacy on behalf of urban forest conservation in the future.

In order to increase volunteer recruitment, future advertising must focus on making better use of social media. While these have been used to some extent, many participants have indicated

Table 2. Summary of Forest Health Ambassador Program Participation, 2014–2017.

	2014	2015	2016	2017
Number of volunteers trained	28	28	36	50
Number of data submissions	11	22	27	28
Number of trees surveyed	545	972	1829	1525
Number of streets surveyed	40	62	61	95
Average number of trees surveyed/data submission	50	44	68	54

that their awareness of the program came from local print and online advertisements and by word of mouth. Direct, long-term connections with high schools should also be made in order to further promote the program among high school students. These connections may be made through school boards and high school environmental clubs, where there may be an opportunity to communicate volunteer opportunities directly to students. Private enterprise, through employee engagement activities and corporate donations, may also represent a demographic with greater involvement in the future.

CONCLUSIONS

The Forest Health Ambassador Program was jointly developed by municipal staff from the Town of Oakville and staff from the private forest health and pest management company, BioForest. The program is a core component of a comprehensive forest health monitoring program. The Forest Health Ambassador Program demonstrates how a nominal investment by a municipality can extend early detection capability beyond monitoring programs staffed with professionals. For some municipalities with extreme budget constraints, such an investment may mean the difference between having some degree of active early detection capability and having none.

Trained volunteers themselves become sources of knowledge in the community. By receiving training each year, volunteers increase their awareness of urban forest health issues, learning to look for and identify problems or concerns. Volunteers carry cards identifying themselves as “Forest Health Ambassadors,” which they are free to distribute to any other residents who approach them with questions about their activities. Thus, the volunteers spread additional awareness about the importance of urban forest health issues and opportunities for residents to become involved. Effectively, volunteers are acting as supplementary sources of communication to the public regarding municipal urban forest management and are helping to reinforce a positive image of it. This sort of activity by citizen science volunteers has been found to promote advocacy for urban forest and environmental issues, and also contributes to a better community in a general sense (Bloniarz and Ryan 1996; Johnson et al. 2014).

The program’s development over five years points to an appetite among the public to learn about urban forest health issues and to participate in urban forest stewardship activities. The program’s growth also suggests that the potential exists to further increase awareness among the general public about urban forest health and invasive species using a variety of tactics. Some of the program’s achievements are due to the growing number of high school students who have joined the program, in part, to complete curriculum-mandated volunteer hours. Raising interest in urban forest issues among youth is a priority issue for the future conservation of urban forests. By enlisting members of the community for early invasive species detection and tree health data collection, the Forest Health Ambassador Program generates pertinent data that are useful for municipal operations and helps cultivate an awareness of urban forest health issues among Oakville’s residents.

The Forest Health Ambassador Program constitutes a framework that was designed specifically for the Town of Oakville, in collaboration with municipal staff. However, the specifics of the program are not rigidly defined; rather, the program could be adapted to suit the needs of many urban areas, with different population sizes, species compositions, and climatic influences. In Oakville, volunteers were invited to suggest new areas of interest that may be addressed by the program, so that it can adapt and remain relevant to residents. As the risk of introducing new invasive species through international trade remains high, the program is designed with the flexibility required to keep pace with these finds and to educate residents on how to look for the signs and symptoms of newly introduced pests. The focus on municipal street trees, while at the core of the program as it is used in Oakville, is not necessarily a barrier to focusing on other aspects of forest health in other municipalities. While some municipalities are concerned with invasive insects that target trees, others may be more focused on addressing problems with invasive plants in natural areas. Using the approach outlined in this paper, volunteer resources may be harnessed to address problems associated with invasive plants as well.

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Résumé. Le Programme des bénévoles pour la santé des forêts, une initiative de partenariat public-privé à Oakville, Ontario, Canada, recrute des volontaires de la communauté afin d'évaluer les arbres d'alignement municipaux pour des considérations de santé et détecter les signes de la présence d'insectes envahissants. En partenariat avec des employés municipaux, le personnel de Bio-Forest, un consultant privé, forme des bénévoles pour l'observation de diverses conditions de structure et de feuillage des arbres ainsi que pour la détection de signes et de symptômes d'infestation par l'agrite du frêne, la spongieuse et le longicorne asiatique. Depuis 2014, 4 871 arbres ont ainsi été évalués grâce à un nombre croissant de bénévoles. Le programme augmente efficacement le nombre d'individus impliqués dans le dépistage précoce de ravageurs envahissants, bien au delà de ce que permettraient les ressources gouvernementales. Il en découle que ce programme se distingue par un investissement peu onéreux rapportant de nombreux avantages accessoires et canalisant les efforts de la communauté en un tout cohésif. Les résultats procurent des données ayant des implications immédiates pour les opérations de foresterie urbaine tout en aidant à identifier les préoccupations futures de la santé des arbres. Par exemple, le signalement d'une quantité relativement élevée de masses d'œufs de spongieuses par les bénévoles, permet à la municipalité de prendre des mesures de redressement et d'atténuer les dommages. Une diversité de médias sont mis à contribution afin d'annoncer le programme, incluant les hebdomadaires de quartier et les médias sociaux ainsi que sa publicisation dans les écoles locales et lors d'événements communautaires. Le programme est bien adapté pour les étudiants de niveau secondaire ou lycée qui peuvent alors compléter un programme imposé d'heures de bénévolat tout en acquérant simultanément des connaissances environnementales. Le programme favorise l'émergence d'une préoccupation pour les questions relatives aux forêts urbaines municipales, particulièrement en ce qui a trait aux espèces envahissantes et à la santé des arbres en milieu urbain.

Zusammenfassung. Das Freiwilligen-Programm zur Erhaltung der Wälder, eine gemeinsame öffentlich-private Initiative aus Oakville, Ontario, Kanada, rekrutiert Freiwillige aus der Gemeinde, um öffentliche Bäume bzgl. Ihrer Gesundheit und Anzeichen von invasiven Insekten zu untersuchen. In Partnerschaft mit kommunalen Angestellten, trainieren die Mitarbeiter von Bioforest, einem privaten Gutachterbetrieb, die Freiwilligen in der Untersuchung von Bäumen bzgl. Baumstruktur und Blattkonditionen, sowie auf Anzeichen und Symptomen einer Infektion durch den Asiatischen Eschenprachtkäfer, Schwammspinner und Asiatischen Langhornkäfer. Seit 2014 wurden 4.871 Strassenbäume durch eine wachsende Basis von Freiwilligen untersucht. Das Programm erhöht weit über den Etat, den die öffentlichen Ressourcen typischerweise erlauben, effektiv die Anzahl der Teilnehmer, die in die frühe Detektion von Schadinsekten involviert sind. Das Programm stützt sich auf eine Investition mit niedrigen Kosten mit der Folge, dass multiple zusätzliche Vorteile entstehen und die kommunalen Be-

mühungen in einem zusammenhängenden Produkt münden. Die Resultate liefern Daten mit direkten Implikationen für kommunale Forstoperationen und helfen auch Trends in der urbanen Waldgesundheit über die Zeit zu identifizieren. Zum Beispiel wurde von relativ hohem Aufkommen von Schwammspinner-eigelegten durch Freiwillige berichtet, was der Kommune in Anschluss erlaubte, Gegenmaßnahmen zu ergreifen und den Schaden zu entschärfen. Eine Reihe von Medien wurde zur Werbung für das Programm genutzt, einschließlich kommunale Zeitungen und social media, ebenso wie die Kommunikation in lokalen Schulen und bei kommunalen Veranstaltungen. Das Programm ist zugeschnitten für Hochschulstudenten, die in der Lage sind, ein im Curriculum vorgeschriebenes Maß an Stunden abzuleisten und dabei simultan ökologisches Fachwissen zu erwerben. Das Programm gestattet besonders in Bezug auf invasive Arten und Baumgesundheit eine Vermehrung von Bewusstsein und Erziehung in Verbindung mit kommunalen Forstthemen.

Resumen. El Programa de Voluntarios de Sanidad Forestal, una iniciativa conjunta público-privada en Oakville, Ontario, Canadá, recluta voluntarios de la comunidad para evaluar los árboles de las calles municipales con el fin de detectar problemas de salud y signos de insectos invasivos. En colaboración con los empleados municipales, el personal de BioForest, un consultor privado, capacita a voluntarios para inspeccionar los árboles para un conjunto de condiciones estructurales y foliares, así como para detectar signos y síntomas de infestación por el barrenador esmeralda del fresno, la mariposa gitana y el escarabajo asiático de cuernos largos. Desde 2014, 4,871 árboles de la calle han sido evaluados por una creciente base de voluntarios. El programa aumenta efectivamente el número de participantes involucrados en la detección temprana de plagas, más allá de lo que los recursos del gobierno generalmente permiten. Por lo tanto, el programa implica una inversión de bajo costo que proporciona múltiples beneficios y canaliza los esfuerzos de la comunidad en un producto cohesivo. Los resultados proporcionan datos con implicaciones directas para las operaciones forestales municipales y ayudan a identificar tendencias en la salud de los bosques urbanos a lo largo del tiempo. Por ejemplo, los voluntarios informaron sobre la detección de un número relativamente alto de masas de huevos de polilla gitana, lo que permitió al municipio tomar medidas correctivas y mitigar los daños. Se utiliza una variedad de medios para anunciar el programa, incluidos los periódicos comunitarios y las redes sociales, así como las comunicaciones en las escuelas locales y en los eventos comunitarios. El programa es adecuado para estudiantes de secundaria, que pueden completar horas de voluntariado exigidas por el currículo a través del mismo, mientras que al mismo tiempo obtienen conocimientos ambientales. El programa permite la proliferación de la conciencia y la educación en relación con las cuestiones forestales urbanas municipales, en particular las relacionadas con las especies invasoras y la salud de los árboles urbanos.