Resident Attitudes and Actions Toward Native Tree Species: A Case Study of Residents in Four Southern Ontario Municipalities

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Abstract. Urban forests are increasingly acknowledged as important areas for producing ecosystem services and maintaining ecosystem processes. In response, municipalities throughout North America have been adopting long-term plans to support strategic management of the urban forest. These plans have the potential to shape the urban forest for decades to come. Most management plans emphasize the planting of native trees, to improve ecological integrity and ecosystem services, and acknowledge the need for resident stewardship to help meet urban forestry goals. Residents' support and action is crucial, since the majority of urban trees are located on residential property, yet it is unclear what residents' attitudes and actions are regarding native trees. Using a case study of four municipalities in southern Ontario, Canada (two that have management plans that call for more native species plantings and two that do not), researchers administered a survey that explored residents' attitudes and actions toward native tree species, focusing on the relationship between municipal emphasis on native species planting, household socio-demographics, and residents' attitudes and actions toward native species. The results indicate that residents' generally have positive attitudes toward native trees, although fewer are interested in planting native species if they create a hazard or increase costs. Moreover, these generally positive attitudes do not translate into emphasizing native species when actually selecting tree species to plant. This paper adds to existing research surrounding the need for further outreach and environmental education and greater availability of native plants in local nurseries.

Key Words. Carolinian Canada; Municipal Policy; Native Species; Nurseries; Ontario; Residents; Stewardship; Urban Forest.

Urban forests are increasingly recognized as important areas for producing life-sustaining ecosystem services (Dobbs et al. 2011; Ostoić and Konijnendijk van den Bosch 2015). As a result, urban forests are often managed to maximize societal benefits through a focus on ecosystem service provision, including microclimate regulation, stormwater mitigation, erosion control, shading, carbon sequestration, and human-stress reduction (Bolund and Hunhammar 1999; Alvey 2006; Dobbs et al. 2011; Elmqvist et al. 2015). In addition, maintaining native species assemblages can increase ecological integrity and provide resilience against disturbances (Alvey 2006; Raupp et al. 2006; Alberti 2010; Ordóñez and Duinker 2012).

Recent research has focused on the role of key actors involved with stewardship of the urban forest to better understand the socio-ecological dynamics contributing to urban forest conditions and to support effective management (e.g., Avolio 2015; Conway et al. 2011; Watkins et al. 2016). Of these actors, residents may be the least understood but perhaps the most important, as the majority of trees in the urban forest are located on private property (Nowak 2012). Thus, many of the decisions regarding urban tree planting, species selection, maintenance, and removal are being made by residents.

An expansive literature has documented the relationship between residents' socio-demographic characteristics and urban forest characteristics at the property and neighborhood scale, planting activities, and general support for municipal urban forestry (Sommer et al. 1994; Fraser and Kenney 2000; Grove et al. 2006; Heynen et al. 2006; Troy et al. 2007; Landry and Chakraborty 2009; Tooke et al. 2010; Zhang and Zheng 2011; Kendal et al. 2012; Pham et al. 2012). Additionally, several studies have shown that residents' attitudes toward urban greenery are typically expressed through planting and maintenance

actions (Finger 1994; Zagorski et al. 2004; Fishbein and Ajzin 2010; Conway and Shakeel 2014).

Research has also recently explored who participates in voluntary tree-planting programs (Greene et al. 2011; Locke and Grove 2016; Nguyen et al. 2017), as well as strategies to increase community tree stewardship success (Vogt et al. 2015). Initiatives, such as the Million Trees projects in New York City, New York, and Los Angeles, California, U.S., have enhanced community tree stewardship in their municipalities, and have been adopted by other municipalities (e.g., City of London, Ontario) after recognizing their success. However, little is known about residents' attitudes and stewardship actions related to common municipal urban forest management goals beyond planting trees. More specifically, it is unclear if residents support native species goals that many municipalities are adopting, or if they are willing to select tree species to plant that align with these goals.

To better understand residents' potential role in increasing native tree species in the urban forest, the major objectives of this study were to 1) explore urban residents' attitudes and actions related to native tree species; 2) examine if the presence of a municipal urban forest management plan (UFMP) emphasizing native species is related to those attitudes or actions; 3) determine if attitudes vary among residents with different sociodemographic characteristics; and 4) explore if positive attitudes toward native species translates into planting native tree species. These objectives are addressed through this case study of four municipalities, two with a management plan emphasizing native species planting, and two without, in Carolinian Canada (Ontario, Canada). The following sections outline recent research considering native species in urban forests and resident interactions with the urban forest, the methods and results, and the broader implications of the relationships present between residents and native tree species.

NATIVE SPECIES AND RESIDENTIAL ACTORS IN THE URBAN FOREST

Typically, urban forests contain higher tree species richness than neighboring natural forests, primarily because of the numerous non-native species regularly planted by municipalities, residents, and other actors (Miller and Hobbs 2002;

Stewart et al. 2004; Bertin et al. 2005; Alvey 2006). This richness is not indicative of an even species distribution, as a few species often dominate, some native species are not planted, and many native and non-native species are quite rare within a given city (Kendle and Rose 2000; Clemants and Moore 2003; Hitchmough 2011; Schaeplfer et al. 2012).

The benefit of maintaining native species diversity within urban forests is contested throughout the academic literature (Alpert et al. 2000; D'Antonio and Meyerson 2002; Sagoff 2005; Davis 2012; Sjöman et al. 2016); the multiple stressors within urban ecosystems, potential ecosystem service benefits of planting non-native species, having a limited catalogue of native species to fulfill ecosystem services and resilient to harsh urban ecosystems, and the uncertainty of added environmental stressors from a changing climate raise questions about the benefits of a native-first approach. In any case, as many municipalities are pursuing aggressive tree-planting goals alongside the adoption of native species goals—often in response to loss of natural cover (Bardekjian et al. 2016)—there is a push for all urban forest actors to plant more native tree species in many North American cities.

Across Canada, the planting and maintenance of native tree species is the only management topic that all municipalities' UFMPs has in common (Ordóñez and Duinker 2013). The promotion of native species in these plans is based on their contribution to ecological integrity, ability to grow well in the local climate, and the known risks associated with invasive non-native species (Almas and Conway 2016). Although many municipalities in Canada and elsewhere are emphasizing native species planting in their urban forests, it is unclear whether residents are supportive of these goals or are taking actions that help meet them.

Residents' role in shaping the structure and function of the urban forest is not fully understood, in part, because residents' planting choices and motivations typically go undocumented. Collectively, residents manage much of the distribution and condition of the urban forest through the cumulative effects of many individual property-level decisions (Conway and Shakeel 2014). This is particularly true for municipalities that have adopted ambitious long-term management plans to grow the urban forest, as residential planting is often

explicitly needed to achieve plan goals (e.g., Town of Oakville 2008; City of London 2012). Given the short history and lack of research regarding the influence of urban forest management plans, it is unclear if their adoption has altered the likelihood of residents planting a tree, much less a native tree. North American municipalities typically do not regulate tree plantings by residents (outside of the initial development process), or dictate which species of trees to plant. So if municipalities are going to affect the actions of residents, they must do so through education and outreach that influence residents' attitudes and ultimately impacts their actions. As a result, it is critical to establish a better understanding of residential planting attitudes and actions in relation to native species, and the factors that are related to those attitudes.

Attitude is a complex construct, formed and affected by socioeconomic, cultural, and bio-physical interactions (Balram and Dragićević 2005). Knowledge of species, interest in nature, and nature experiences are the factors that best promote positive attitudes toward environmental issues, biodiversity, and a sustainable life style (Chawla 1999; Corcoran 1999; Palmer et al. 1999; Palmberg and Kuru 2000; Lindemann-Matthies 2006; Martin et al. 2013; Baur and Haase 2015; Palmberg et al. 2015); these likely play a role in residents' attitudes toward native species in the urban forest. Residents generally express a positive attitude toward trees (Barro et al. 1997; Lohr et al. 2004; Schroeder et al. 2006; Zhang et al. 2007; Jones et al. 2012), although Kirkpatrick et al. (2012) documented a variety of attitudes toward urban trees among residents in Australia, which they divided those attitudes into seven categories: aesthetes, tree huggers, practical tree lovers, arboriphobes, native wildlife lovers, tree hazard minimizers, and tree indifferents. Moreover, desire for specific vegetated land covers varies among ethno-cultural communities and 'lifestyle groups,' and is not uniform within income classes (Fraser and Kenney 2000; Grove et al. 2006).

Education about urban forestry programs can affect the attitudes and actions of residents, with people who know more about urban forestry programs (measured by the total number of forestry services the respondent could name) more likely to support the goals of tree-planting

programs by donating money (Zhang and Zheng 2011). However, efforts to increase native species plantings that focus on consciousness-raising and attitude change are not always effective (Summit and Sommer 1998). Thus, residents' attitudes toward native species are likely a result of multiple factors but may not be easy to modify.

Like attitudes, residents' tree-planting decisions are affected by various factors, including the existence of tree-planting policy and programs, the availability of trees from nurseries and garden centers, preferences of influential gardeners and landscape designers, as well as residents' attitudes (Kendal et al. 2012; Conway and Vander Vecht 2015). For example, Kirkpatrick et al. (2012) found residents' attitudes about urban forest issues, including invasive species, canopy cover, and biodiversity, can affect planting actions on their property in eastern Australia, such that residents who prefer native species tend to plant native species, and avoid non-native species. Additionally, residents' who appreciate native flora, tend to plant native flora. In a study of residents in Perth, Australia, the attitudinal variable with the strongest relationship to garden-type preference was residents' attitude toward native plants (Kurz and Baudains 2012). Preferences were also highly related to prevailing gardening norms in respondents' local area.

Studies regarding residential urban forest native species attitudes and actions have not been conducted in the Carolinian Zone of Canada, so it is unclear if residents will have the same attitudes and related actions toward planting native species that residents in Australia demonstrated.

Recent North American studies have compared residential characteristics, such as participation in tree-planting programs in relation to tree or canopy abundance (Zhang and Zheng 2011). Additionally, there is evidence that tree-planting actions vary among residents based on their socio-demographic characteristics. Locke and Grove (2016) found that municipal street tree requests are most likely to come from relatively highly treed neighborhoods. Participants in backyard tree-planting programs are more likely to be white homeowners from neighborhoods with high socioeconomic status (Perkins et al. 2006; Greene et al. 2011), while people with higher income and education levels between the ages of

30 and 49 are most likely to participate in general urban forestry activities (Fleming et al. 2006).

While attitudes, knowledge, and socio-demographic characteristics affect residents' planting actions and support for urban forestry efforts, it is unclear what residents' attitudes toward native species in the Carolinian Canada forest are, and whether the presence of an urban forest management plan and/or positive attitudes are associated with actually planting native trees.

METHODS

Study Area

This study was conducted in four large municipalities in the part of southern Ontario known as the Carolinian Zone of Canada (Figure 1). It is the most densely populated region in Canada, with more than eight million people living in one-quarter of one percent of the country's land area (Reid 2002). Moderated by the proximity of the Great Lakes, the Carolinian Zone's climate is classified as humid continental (Köppen Dfa to Dfb) with four distinct seasons. The region's vegetation is unique within Canada, characterized by broadleaf-deciduous trees, like *Sassafras albidum* (sassafrass), *Gymnocladus dioicus* (Kentucky coffeetree), *Liriodendron tulipifera* (tuliptree), and *Magnolia acuminata* (cucumber magnolia), while also representing the southern extent of the Great Lakes–mixed boreal forest. As a result, it is a biodiversity hotbed with the highest species richness of any ecozone in Canada (Johnson 2007). Historically, this region's land cover was 80% forest, which now only occupies 11% of the landscape (Johnson 2007).

Residents from the municipalities of London, Hamilton, Oakville, and Markham, Ontario, were surveyed to better understand attitudes and actions toward native tree species (Table 1). These municipalities were chosen because they are relatively large urban municipalities that have experienced two distinct patterns of growth. London and Hamilton are characterized by older urban development, and have been among Canada's largest municipalities since the inception of the Canadian Census in 1871. These older municipalities have similar demographics, with relatively low average household incomes and smaller immigrant populations than the two newer study areas of Oakville and Markham. The cities of Oakville and Markham have both experienced exponential population growth in the past few decades and are two of the most ethnically diverse municipalities in North America, primarily because of large immigrant populations. One older (London) and one newer growth (Oakville) municipality have adopted UFMPs (Town of Oakville 2008; City of London 2012), while Hamilton and Markham have not, allowing for examination of the impacts of the UFMPs and differing demographics on residential attitudes and actions regarding native tree species in urban forests.

Resident Surveys

For this study, researchers asked 1600 residents (400 in each municipality) to participate in a survey about their attitudes and actions toward native tree species in the summer of 2015. Potential survey respondents were chosen using a spatially stratified random sample to capture the range of socio-demographic and urban forest variation within each municipality, given that most socioeconomic and tree factors are spatially clustered. At the beginning of
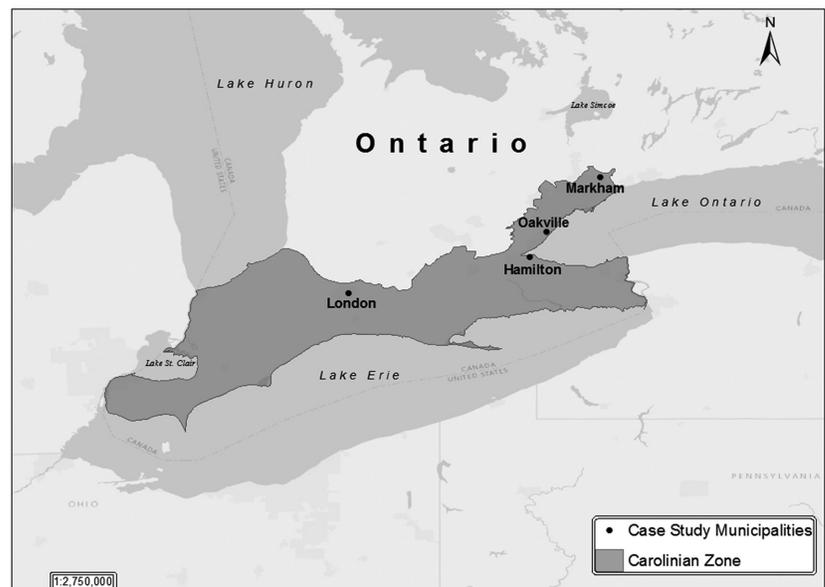

Figure 1. Map of the Carolinian forest zone in Canada showing the four surveyed municipalities.

Table 1. Summary of socio-demographic and tree-planting variables, shown as a percentage of all respondents.

	Combined	London	Hamilton	Oakville	Markham
Education					
No certificate, diploma, or degree	3	2	8	1	3
High school certificate or equivalent	19	23	24	13	12
Apprenticeship, college, CEGEP	30	35	36	20	25
University bachelor's degree	33	22	24	49	46
Masters or doctorate degree	15	19	8	18	15
Ethnicity					
British Isles	51	64	45	67	19
European	30	30	42	19	26
Other	19	5	13	14	55
Born					
Ontario	59	50	67	73	49
Outside of Ontario	41	50	33	27	51
Years at this current address					
1 year or less	4	4	5	3	6
2 to 4 years	10	10	12	10	10
5 to 9 years	16	17	17	15	12
10 to 14 years	15	17	8	13	20
15 to 19 years	13	13	13	10	18
20 or more years	42	40	45	49	34
Household income					
0 to 29,000	5	6	7	5	1
30,000 to 59,000	22	24	30	16	17
60,000 to 89,000	23	21	24	29	18
90,000 to 119,000	16	17	10	23	11
120,000 to 149,000	9	6	16	10	5
150,000 to 179,000	9	12	4	8	11
Over 180,000	16	14	9	10	37
Planted a tree on your property					
Yes	71	80	62	76	59
No	29	20	38	24	41
Planted a native tree on your property					
Yes	36	43	31	38	26
No	64	57	69	62	74
Knowledge of native trees (correctly identified native status)					
Yes	40	44	40	35	38
No	60	56	60	65	62

the survey, "tree" was defined as a woody perennial plant having a trunk greater than 10 cm in diameter, and "native species" was defined as occurring naturally within the region, either evolving there or arriving and becoming established without human assistance, to ensure a basic knowledge of each concept and consistent interpretation. The survey asked residents to indicate the factors they would consider when deciding to plant a tree on their property, the current number of trees present, recent actions related to tree planting and removal, and their knowledge and actions related to their municipality's UFMP, if applicable. Attitude related to respondents' level of support for native tree species in urban areas was assessed using a five-point Likert scale for 16 statements related to the planting and maintenance of native species by individuals and municipalities (see Appendix). Additionally, residents' knowledge of native tree species was gauged, with knowledge based on the number of common street tree species' native-status the respondents could correctly identify (Almas and Conway 2017).

Analysis

To better understand residents' role in planting native tree species in the urban forest, urban residents' attitudes and actions related to native tree species, and the factors correlated with those

attitudes and actions, were examined through a series of analyses. To explore these attitudes, a PCA analysis was used to determine if different dimensions of attitudes toward native species exist based on responses to the 16 attitude statements in the survey. The relationships between the primary PCA-derived components of native species attitudes, the presence of an UFMP emphasizing native species, and residents' socio-demographic characteristics were examined using ANOVAs. Cross-tabulations and a logistic regression was utilized to explore factors correlated with the act of planting a native tree.

First, basic summaries of each survey question were calculated to understand prevailing attitudes and actions, current property-level tree conditions, and respondents' socio-demographics. Reponses to open-ended questions were coded using NVivo software.

Second, a PCA was completed to analyze relationships among the 16 statements assessing attitudes toward native species. Given the exploratory nature of this study, a PCA was chosen to determine if discrete patterns existed among the responses to the different attitudinal statements. Components with eigenvalues greater than 1 were retained (Kim and Mueller 1978). These components were then used to represent different dimension of attitudes toward native trees when examining the relationship between native species attitudes and categorical variables representing socio-demographics, presence of an UFMP, and residents' actions in a series of ANOVAs. Bonferroni's *post hoc* test was used to determine significant differences between groups when a significant relationship existed.

Third, the relationship between planting native species, UFMP presence, and socio-demographic factors was initially examined through a series of cross-tabulations, using Cramer's V as the test statistic. In order to meet the assumptions of Cramer's V, some categories within variables, such as ethnicity (e.g., placing all European ethnicities in one category) and age, were combined to meet the minimum sample assumptions. Binary logistic regression was then used to further examine the factors related to having knowingly planted a native tree, defined as planting at least one native tree or not planting any native trees. The variables that have a significant relationship with planting a native tree in the cross-tabulations were ini-

tially included in the model. A second model was examined that also included the attitudinal PCA components as explanatory variables to explore the importance of attitude in relation to action.

It was expected that the presence of an UFMP in a municipality would be related to more positive attitudes toward native species and a greater likelihood of planting a native species. It was also expected that residents with higher household incomes would be more likely to plant native species given that wealthier areas tend to have larger properties with larger planting areas (Gorman 2004; Lohr et al. 2004; Landry and Chakraborty 2009; Zhang and Zheng 2011), and residents with more disposable income have more choices when it comes to planting practices, which in turn can also lead to opinions being formed about what constitutes "better practice" (Kirkpatrick et al. 2012). Finally, researchers expected higher native species knowledge levels and positive attitudes toward native species would be related to actually planting native species.

RESULTS

Of the 1600 possible respondents, 90 surveys were not successfully delivered, and 552 surveys were completed, representing a 37% response rate. London had the highest response rate at 44%, while Markham had the lowest response rate at 29% (Table 1). The average age of the respondents was 58 years, and 55% were male. Forty-eight percent had earned at least a bachelor's degree, and the average annual household income was CAD $117,650. On average, respondents had lived at their current address for between 15 and 19 years, while 59% were born in Ontario. There was a 96% homeownership rate, with 88% living in detached homes. Eighty-one percent of respondents indicated that they were of British Isles or European ethnicity.

When compared to recent census data (Statistics Canada 2011), the percent of university-educated participants and average household income were higher for survey respondents than the corresponding municipal level, possibly as a result of limiting participants to non-apartment dwellers. The number of Ontario-born survey participants reflects the proportion of the municipality born in the province, with the exception of London. However, the accuracy

of the 2011 census is unclear given the different voluntary approach used only in this census year (Statistics Canada 2015), making the cause of divergences (census issues, survey representativeness, or temporal differences) uncertain.

Attitudes Toward Native Species

In general, respondents believe that native species are more beneficial than non-native species in urban areas: 85% said that native species are or may be more beneficial, while only 15% did not believe that native species are more beneficial. Based on coding of an open-ended question, the most common reasons stated as to why native species are more beneficial are: they grow better, are better suited to the climate, have a better chance of survival, are resilient, contribute to the native ecosystem, are healthier, and non-native trees can become invasive. In contrast, the most common reasons given as to why native species are not more beneficial in urban areas were: urban areas are not native, trees are trees, and variety is helpful to adapt to climate change.

While there was widespread recognition of the value of native species in urban areas, only 20% of respondents said native status of the tree was a primary consideration when choosing a tree to plant on their property. The most common factors were: shade provision (58% of respondents), size and shape of tree species (54% of respondents), suits the aesthetic of their home (48% of respondents), and maintenance requirements of the tree (36% of respondents), suggesting that a list of "native alternatives to non-native trees" would be a useful education tool for municipalities to provide.

Most respondents (64%) agreed or strongly agreed that their municipality should be planting more trees, planting more native trees (65%), and that other homeowners should also plant more native trees (52%). In contrast, only 9% thought that their municipality should plant more non-native trees. These results are reinforced by the finding that 73% of respondents believe that their municipality is responsible for maintaining their natural heritage, with more respondents from municipalities with an UFMP believing (81%) that it is the responsibility of the municipality to maintain natural heritage. However, only 19% of respondents thought that all varieties of native trees should be planted by municipalities if they could lead to added costs or hazards, and 57% thought that municipalities should not plant native trees if they require extra maintenance.

Four components were retained from the attitude statement PCA (Table 2). Component 1 (generally positive attitudes toward native species) was associated with statements that captured attitude toward native tree species issues, with more positive values related to preference for selecting native species and considering them beneficial. The statements associated with municipalities and homeowners not needing to plant more trees were most highly, positively loaded on Component 2 (no tree planting). Component 3 (reduced hazards and future conditions) is associated with statements about tree hazards and practicing assisted migration. The fourth component (plant all natives) represents the statement: all varieties of native trees should be planted by the municipality, even if this leads to greater hazards and/or maintenance costs. It is interesting that this statement was only weakly associated with the first component, which is most strongly correlated to all other statements related to valuing and planting native species; support to plant all species of native trees regardless of hazards and costs differs from generally appreciating native species and believing that homeowners and municipalities should plant them.

Based on the ANOVA (Table 3), general attitudes toward native species (Component 1) is strongly related to education and place of birth. Specifically, respondents with higher education-levels, and those who still live in their municipality of birth or those born in Ontario are more likely to have positive native species attitudes. Additionally, place of birth is related to the idea that homeowners and municipalities should be planting more trees (Component 2); Immigrants were more likely to feel that homeowners and municipalities do not need to plant more trees (Component 2). Immigrants to Canada were also more likely to be in favor of planting all varieties of native trees (Component 4), even if it leads to greater hazards and maintenance costs. Results from Component 3 (reduced hazards and future conditions) were not significantly related to place of birth. The ANOVA indicated no significant relationships between the presence of an

UFMP and attitudes toward native tree species, although it is important to note that differing levels of municipal investment in education and outreach regarding UFMPs could alter this result.

Knowledge of native tree species had a mixed relationship with being in favor of planting all natives (Component 4). Those who correctly identified the native status of 1 to 3 (out of 12) tree species were more likely than those who could not correctly identify any species to support the planting of all native species, while respondents who were able to correctly identify more than three native tree species did not strongly support planting all natives. Finally, residents who were aware that their municipality is located in Carolinian Canada were more likely to have positive attitudes toward native species (Component 1), and believe that more trees should be planted by homeowners and the municipality (Component 2).

Table 2. Principle components analysis of native tree species attitude questions.

Statements	Components			
	General attitudes 1	No tree planting 2	Reduce hazards and future conditions 3	Plant all natives 4
Natives are more beneficial in urban areas	*0.65*	-0.03	-0.192	-0.123
I do not consider nativeness when planting	-0.476	-0.062	0.418	0.365
I want my neighbors to plant native	*0.706*	0.088	-0.09	-0.059
Two similar trees: native over non-native	*0.697*	0.151	0.031	-0.071
I prefer native	*0.751*	0.306	-0.01	0.014
I prefer a native street tree	*0.792*	0.213	0.009	-0.003
City should plant more natives	*0.728*	-0.057	0.084	0.125
Homeowners should plant more natives	*0.766*	-0.069	0.032	0.118
City should plant more non-native	*-0.563*	-0.008	0.216	0.319
City doesn't need to plant more trees	-0.352	*0.767*	0.138	0.034
Homeowners don't need to plant more trees	-0.337	*0.788*	0.091	0.046
Only plant natives that grow well	*0.545*	0.273	0.323	0.023
City is responsible for natural heritage	*0.587*	-0.07	0.287	0.312
Plant all native species	0.21	0.053	-0.237	*0.784*
Don't plant native trees that have hazards	0.083	-0.023	*0.707*	-0.388
Practice assisted migration	0.217	-0.31	*0.595*	0.154
Initial Eigenvalues	5.236	1.570	1.398	1.179
% of variance	32.725	9.811	8.739	7.368

Table 3. Analysis of variance (ANOVA) with PCA components, socio-demographics, and action variables.

	Component 1			Component 2			Component 3			Component 4		
	df	F	P	df	F	P	df	F	P	df	F	P
Socio-demographics												
Gender	1	2.499	0.115	1	1.211	0.272	1	0.120	0.730	1	0.165	0.685
Education	4	5.795	*0.001*	4	0.791	0.531	4	1.452	0.216	4	2.461	*0.045*
Ethnicity	2	1.488	0.227	2	2.113	0.122	2	2.485	0.084	2	2.543	0.080
Where born	3	3.133	*0.025*	3	3.075	*0.027*	3	2.542	0.056	3	4.773	*0.003*
Length of time at current residence	5	0.361	0.875	5	0.580	0.715	5	2.133	0.060	5	0.791	0.557
Own or rent home	1	2.381	0.123	1	0.277	0.559	1	0.366	0.545	1	0.021	0.884
Income	6	0.952	0.458	6	1.841	0.090	6	0.289	0.942	6	1.319	0.247
Number of people over 65	4	0.174	0.951	4	2.183	0.070	4	1.144	0.335	4	0.612	0.654
Number of people 45 to 64	3	0.236	0.871	3	1.269	0.285	3	0.602	0.614	3	1.047	0.371
Number of people 18 to 44	4	2.756	*0.028*	4	0.975	0.421	4	1.406	0.231	4	0.435	0.784
Number of people under 18	4	0.425	0.790	4	1.734	0.141	4	0.856	0.490	4	2.333	0.055
By municipality	3	1.909	0.127	3	1.108	0.346	3	2.091	0.101	3	0.050	0.985
Presence of UFMP	1	1.053	0.305	1	1.029	0.311	1	0.118	0.731	1	0.111	0.739
Knowledge and action variables												
Knowledge of native species	4	1.964	0.099	4	0.313	0.870	4	1.252	0.288	4	2.841	*0.024*
Carolinian Canada awareness	1	28.327	*0.001*	1	6.980	*0.009*	1	0.055	0.814	1	3.785	0.052
Participated in UF activity	2	0.091	0.913	2	0.051	0.951	2	0.844	0.433	2	1.072	0.346
Knowingly planted native	1	2.175	0.141	1	0.084	0.772	1	0.382	0.537	1	0.306	0.581
Trees removed since moving	5	0.609	0.693	5	0.546	0.741	5	1.009	0.412	5	0.338	0.890
Trees planted since moving	4	0.488	0.744	4	1.938	0.103	4	1.162	0.327	4	1.999	0.094
Number of trees on property	4	0.410	0.801	4	0.514	0.725	4	0.137	0.969	4	1.051	0.380
Number of native trees on property	4	1.049	0.381	4	2.598	*0.036*	4	0.623	0.647	4	1.194	0.313

Native Species Planting Actions

The vast majority of respondents had planted trees on their property since moving there (72%; Table 4). Additionally, 34% of respondents had knowingly planted a native tree on their property, meaning that nearly half of the people who had planted trees had knowingly planted at least one native species.

Not surprisingly, only 6% of respondents indicated that they had planted a tree with the goals of an UFMP or the forestry department in mind. However, respondents who live in municipalities with an UFMP (London and Oakville) are more actively engaged in planting native trees, planting and removing of trees on their property in general, and had more trees currently on their property, as compared to Hamilton and Markham (Table 4).

Through a series of cross-tabulations (Table 5), the relationship between socio-demographic variables and native-species planting actions was explored. There was no significant relationship between having a native species and planting with forestry goals in mind. However, having knowingly planted a native species was related to the presence of an UFMP. Respondents' immediate plans to plant a tree, and plans to plant a native tree were both related to their income level, with the middle-income respondents most likely to have planting plans. Similarly, plans to plant a tree and plant a native tree were also related to respondents' age, with younger (18–40-year-olds) respondents most likely to have plans to plant a tree and plans to plant a native tree.

Results from the logistic regression (Table 6) indicate that knowingly planting native trees is related to higher levels of knowledge of native trees, awareness of living in the Carolinian zone, and presence of an urban forest management plan, while socio-demographics and attitudes toward native trees were not significantly related to having knowingly planted a native tree. However, the Nagelkerke R Square value was not high (0.118), meaning there is considerable variation in the planting variable that is not captured by the explanatory variables.

Table 4. Summary of respondents' tree-planting actions.

		Trees Planted and Removed		
Number of trees planted		1 to 4	5 to 10	10+	Total
Percentage of respondents		43%	17%	12%	72%
Number of trees removed		1	2	3 to 5	Total
Percentage of respondents		22%	14%	24%	60%
Future Actions		Plans to plant a tree	Plans to plant native	May plant a tree	May plant a native tree
Percentage of respondents		11%	7%	31%	36%

Table 5. Cross-tabulation results of action and socio-demographic variables.

		Age category	Gender	Highest education	Ethnicity	Where born	Length of residence	Ownership	Income	Presence of UFMP
Knowingly planted a native tree	Cramer's V	0.069	0.088	0.118	0.014	0.069	0.044	0.034	0.071	0.129
	P-value	0.311	0.051	0.146	0.956	0.497	0.964	0.442	0.926	***0.003***
Plan to plant a tree	Cramer's V	0.100	0.04	0.096	0.058	0.052	0.070	0.030	0.181	0.043
	P-value	***0.039***	0.672	0.317	0.490	0.832	0.890	0.788	***0.009***	0.611
Plan to plant a native tree	Cramer's V	0.109	0.034	0.100	0.053	0.051	0.073	0.012	0.188	0.044
	P-value	***0.018***	0.753	0.262	0.593	0.843	0.853	0.966	***0.005***	0.589
Planted with forestry goals in mind	Cramer's V	0.029	0.060	0.053	0.044	0.072	0.069	0.020	0.139	0.039
	P-value	0.811	0.174	0.836	0.611	0.441	0.780	0.651	0.255	0.364

Table 6. Variables in the logistic regression (dependent variable = knowingly planted a native tree).

Variable	B	Wald	Sig.
No urban forest management plan	-0.511	5.808	0.016
Carolinian aware	0.627	5.284	0.022
Knowledge of trees		25.768	0.000
Knowledge of trees (0)	-2.428	25.002	0.000
Knowledge of trees (1–3)	-1.278	9.767	0.002
Knowledge of trees (4–6)	-1.050	7.690	0.006
Knowledge of trees (7–9)	-1.125	8.117	0.004
Attitude Component 1	-0.211	3.867	0.059
Attitude Component 2	0.009	0.007	0.932
Attitude Component 3	-0.107	1.012	0.314
Attitude Component 4	-0.111	1.070	0.301
Constant	0.835	5.715	0.017

DISCUSSION AND IMPLICATIONS

This study examines the role of residents' attitudes and actions toward native tree species in light of recent urban forestry goals to increase their presence. While civic engagement in the form of participatory planning has occurred in municipalities that have an active urban forest management plan (e.g., Town of Oakville 2008; City of London 2012), the survey results highlight the need for municipalities to more actively engage residents regarding the goals and targets of their management plans, and to reinforce the property-level value of planting native trees to achieve resident buy-in for these initiatives. The PCA showed that most residents expressed generally positive attitudes toward native species and were overwhelmingly in favor of their neighbors and the municipality planting more native trees, and most respondents also indicated that if given the choice between two trees with similar attributes they would choose the native tree. These positive attitudes did not relate to having native trees on their property or to a desire to plant native species regardless of costs. Additionally, in the event that the native trees could cause hazards or had higher maintenance costs, then residents tended not to support them.

There was a strong relationship between respondents' level of education and positive attitudes toward native tree species. This relationship between education-level and participation in urban forest activities has been noted by others (Grove et al. 2006; Heynen et al. 2006; Zhang et al. 2007; Landry and Chakraborty 2009; Tooke et al. 2010; Zhang and Zheng 2011; Pham et al. 2012; Conway and Shakeel 2014). Interestingly, other socio-demographic factors commonly related to urban forest extent and participation (e.g., income, ethnicity, age) were not found to be significantly related to native species attitudes in this study.

One explanation for the significance of education is that public campaigns in Carolinian Canada against invasive species like *Acer platanoides* (Norway maple) and *Rhamnus cathartica* (common buckthorn) may have swayed opinions in favor of native trees. Similarly, the outreach, including posted signage in the remnant Carolinian forest areas that praise the existing diversity of native species, likely also have garnered support for native species. People with a higher education level are possibly more likely to have been exposed to this literature and/or understand the broader implications.

In fact, while residents tend to believe that native species are more beneficial in urban areas, the motivations that drive their tree-planting actions are dominated by pragmatic, property-level concerns, such as the size and shape of the tree, amount of maintenance required, shade provision, and the aesthetic value placed on the tree. This is mirrored by others' findings that homeowner planting is primarily motivated by aesthetics and the maintenance requirements of trees (Summit and McPherson 1998; Camacho-Cervantes et al. 2014; Avolio et al. 2015; Conway 2016). This dichotomy between attitudes and actions was also observed in relation to municipal planting. Only 9% of respondents believe the municipality should plant more non-native trees, but surveyed residents did not prioritize native species when given the opportunity to choose the species of tree that the municipality planted on their boulevard. This also helps explain why the majority of residents have positive attitudes toward native trees, but do not support planting certain species that may cause additional hazards or maintenance costs.

This pragmatic relationship that residents have with native tree species reinforces others' findings that suggest factors such as native tree availability from nurseries, as well as garden centers may play a significant role in the make-up of the urban forest canopy (Brzuszck et al. 2007; Polakowski et al. 2011; Sydnor et al. 2010; Conway and Vander Vecht 2015). Since the majority of urban residents acquire the trees planted on their property

directly or indirectly (through contractor sourcing) from nurseries and garden centers, their choice of tree is limited to what is in stock (Sydnor et al. 2010), and considering the specific motivations that drive residents' tree planting decisions (i.e., shade provision, size, shape, aesthetic), it is likely that a native tree may not be available that meets the specific planting motivations of the resident. It is also noted that garden centers and nursery employees are often not advocates of native tree species, and may not be able to recommend a suitable native tree to meet residents stated requirements (Polakowski et al. 2011).

Residents born outside of Canada indicated less support for native trees as compared to those who live in the municipality where they were born. This relates to Almas and Conway's (2017) findings that immigrants are less knowledgeable about urban forest issues, while residents who had lived at their house for over 15 years were more knowledgeable about native tree species in particular. Johnston and Shimada (2004) argue that municipalities often lack the tools to meaningfully communicate with immigrants, and that terms like 'native' and 'alien' can be off-putting or offensive, discouraging further interest among immigrant populations.

Based on this study, urban forest management plans appear to have had some relationship to residents' planting habits, such that residents are more likely to have knowingly planted a native tree. It is unclear if this is a result of the management plans, a result of Oakville and London (who have plans) properties having more available planting space, or if legacy effects from historic socio-economic conditions have impacted current canopy cover patterns (Luck et al. 2009; Boone et al. 2010).

The presence of an urban forest management plan, and the availability of resources it takes to enact a plan, indicate there is some residential buy-in to managing the urban forest in London and Oakville, although that has not translated into a deeper appreciation for native tree species. Thus, making a management plan is not enough to ensure residential stewardship is in line with the plan's goals. Municipal education and outreach undoubtedly play a large role, as the results from the logistic regression indicate that those who plant native species tend to be more knowledgeable about native species. Since the majority of residents' actions appear to be guided by pragmatic decision-making that prioritizes aesthetics and tree functions over nativeness, a systemic approach that involves changing the species availability at the point of purchase (nurseries and garden centers) to represent a wider diversity of native trees would likely alter residents' actions in favor of native species diversity.

A first step that municipalities can take is to require more native species diversity and quantity in their tree-planting request for tenders from nurseries. As municipalities create a large demand for tree stock from the nurseries that bid on their tender, this action should cause the supply side to adjust. In some instances, this type of supply-chain influence has been found to be more effective than educating residents (Summit and Sommer 1998). Though residents may still choose trees based on their aesthetic and functional value, if the available nursery stock represents a higher number of native tree species, the ratio of native to non-native trees residents select will likely shift.

Most residents expressed generally positive attitudes toward having native tree species in their yards and in public spaces. However, if costs and risks were greater with native species, fewer respondents were supportive of native-tree planting. Moreover, having a positive attitude toward native species did not necessarily translate into action. Given that presence of an urban forest management plan was not significantly related to native species attitudes, municipalities with native species planting goals should engage in more education and outreach to ensure that residents do not just express support for native species but are willing to prioritize them when making species-selection decisions. Since knowledge of native trees was related to planting native trees, educating residents about local ecology is a good first step toward native species stewardship. Additionally, working with nurseries to ensure a diverse supply of native trees could also help residents meet their pragmatic species criteria while selecting a native species.

Supplemental Content. The appendix to this manuscript, Native Trees and Urban Forest Survey, is available for browsing on the website of the publisher, International Society of

Arboriculture (www.isa-arbor.com). The appendix is also available as an electronic file (.pdf) upon individual request (editor@isa-arbor.com).

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Résumé. Les forêts urbaines sont de plus en plus reconnues comme un domaine important pour la production et le maintien de services et de processus écosystémiques. En réaction, les municipalités à travers l'Amérique du Nord ont adopté des plans à long terme pour soutenir la gestion stratégique de leur forêt urbaine. Ces plans ont le potentiel de façonner la forêt urbaine pour les futures décennies. La plupart des plans de gestion mettent l'accent sur la plantation d'essences indigènes afin d'améliorer l'intégrité écologique et les services écosystémiques et reconnaissent la nécessité d'une prise en charge par les résidents afin d'aider à atteindre les objectifs de la foresterie urbaine. Le soutien et l'action des résidents sont cruciaux puisque la majorité des arbres urbains sont situés sur les propriétés résidentielles, sans que nous sachions pour autant quelles sont les comportements et les actions des résidents à l'égard des essences indigènes. Sur la base d'une étude effectuée dans quatre municipalités du sud de l'Ontario (dont deux d'entre elles possèdent des plans de gestion favorisant la plantation de plus d'espèces indigènes et deux autres non), les chercheurs ont mené un sondage examinant les comportements et les actions des résidents envers les espèces d'arbres indigènes, en considérant la relation entre l'emphase des municipalités à encourager la plantation d'espèces indigènes, les données sociodémographiques des ménages et les attitudes et actions des résidents envers les espèces indigènes.

Les résultats indiquent que les résidents ont généralement une attitude favorable envers les arbres indigènes, bien que plusieurs d'entre eux soient moins intéressés à la plantation d'espèces indigènes si elles créent un danger ou augmentent les coûts. De plus, cette attitude généralement positive ne se traduit pas nécessairement par une accentuation en faveur des espèces indigènes au moment du choix des espèces d'arbres en vue d'une plantation. Cet article s'ajoute à la recherche existante sur la nécessité d'efforts supplémentaires, d'une éducation à l'environnement et d'une plus grande disponibilité de plantes indigènes dans les pépinières locales.

Zusammenfassung. Urbane Forste werden immer stärker als wichtige Flächen für die Produktion von Ökosystemleistungen und für die Erhaltung der Ökosystemprozesse verstanden. In Antwort darauf haben Kommunen in den ganzen Vereinigten Staaten Langzeitpläne entwickelt, um das strategische Management der urbanen Forste zu unterstützen. Diese Pläne haben das Potential, die urbanen Forste für die nächsten Dekaden zu gestalten. Viele Managementpläne bevorzugen die Pflanzung von nativen Baumarten, um ökologische Integrität und Ökosystemleistungen zu verbessern, und wertschätzen den Bedarf an Baumpatenschaften durch die Anwohner, um die urbanen Forstziele hilfreich zu unterstützen. Die Unterstützung der Anwohner und deren Aktion sind höchst bedeutsam, da die Mehrheit der urbanen Bäume auf deren Anwesen steht und die Einstellung zu nativen Bäumen und die mögliche Aktion der Anwohner dazu weitgehend unbekannt sind. Unter Verwendung einer Fallstudie an vier Kommunen (zwei davon hatten einen Managementplan, der mehr native Baumarten forderte, und zwei, die das nicht hatten) im Süden von Ontario, Kanada, reichten die Forscher einen Bericht ein, der die Einstellungen der Anwohner und deren Aktionen in Richtung nativer Baumarten erforschte, wobei er auf die Beziehung zwischen kommunalen Dringen auf der Pflanzung von nativen Arten, die sozio-demographische Haushaltszusammenstellung und der Einstellung und Aktion der Anwohner in Richtung nativer Bäume fokussierte. Die Ergebnisse zeigen, dass die Anwohner generell eine positive Einstellung bezüglich nativer Baumarten haben, obwohl weniger daran interessiert sind, native Arten zu pflanzen, wenn sie ein Risiko darstellen oder die Kosten erhöhen. Mehr noch, die

generell positiven Einstellungen lassen sich nicht dahin verstehen, dass die Anwohner bei einer aktuellen Auswahl von Bäumen zu verstärkt zu nativen Baumarten greifen. Diese Studie schließt sich and die bereits existierende Forschung an und umreißt den starken Bedarf an weiterer Aufklärung und umweltpolitischer Bildung und größerer Verfügbarkeit von nativen Pflanzen in den lokalen Baumschulen.

Resumen. Los bosques urbanos son cada vez más reconocidos como áreas importantes para la producción de servicios ambientales y el mantenimiento de los procesos ecosistémicos. En respuesta, los municipios de América del Norte han estado adoptando planes a largo plazo para apoyar la gestión estratégica del bosque urbano. Estos planes tienen el potencial de dar forma al bosque urbano en las próximas décadas. La mayoría de los planes de manejo enfatizan la plantación de árboles nativos, para mejorar la integridad ecológica y los servicios del ecosistema y reconocen la necesidad de la administración de residentes para ayudar a cumplir los objetivos de la dasonomía urbana. El apoyo y la acción de los residentes es crucial, ya que la mayoría de los árboles urbanos se encuentran en propiedades residenciales, sin embargo, no son claros cuáles son las actitudes y acciones de los residentes con respecto a los árboles nativos. Usando un estudio de caso de cuatro municipalidades en el sur de Ontario, Canadá (dos que tienen planes de manejo que requieren más plantaciones de especies nativas y dos que no), los investigadores administraron una encuesta que exploró las actitudes y acciones de los residentes hacia las especies de árboles nativos, centrándose en la relación entre el énfasis municipal en la plantación de especies nativas, la socio demografía del hogar y las actitudes y acciones de los residentes hacia las especies nativas. Los resultados indican que los residentes generalmente tienen una actitud positiva hacia los árboles nativos, aunque pocos están interesados en plantar especies nativas si crean un riesgo o aumentan los costos. Además, estas actitudes generalmente positivas no se traducen en el énfasis de las especies nativas cuando se seleccionan las especies arbóreas para plantarlas. Este documento se suma a la investigación existente en torno a la necesidad de una mayor divulgación y educación ambiental y una mayor disponibilidad de plantas nativas en el ámbito local.