A Volunteer and Partnership Baseline for Municipal Forestry Activity in the United States

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Abstract. Communities cultivate citizen support of municipal forestry operations through volunteers and partnerships. Through a national census and survey of urban forestry activity in over 660 municipalities in the United States, researchers found two-thirds of all responding communities involve volunteers in tree activities. This increases from half of small communities (2,500 to 4,999 people) to all large communities (one million or more people) involving volunteers. When tabulated for the United States, a mean national estimate of 345,466 (195,754 SEM) people volunteered 1,484,204 (665,460 SEM) hours with municipal tree activities. This equates to 714 (320 SEM) full-time equivalent (2,080 hour-base year) positions. Overall, volunteers completed nearly 5% of municipal tree care activities. Nearly 80% of the municipalities train their volunteers. Tree planting (85% of communities) was the most common activity, followed by tree watering (40%), awareness/education programs (39%), tree pruning (28%), and fundraising (20%). Findings were contrasted with U.S. census population groups to disaggregate if volunteerism varied by community size. Volunteers were more commonly involved in communities with a greater urban-forestry capacity derived from a sustainability index score. Six attributes of municipal forestry program had either positive (+) or negative (-) effect on volunteer participation in urban forestry activities. These included adequate budget (-), per capita spending (-), tree board (+), outreach (+), strategic plan (+), and total employment (+).

Key Words. Civic Science; Municipal Forestry; Partnership; Volunteer.

The urban forest results from many social and environmental human activities (Miller et al. 2015). People, through their decisions, policies, plans, and actions are the primary agent influencing the trees that grow in built environments. Community tree populations result from trees existing prior to development, natural regeneration, and through trees planted by humans (Nowak et al. 2004; Miller et al. 2015). Collectively, the urban forest results from people who plant, maintain, and remove trees through varying levels of activity across public and private land (Miller et al. 2015; Vogt et al. 2015). In the context of public land, public employees, contracted companies, and volunteers are three primary ways that urban forestry activity happens (Johnson et al. 2016; Peterson and Hauer 2016). 'Activity' in this sense is defined as any effort to maintain urban tree populations in a built environment. In the United States, Hauer and Peterson (2016) found that 54% of the time associated with tree activities occurs through public employees. Contractors accounted

for 41% of time associated with urban forestry activities. Volunteers represented 5% of the time with activities. The implications of volunteer activity within municipal forestry programs is a focus of this paper.

Volunteerism in general has been relatively well studied, with Musick and Wilson (2008) and Wilson (2012) writing about such activities in their recent reviews. Individuals with certain personality traits (e.g., extraversion, agreeableness, resilience, and empathy when accompanied by a feeling of obligation) are more likely than others to volunteer (Wilson 2012). Other studied predictors of volunteering include an interest in overcoming identity problems (by joining a like community of volunteers), a desire to benefit themselves through display of volunteer status to friends and acquaintances, and a previous religious experience (Wilson 2012). Additionally, studies have observed that women are more likely to volunteer than men, Caucasians volunteer at higher rates than other racial or ethnic groups,

citizens more likely than non-citizens, those in good health more than those in poor health, and more highly educated and higher-income earners than those less educated or of lower income (Wilson 2012). Lastly, research on the volunteer sector has observed that social context and surrounding community matters: people with larger social networks volunteer more, including students and those with school associations, and homeowners and others more tightly connected to their neighborhood volunteer more than renters or less connected individuals (Wilson 2012). Ethnically diverse areas experience lower volunteer rates.

In the urban forestry sector, volunteering one's time for civic engagement and community betterment is not a new concept (Ball 1986; Makra and Andresen 1990; Westphal and Childs 1994; Johnson 1995; Hauer et al. 2017). Historical evidence of tree activities to benefit a community by people receiving no compensation goes back many centuries and likely several millennia (Hauer et al. 2017). Lipkis and Lipkis (1990) wrote about the important role that civic engagement plays in urban forestry through the simple act of planting a tree to heal a neighborhood. Similarly, Krasny and Tidball (2015) discuss the practices and impacts of "civic ecology" (actions to steward or restore the environment, such as tree planting, gardening, etc.) by volunteers. Voluntary civic-ecology practices, these authors argue, have benefits not only for ecosystem services, but also to the well-being of people, for encouraging social learning, generating networks and partnerships, and restoring communities (Krasny and Tidball 2015). In a recent study on tree-planting volunteerism associated with New York City's MillionTreesNYC initiative, Fisher et al. (2015) stated that, "There is an implicit claim related to . . . residents' actions [volunteering to plant trees] that quality of life in cities is, in part dependent upon preservation of the local environment" (p. 3). Fisher et al. (2015) observed that volunteers who planted trees also had high levels of broader civic engagement (with other organizations, at rallies, voting, etc.). Evidently, the reasons for people getting involved with urban forests include a variety of social and environmental factors (Nesbitt et al. 2017; Ordóñez et al. 2017).

Volunteers may have any of a number of motivations for their participation or engagement in urban forestry activities. Participating in local tree-planting and follow-up care involves working with nature and can result in a strong social connection to other participants (Westphal 1993; Austin 2002). The belief that participants are helping the environment is another stronger motivation of volunteer engagement (Bruyere and Rappe 2007). Westphal (1993) discovered that emotional, aesthetic, and psychological values of trees, rather than benefits derived from property values or the cooling effects of trees, motivated volunteer TreeKeeper participants in Chicago, Illinois, U.S. In Toronto, Canada, Conway (2016) similarly found resident motivations for tree planting were primarily aesthetic rather than for ecosystem services. Regardless of the reasons, engagement in urban forestry is more likely when volunteers know, or are educated about, the importance of the topic (Moskell et al. 2010).

There are many reasons urban forestry professionals may incorporate volunteers in urban forest activities (Still and Gerhold 1997). Civic engagement builds community connections (Lipkis and Lipkis 1990; Portney 2005; Elmendorf 2008; Moskell et al. 2010; Krasny and Tidball 2015). City residents become more satisfied with the outcome of public street trees when the resident planted the street tree compared to residents who had a street tree planted by the city (Sommer et al. 1994). People tend to have a greater sense of pride when involved with stewardship projects (Mincey and Vogt 2014). Volunteers can possibly initiate and/or complete projects that would otherwise not occur due to a lack of resources (McPherson and Johnson 1988; Bloniarz and Ryan 1996; Miles et al. 1998; Snyder and Omoto 2008; Pincetl 2010; Moskell et al. 2016). Community involvement may also lead to greater tree survival (Sklar and Ames 1985; Mincey and Vogt 2014; Widney et al. 2016).

Volunteerism provides participants with a sense of satisfaction, a sense of place within a community, and results in a better place to live (Still and Gerhold 1997; Snyder and Omoto 2008). Community engagement may also facilitate social recovery following a natural disaster with a tree-planting activity used to memorialize the loss associated with the storm (Tidball et al. 2010; Krasny and Tidball 2015). Storms (e.g., hurricanes, ice storms, tornadoes) are common events that affect

tree loss annually in populated environments (Hauer et al. 2011a). Ultimately, for the many reasons that incorporating volunteers is important, Summit and Sommer (1998) suggest the activity needs to be easy to engage and must provide personal advantages to best encourage participation.

Even though civic engagement has important values, approximately 75% of the United States population did not volunteer their time in any activity in 2015 (BLS 2016). Moskell and Allred (2013) found in two New York City, New York, U.S., neighborhoods that the majority (over 60%) of residents believe the government should be responsible for tree stewardship. However, nearly half of municipal foresters indicated that funding is not sufficient to meet identified needs (Hauer and Peterson 2016).

In light of the importance of volunteers to sustainable urban forestry programs, this study sought to assess the incorporation of volunteers within the United States through five research goals. First, researchers set out to describe the current state of volunteer incorporation into municipal forestry programs. Second, the activity areas that volunteers undertook was quantified. Third, researchers identified informal partnerships through organizations within a community as part of the public tree program. Fourth, researchers determined whether program strength using an urban forestry sustainability model was associated with the likelihood to incorporate volunteers. Finally, attributes were ascertained that predict incorporating volunteers in municipal forestry program, using logistic regression methods.

METHODS

Sampling Design

Tree activities in municipalities in the United States were estimated for 7,478 census-designated places. A total 1,727 places were sampled for this research, based on a national study conducted by Hauer and Peterson (2016). A complete census of all communities with 50,000 or more people occurred, with all places asked to participate. All census-designated places below 50,000 people were randomly sampled at a lower intensity: 50.9% of communities between 25,000 and 49,999 people and 10.3% of communities between 2,500 and 24,999. The sampling approach and intensity was consistent with four previous municipal

tree management projects (Ottman and Kielbaso 1976; Giedraitis and Kielbaso 1982; Kielbaso et al. 1988; Tschantz and Sacamano 1994) in the United States. The sampling design for all places at the national level relates to a person and the likelihood that they live in a place conducting any of the municipal forestry and tree care activities ascertained in the study. Within a population group (e.g., 2,500 to 4,999 people), the design allows interpretation at both the person and the community level. In the cases that reporting involves the percent of all communities (n = 7,478) associated with a study question, researchers adjusted by weighting of smaller communities (e.g., 2,500 to 4,999) to account for the sampling percent used. By example, for the 2,500 to 4,999 population group, Weight Factor = 1 / (% Sampled/100); 9.7261 = 1 / (10.2816 / 100); whereas % sampled = (sample size/total population; 10.2861 = (241 / 2344) * 100. Likewise, adjustments were made for other population groups by the methods above, following the approach of Hauer and Peterson (2016).

The primary person associated with community tree activities was asked to participate. The list was created by initially asking each state urban and community forestry (U&CF) group, with contact information supplied by 41 coordinators. In nine states where researchers were unable to obtain contact information, and in places that U&CF coordinators were unable to provide contact information, the final list was created by searching a community website to identify a person (e.g., city forestry, parks manager, public works director, city clerk) who directs community tree activities. A paper-based questionnaire was sent by the U.S. Postal Service using methods by Dillman et al. (2014) to the identified primary person. Both long- and short-form questionnaires containing 109 and 53 questions, respectively, were sent as part of the study, including questions, to ascertain volunteer involvement with tree care activities. The survey was conducted in 2014. In brief, a pre-letter explaining the project was followed by a second mailing with the long-form questionnaire and a self-addressed return envelope. A third reminder (postcard) was sent to non-respondents. A fourth contact, with a replacement long-form questionnaire and a self-addressed stamped envelope, was sent to non-respondents. A fifth reminder e-mail

was sent to locations where an e-mail was available. A sixth mailing with a replacement short version of the questionnaire was sent. A total of 667 communities (38.6%) responded, and this was slightly higher than two previous municipal tree care surveys in 1986 (38.1%), by Kielbaso et al. (1988), and in 1993 (34.1%), by Tschantz and Sacamano (1994). The Institutional Review Board associated with this study was involved to approve the protocol for the study. No non-respondent bias was discerned in this study as determined by comparing results from this study with equivalent published results. For example, the total volunteer hours reported in this study were consistent with results collected by the United States Department of Agriculture Forest Service (USDA-FS) Urban and Community Forestry Program in the study year.

Statistical Approach

Each research question was crafted *a priori* to implementation of the study analysis. These questions included: 1) What volunteer capacity occurred in municipal forestry in 2014 (e.g., total number, total hours, full-time equivalents, mean time per person)? 2) What activity areas do volunteers participate in (e.g., tree boards, tree maintenance types, advocacy, fundraising, policy), and if training is provided? 3) What organizations were involved with community tree management partnerships (e.g., individual residents, civic organizations, neighborhood associations, business associations, school groups/youth organizations, nonprofit groups, municipal governance group, and utilities)? These three questions were further disaggregated by population (group) of communities.

The fourth question ascertained if community strength of their urban forestry program was related to volunteer incorporation into municipal forestry activity. Each community was given an index score using a model of urban forestry sustainability (Clark et al. 1997). A total 19 of 20 index areas were used, each with a 1 to 4 score possible, with a composite index score ranking between 19 and 76. The native vegetation criteria in the vegetation resource component was unable to be ascertained in this study. The composite index score was derived from summing the three component (category) groups that relate to resource

management, community framework, and vegetation resource criteria (Clark et al. 1997). The index score was used to test the hypothesis that more advanced programs (interpreted as a higher index score) were more likely to incorporate volunteers (Ha: Programs with greater score more likely to incorporate volunteers). ANOVA were performed to compare communities on number of volunteers used, amount of volunteer hours used, and urban forestry sustainability index score. As a test, if volunteers were a replacement for a municipal forestry program, χ^2 analysis was further used to ascertain if communities that did not conduct public tree activity were more likely to incorporate volunteers. An $\alpha \leq 0.05$ significance level was used to detect a difference for both statistical tests.

The fifth research question identified if attributes of a municipal forestry program explained if a community engages volunteers. Logistic regression was used to model whether a community involved volunteers in urban forest/tree management activities against seventeen predictors (Table 1). Initial preliminary models used an $\alpha \leq 0.25$ significance level to determine if a variable potentially explained volunteer inclusion. Through subsequent model refinements, the best model was selected based on the significance of individual predictors and the Akaike information criteria (AIC) value of the models (Hosmer et al. 2013). Researchers also used the ANOVA function (glm) in R (version 3.3.1) to compare nested models. Overall significance of the model was tested using χ^2 goodness-of-fit test (Hosmer et al. 2013); researchers also used residual plot (both Pearson and deviance) to examine model fit (Hosmer et al. 2013). Researchers also used receiver operating curve (ROC) and area under ROC to evaluate model fit (Hosmer et al. 2013). Finally, a combination of backward and forward selection procedures were then used to examine the best model, and to determine if initially excluded variables provided explanation as interpreted with an $\alpha \leq 0.05$ significance level, with no previously excluded variables found to be significant.

RESULTS

Communities in the United States commonly incorporated volunteers and informal partnerships with organizations into municipal tree activities

Table1. Variables used as a predictor of volunteer involvement in urban tree/forest management.

Code variable	Variable description	Percent or mean (standard deviation)
Volt	Community works with volunteers or partners	65.4%
Pop	Community population from 2010 census	91,871 (339,889)
Foract	Community conduct any kind of shade tree/urban and community forestry activities	86.0%
Cetarb	Community has ISA Certified Arborist staff	60.9%
Degree	Staff has degree (two, four, or masters)	56.5%
Totemp	Total employee	10.0 (16.3)
Contractor	Paid contractors used	87.7%
Adbudget	Budget adequate to meet current identified need	52.5%
Trboard	Community has government authorized tree board, parks board, city department, etc.	67.1%
Ordinance	Municipality have one or more municipal ordinances that pertain to trees	91.0%
Strgplan	Community have a written strategic plan for urban forestry	50.3%
Voltrain	Volunteers receive training	45.2%
Treeinven	Community have a tree inventory	66.6%
Systematic	Community have systematic tree care activities	45.4 (34.3)
Rskmgmt	Community conducts tree risk management (hazard tree identification)	57.3%
Outreach	Municipal staff provide educational presentation to city residents	59.4%
Treecity	Community is a Tree City USA	73.0%
Percapita	Per capita budget	0.52 (0.50)

across public lands. Nearly two-thirds (65%) of respondents indicated that volunteers take part in public tree activities (Figure 1). Thus, nationally, 65% of people live in a community that engages people to volunteer in public tree management. This ranged from 52% of communities in the smallest places (2,500 to 4,999 people) to 100% of communities with one million or more people reporting such. Seventy-nine percent of communities trained volunteers prior to implementing an urban forestry activity. As community size increased, the commonality of training increased from approximately 50% in the smallest population groups (2,500 to 9,999 people) to 100% in places with 500,000 or more people (data not shown).

Tree planting was the most common activity that involved volunteers and partner organizations in 85% of reporting communities (Figure 1). Population groups were similar with most exceeding 80% inclusion of volunteers for tree planting in their communities. Watering trees was reported for 40% of communities, with most population groups between 30% and 44% inclusion. Tree pruning occurred in 28% of communities, varying among population groups with no discernable trend. Pest management and tree removal were uncommon with just 3% and 9% of communities, respectively.

Interestingly, 35% of places in the smallest population group (2,500 to 4,999 people) indicated volunteer involvement with tree removal, with no responding community of 500,000 or more people using volunteers to assist with tree removal. Volunteers also provide service through awareness and education programs (39%), fundraising (20%), and management and policy development (18%). There were no discernible differences among population groups (data not shown).

A variety of organizations informally partner and help communities to carry out tree care activities (Figure 2). Individual residents involved in an organized tree care or management activity were most common in 60% of reporting communities. Organized groups that were commonly involved include school groups or youth organizations, such as 4-H and scouting organizations (55%), nonprofit groups (50%), and neighborhood associations (44%). Service of volunteers through tree-related governance groups involved park/tree boards (48%), city council/village boards (37%), and beatification committees (28%).

The number of people and amount of time that volunteers provided communities is displayed in Table 2. On average, 205.0 people are annually involved with a municipality in a volunteer
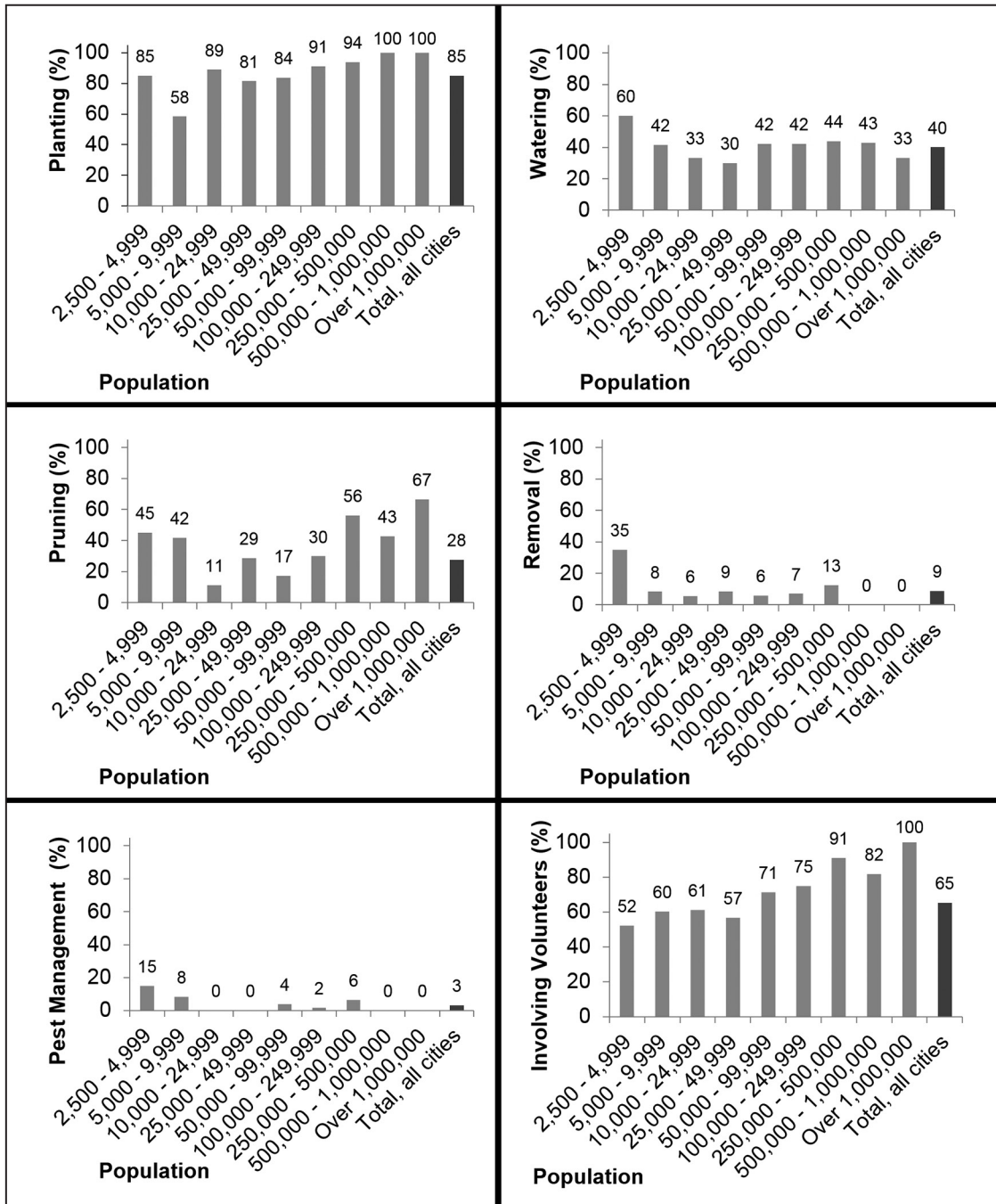
Figure 1. Percentage of communities that involve volunteers (n = 644; individuals or groups not paid for providing services) for tree activities (n = 307; tree planting, watering, pruning, removal, and pest management) on public property.

role. Not surprising, fewer people on average volunteered in smaller communities (2,500 to 4,999 people group, 34.2 people, 18.2 SEM) than larger places (500,000 to 999,000 population group, 525.5 people, 311.3 SEM) in some capacity (F = 7.308; df = 8, 207; $P < 0.0001$). Expressed on a per 1,000 people basis, 3.22 (0.92 SEM) people per 1,000

people volunteered. This decreased from 10.9 (0.64 SEM) people per 1,000 in the smallest population group to 0.55 (0.42 SEM) people per 1,000 in places with 1,000,000 or more people. Nationally, an estimated 345,466 (195,754 SEM) people volunteered.

The number of volunteer hours increased from the smallest to largest cities, with a national esti-

mated mean of 852.3 (174.3 SEM) hours of volunteer time occurring in a community (Table 2). This increased from a few hundred hours on average per small communities to several thousand hours in larger communities (F = 10.321; df = 8, 194; P < 0.0001). Expressing volunteerism on a mean time per person basis, 9.82 hours (1.38 SEM) per person occurred. There was no difference in time per person among population groups (F = 1.528; df = 8, 191; P = 0.15). People volunteered an estimated 1,484,204 (665,460 SEM) hours with municipal tree activities. Stated another way,

these volunteered hours equate to 714 (320 SEM) full-time equivalents (2,080 hour-base year).

Communities that incorporated volunteers into their urban forestry activities ranked higher with a sustainability index (F = 13.952; df = 1, 447; P < 0.001) than locations not involving volunteers (Table 3). The composite score for communities with volunteers scored 46.1 (0.43 SEM) compared to 42.7 (0.50 SEM) in locations not using volunteers. The community framework component had the strongest difference (F = 17.652; df = 1, 447; P < 0.0001), scoring 16.4 (0.23
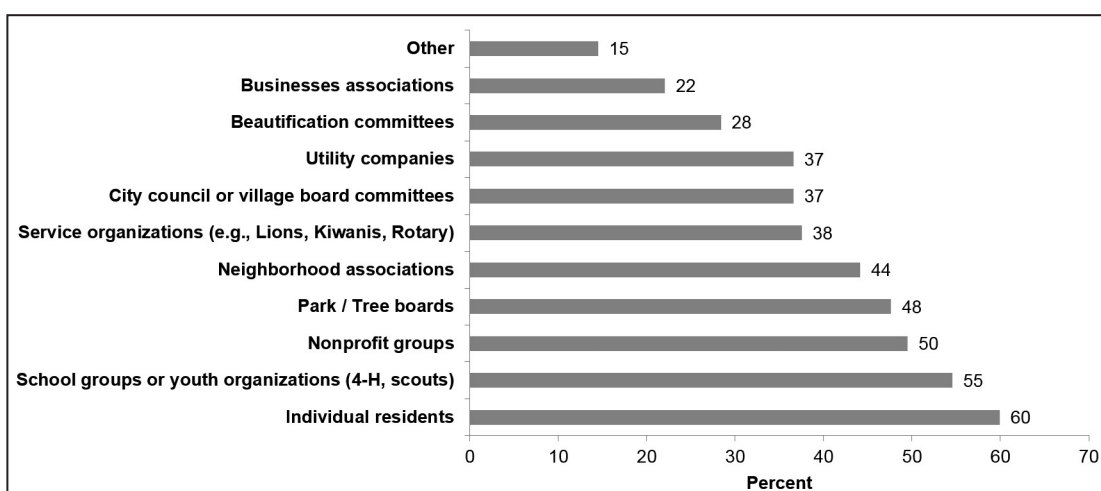

Figure 2. Organizations that help communities to carry out tree care or management (n = 317).

Table 2. Mean number of volunteers and volunteer hours along with standard error of the mean (SEM) for different population groups and geographic regions that were ascertained for information related to urban trees/forest management activities in the United States.

Classification	Sample size (n)	Mean number of people (#)	Mean time all people (hours)	Mean time per person (hours)	SEM of number of people (#)	SEM of time all people (hours)	SEM of time per person (hours)
Total, all cities	216	205.0	852.3	9.82	56.1	174.3	1.38
Population Group							
2,500 to 4,999	16	34.2	270.4	26.16	18.2	124.5	13.17
5,000 to 9,999	11	31.0	158.7	6.99	14.6	71.9	1.38
10,000 to 24,999	14	37.6	158.3	8.42	15.0	69.1	3.02
25,000 to 49,999	52	211.5	368.4	9.48	151.7	139.3	2.11
50,000 to 99,999	65	119.1	631.5	9.14	52.8	209.0	2.22
100,000 to 249,999	41	251.9	1089.7	7.40	64.6	243.0	1.89
250,000 to 499,000	11	324.1	3087.2	8.03	166.7	1830.2	3.72
500,000 to 999,999	4	525.5	2606.8	3.71	311.3	1227.2	0.51
1,000,000 +	2	4068.5	12,538	4.76	3879.5	11,306	1.76
Geographic Region							
Midwest	77	60.9	378.5	8.42	13.7	108.7	1.40
Northeast	29	325.1	1508.6	20.75	272.8	907.4	8.45
South	46	149.0	1052.6	8.61	51.4	467.5	1.98
West	64	364.2	971.4	7.45	136.7	227.4	1.32

SEM) with volunteers, compared to 14.6 (0.37 SEM) without. The vegetation resource component was also significantly greater (F = 6.376; df = 1, 447; P = 0.012) in communities including volunteers. A marginal difference was found in the resource management (P = 0.067) component, again scoring higher in communities that engage volunteers into municipal forestry.

The final logistic model to test for a relationship between inclusion of volunteers and a variety of parameters was overall significant (χ^2 = 55.7; df = 6; P < 0.001; AIC = 336.32). Residual plots did not show any problems with model fit, and area under the ROC curve was 0.76, indicating a good discriminatory power of the model. Six variables significantly explained whether a municipality involved volunteers in urban forest/tree management, out of the seventeen tested in the logistic regression model (Table 4). If a community indicated their budget was adequate (P = 0.016) based on identified needs, the odds of volunteer participation decreased by 50%. Furthermore, an increase in the tree budget on a per capita (P < 0.0001) basis reduced the odds of volunteer participation by 72%. Communities that have a tree board (P = 0.045) were more likely to involve volunteers, increasing the odds of volunteer involvement by 91% (Table 1). Outreach (P = 0.008) activities increased the odds of volunteer participation by 115%. Similarly, having a strategic plan (P = 0.046) also increased the odds of participa-

tion by 77%. Interestingly, volunteer participation did not decrease the number of employees working in the forestry program in a community. Rather, an increase in the number of total employees (P = 0.018) increased the odds of volunteer participation by 4%. Program activity matters as only 38.5% of the communities that stated they did not formally conduct municipal tree activities had volunteers conduct activities (χ^2 = 35.5; df = 1,630; P < 0.0001), compared 70.5% of communities that formally conducted municipal activities.

DISCUSSION

This is the first known study to investigate volunteer capacity within municipal forestry programs across the United States. Case studies have addressed local and regional volunteer efforts (Miller et al. 2015; Vogt et al. 2015; Moskell et al. 2016; Morgenroth and Östberg 2017), but not national enumeration, with the exception of annual volunteer hours listings by the USDA-FS (2016). From the current study, nearly two-thirds of people in the United States live in a community that involves volunteers in some municipal tree activity. Thus, an opportunity to volunteer is strong.

This study estimated that people volunteered 1.48 million hours in some municipal tree capacity within the United States. The USDA-FS Urban & Community Forestry program annually collects data from State U&CF coordinators about munici-

Table 3. The comparison of community sustainability index scores in locations without volunteer and those with volunteers. Sustainability index score derived from the model developed by Clark et al. (1997), n = 449.

Index score	Without volunteers Mean (SEM)	With volunteers Mean (SEM)	F-statistic	P-value
Resource management	20.99 (0.44)	21.91 (0.28)	3.364	0.067
Community framework	14.60 (0.37)	16.35 (0.23)	17.652	0.000
Vegetation resource	7.13 (0.16)	7.81 (0.13)	6.376	0.012
Composite score	42.72 (0.50)	46.07 (0.43)	13.952	0.000

Table 4. Coefficients (log odds) and odds ratio of a logistic regression of volunteer participation in urban forest management, n = 309.

Coefficient	Estimate	SE	P-value	Odds ratio	Odds ratio 95% confidence interval
Intercept	0.1833	0.4166	0.6599	1.2012	0.5308–2.7183
Adbudget	-0.6736	0.2783	0.0155	0.5099	0.2955–0.8797
Trboard	0.6492	0.3239	0.0450	1.9141	1.0145–3.6115
Outreach	0.7689	0.2919	0.0084	2.1574	1.2175–3.8231
Percapita	-1.2482	0.3005	<0.0001	0.2870	0.1593–0.5173
Strgplan	0.5761	0.2892	0.0464	1.7791	1.0093–3.1361
Totemp	0.0440	0.0186	0.0182	1.0449	1.0075–1.0838

pal forestry programs. In FY 2014, a total 1.39 million volunteer hours was reported by all 50 states through the state U&CF programs (NUCFAC 2015; USDA-FS 2015; USDA-FS 2016). Thus, the findings from this study were 6% higher—by 91,107 hours—but within the confidence intervals of the findings. Cumulatively, for all 50 states, eight territories, and Washington, D.C., a total 1.48 million volunteer hours were logged. Thus, this study validates one of the data outputs that state U&CF coordinators report annually to the USDA-FS.

This study also quantified attributes of a municipal forestry program that explained whether a community incorporates volunteers into municipal forestry activities. Communities that expressed their budget was adequate were less likely to incorporate volunteers. Unsurprisingly, communities with a higher per-capita budget were also less likely to include volunteers. One could conclude that perhaps volunteers are a replacement for staff in communities that suggested they were underfunded (McPherson and Johnson 1988; Bloniarz and Ryan 1996; Moskell et al. 2016). This study did not support the claim that volunteers replaced municipal staff. Overall, the total number of employees was greater in programs that included volunteers compared to those that did not. Researchers also found communities with no formal tree activity conducted by municipal employees in the study period had a 45% reduction in volunteer engagement. Volunteers also did not act as a replacement for contracted tree work, overall, and no difference in contracting occurred among the volunteer-including and non-including communities (Hauer and Peterson 2016). This is consistent with the attitude of residents in New York City, who believe stewardship of park trees and street trees is best managed by the government/public programs (Moskell and Allred 2013).

The strength of a municipal forestry program corresponded to volunteer inclusion. The Clark et al. (1997) model was used to gauge program strength. The model gives a relative index for a community along a continuum that ranks a program for its direction toward a sustainable program. Communities with a higher index on average were more likely to include volunteers. It is possible that volunteers helped provide a mechanism to improve a community along the continuum. For

example, assisting with a tree inventory, providing expertise to construct a tree ordinance, fostering greater connections to neighborhood associations, and other variables in the index model, would elevate a community's ranking. The other possibility is that a community with greater municipal forestry capacity is better positioned to work with volunteers (Hauer and Johnson 2008; Hauer et al. 2011b). Having a tree board and having a strategic plan were both associated with the greater odds of volunteer inclusion, and these attributes are important for municipal forestry management (Miller et al. 2015). This may partially be explained by people on municipal boards who often serve in a volunteer capacity. Thus, it seems logical that the tree board variable was a significant explanatory variable.

Outreach was an important part of explaining volunteer involvement. Not having an outreach program does not mean a community will not involve volunteers. Rather, communities that had an outreach program were two times more likely to include volunteers in urban forestry activities. Making it easy for volunteers to join enhances the prospects for volunteer participation (Summit and Sommer 1998). Outreach provides a way to educate people on why they should volunteer, which enhances recruitment (Moskell et al. 2016). Overcoming barriers to participate is also important. For example, community-based health volunteers were more likely to stop volunteering when logistical issues and a lack of supplies hamper their work (Chatio and Akweongo 2017).

Training personnel prior to conducting tree activities is important for proper implementation of work. The efficacy of volunteers properly conducting an activity, perhaps as compared to professional standards, is important for quality control (Bloniarz and Ryan 1996; Galloway et al. 2006). Bloniarz and Ryan (1996) found 83% agreement between trained volunteers and certified arborists assessing the condition of trees. When disagreements occur, volunteers were more likely to rate a tree lower in condition than a certified arborist. Student volunteers in Oregon, U.S., were able to measure a quantitative attribute, such as tree diameter, similarly to professionals (Galloway 2006). Qualitative assessment, such as tree-crown class, was significantly different between the student volunteers and professionals. Ball et al. (2007) found

that Master Gardeners trained in collecting tree-inventory data did well in collecting tree-inventory information. Interestingly, the highest error rate occurred with 3.7% incorrectly recording of the property address. Tree identification to the species level was correct 98.8% of the time. Bloniarz and Ryan (1996) found that trained volunteers identified correctly to the species 80% of the time, and to the genera 94% of the time. Roman et al. (2017) found that citizen scientists and experts were consistent with 84.8% of identified tree species. Thus, regardless if one is a volunteer or professional, the credential and/or training of a person is important for precise and accurate measurements (Miller et al. 2015; Morgenroth and Östberg 2017). This study found training was common to the majority (80%) of communities that engage volunteers. Thus, trained volunteers are vital to effectively conduct tree activities. Training is also important if communities engage citizen science with urban forestry research questions (Roman et al. 2017).

In the United States, approximately one in four people volunteered for one or more activities in 2015 (BLS 2016). Collectively, a total 7.8 billion hours were logged by these 62.6 million volunteers. Compared to the volunteer hours estimated in this study, 0.02% of all volunteering time in the United States was for public tree activities. A decline in volunteerism in general has occurred over the past several decades to 24.9% of the population in September 2015 (BLS 2016). Whether this trend has occurred in urban forestry is not known, as the current study provides the first national volunteer assessment in municipal forestry for baseline comparison.

Involving volunteers engages citizens to become better connected to a community through urban forestry activities. The citizen involvement in TreesCount!, a 2015 campaign in New York City, illustrates how a well-developed volunteer effort can successfully implement a tree activity. A total 2,241 trained volunteers inventoried 34% of the 660,000 street tree population (Cochran and Greer 2016). Involvement of volunteers through tree planting (85%) was the most common activity, followed by watering (40%), per this study. The high rate of tree planting is not surprising considering the estimated number of communities with Tree City USA recognition in this study was con-sistent with the 3,400 communities recorded by the Arbor Day Foundation (Hauer and Peterson 2016). The Tree City USA program requires an Arbor Day observance and proclamation as one of the four standards, and a tree-planting event is a common part of Arbor Day. Formative maintenance of trees after planting during establishment is important. Mincey and Vogt (2014) found volunteer watering of newly planted trees was more successful (e.g., greater tree survival) when done collectively, through signed agreements and when monitoring and sanctioning occurred. Roman et al. (2015) found excellent tree survival (95.4% to 99.4% annual survival) with volunteer tree planting. They attributed this to stewardship practices and training at tree planting, as well as maintenance during the establishment period.

Volunteer tree pruning was less common (28%) in the current study, however, in some locations, citizen-pruner programs are well-structured with a rich history. Citizen-pruner programs are an example approach to engage volunteers into municipal forestry, with New York City, for example, establishing a program in 1976 (Moll and Ebenreck 1989). Several other examples exist in municipalities in other states as well (e.g., California, Michigan, and Minnesota). Not every community engages citizens in all municipal forestry activities, and those undertaken are likely a reflection of community needs and interests.

This study also indicated the importance of volunteering in smaller communities, which tend to have less volunteer participation. Less than half (42%) of communities with fewer than 5,000 people have money specifically allocated for municipal tree management (Hauer and Peterson 2016). These communities most likely have an insufficient budget and would benefit from volunteer participation.

The study also speaks to the likelihood of communities incorporating volunteers into activities around urban forestry. That is, the level of analysis is the community. This means researchers cannot say anything about the motivations for individual volunteers' participation in urban forestry activities. Future studies on volunteerism in urban forestry should more thoroughly investigate why individuals might participated in urban forestry activities, as well as the influence of the demographic and social factors

mentioned herein (e.g., gender, race, ethnicity) on individual likelihood of volunteering.

CONCLUSION

This study provides the current volunteer capacity in municipal forestry in the United States. Nearly two-thirds of people live in a community that involves volunteers. Many tree activities involve volunteers, with tree planting as the most common activity, while the more technically challenging activities, such as tree removal, being less common. Developing an outreach program leads to more likely involvement of volunteers in a community. The community ranking along an urban forest sustainability index was greater in communities that involved volunteers.

Whether volunteers lead to a stronger program, whether stronger programs are more likely to include volunteers, or whether this relationship is ultimately a combination of factors, is not known from this study. Finally, the 0.345 million people who volunteered nearly 1.5 million hours of time equate to over 700 full-time staff. The volunteer hours reported in this study were consistent with data reported to the USDA-FS, lending confirmation of state U&CF reported data, or likewise confirmation of this study's findings. People tended to volunteer, on average, ten hours of time annually. Thus, it is unlikely that volunteers would be able to comprise the entire municipal forestry program. Rather, strong programs tend to involve volunteers.

Researchers found that volunteers do not appear to be a substitute for municipal staff or contracted services; rather, they are an addition, typically evident through a planned administrative structure (strategic plan and outreach). Volunteers might lead to increased municipal staff time needed to develop volunteer outreach and training within the urban forestry area. Finally, communities that spent more as reflected by per capita spending and budget adequacy were less likely to involve volunteers.

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Résumé. Les communautés entretiennent le soutien des citoyens aux opérations forestières municipales par le biais de bénévoles et de partenariats. Grâce à un recensement national et à une étude sur l'activité de la foresterie urbaine dans plus de 660 municipalités américaines, les chercheurs ont constaté que les deux tiers des communautés ayant répondu au sondage faisaient appel à des bénévoles pour des activités arboricoles. Il en ressort que la moitié des petites communautés (2 500 à 4 999 personnes) et toutes les grandes communautés (un million de personnes ou plus) font appel à des bénévoles. Lorsque ces données ont été compilées pour l'ensemble des États-Unis, une estimation nationale moyenne de 345 466 personnes (195 754 SEM) a consacré 1 484 204 (665 460 SEM) heures de bénévolat en lien avec des activités impliquant les arbres municipaux. Ceci équivaut à 714 (320 SEM) postes à temps plein (2 080 heures par année). Dans l'ensemble, les bénévoles ont réalisé près de 5 % des activités d'entretien des arbres municipaux. Près de 80 % des municipalités forment leurs bénévoles. La plantation d'arbres (85 % des communautés) était l'activité la plus courante, suivi par l'arrosage des arbres (40 %), les programmes de sensibilisation/éducation (39 %), l'élagage des arbres (28 %) et la collecte de fonds (20 %). Ces constatations ont été comparées avec les recensements de groupes de population des États-Unis afin de valider si le bénévolat variait en fonction de la taille de la communauté. Les bénévoles étaient plus souvent impliqués dans les communautés caractérisées par un développement important de la foresterie urbaine résultant d'une préoccupation marquée envers le développement durable. Six caractéristiques, ayant une action positive (+) ou négative (-) [un budget adéquat (-), les dépenses par habitant (-), un conseil d'administration spécifique aux arbres (+), le rayonnement (+), un plan stratégique (+) et le nombre total d'emplois (+)] sur le programme de foresterie municipale permettaient d'anticiper du taux de participation des volontaires dans la gestion de la forêt urbaine.

Zusammenfassung. Der Support von kommunalen Forstoperationen durch eine kultivierte Bürgerbeteiligung basiert auf Freiwilligen und Partnerschaften. Durch einen nationalen Zensus und einer Erhebung zur urbanen Forstaktivität in über 600 Kommunen in den Vereinigten Staaten, fanden die Forscher heraus, dass zwei Drittel der Kommunnen Freiwillige in Baumarbeiten integrieren. Dieses stieg von der Hälfte der kleinen Kommunen (2.500 bis 4.999 Menschen) bis zu allen großen Kommunen (eine Millionen oder mehr Menschen) , die Freiwillige involvieren. Bei einer Tabulierung für die Vereinigten Staaten fand man heraus, dass durch-

schnittlich auf nationaler Ebene 345.466 (195.754 SEM) Freiwillige 1.484.204 (665.460 SEM) Stunden mit kommunalen Baumaktivitäten zubrachten. Das führt zu 714 (320 SEM) Vollzeitstellen (auf einer 2.080 Stundenbasis pro Jahr). Im ganzen vervollständigten die Freiwilligen annähernd 5 % der kommunalen Baumaktivitäten. Annähernd 80 % der Kommunen trainieren ihre Freiwilligen. Baumpflanzen (85% der Kommune) war die meiste Tätigkeit, gefolgt von Baumwässern (40%), Achtsamkeits und Fortbildungstraining (39%), Baumschnitt (28%), und Mittelbeschaffung (20%). Die Ergebnisse wurden in Kontrast mit amerikanischen Zensus-Populationsgruppen gesetzt, um diese zu zerlegen, wenn die Freiwilligkeit mit der Größe der Kommunengröße variiert. Freiwillige waren gewöhnlich mehr in Kommunen mit größerer urbaner Forstkapazität, die aus einem Nachhaltigkeits-Index-Ziel abgeleitet wurde, involviert. Sechs Attribute mit einem positiven (+) oder negativen (-) Effekt (adäquates Budget -, Prokopfausgaben -, Baumgremium +, Nutzen +, Strategieplan +, und totale Beschäftigung +) des kommunalen Forstprogramms bestimmten die Freiwilligenpartizipation im urbanen Forstmanagement.

    Resumen. Las comunidades cultivan el apoyo ciudadano a las operaciones forestales municipales con la participación de voluntarios y asociaciones. A través de un censo nacional y una encuesta de actividad forestal urbana en más de 660 municipalidades en los Estados Unidos, los investigadores encontraron que dos tercios de todas las comunidades que respondieron involucran voluntarios en actividades de árboles. Esto aumenta de la mitad de las comunidades pequeñas (de 2,500 a 4,999 personas) a todas las comunidades grandes (un millón o más de personas) involucrando voluntarios. Cuando se tabuló para los Estados Unidos, una estimación nacional promedio de 345,466 (195,754 SEM) personas ofreció voluntariamente 1´484,204 (665,460 SEM) horas con actividades de árboles municipales. Esto equivale a 714 (320 SEM) puestos de tiempo completo equivalentes (2.080 horas base de año). En general, los voluntarios completaron casi el 5% de las actividades de cuidado de árboles municipales. Cerca del 80% de los municipios capacitan a sus voluntarios. La plantación de árboles (85% de las comunidades) fue la actividad más común, seguida de riego de árboles (40%), programas de concientización / educación (39%), poda de árboles (28%) y recaudación de fondos (20%). Los hallazgos se contrastaron con los grupos de población del censo de los EE. UU., con el fin de disociar si el voluntariado variaba según el tamaño de la comunidad. Los voluntarios participaron más comúnmente en comunidades con una mayor capacidad de dasonomía urbana derivada de un índice de sostenibilidad. Seis atributos con un efecto positivo (+) o negativo (presupuesto adecuado -, gasto per cápita -, junta directiva +, proyección +, plan estratégico +, y empleo total +) del programa forestal municipal predijeron la participación voluntaria en actividades bosque.