THE USE OF VOLUNTEER INITIATIVES IN CONDUCTING URBAN FOREST RESOURCE INVENTORIES

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Abstract. The accuracy and validity of urban forest resource data collected by trained volunteers were established, using an actual case study in Brookline, Massachusetts. Results indicate that the data collected by trained volunteers are valid, and the accuracy compares favorably with levels found among a control group of certified arborists. Indirect benefits associated with this type of volunteer effort include the development of a more informed urban forest constituency, increased environmental awareness, an increased political voice, and an improved quality of life for urban residents. The cost of utilizing community volunteers to conduct urban forest inventories is competitive with similar programs conducted by professional arborists.

Volunteer initiatives in urban forestry, primarily addressing the implementation of tree planting programs within communities, have been outlined and the benefits of these programs described in the literature (1,5). The development of volunteer initiatives in establishing effective urban forestry programs and assisting other municipal tree care programs has also been discussed by Skiera and Evans (10,4). Berry (2) proposes that "successful urban forest programs are those that break down the boundaries between concepts and roles that traditionally have created a dualism of culture and nature." They work because they create ways for citizens to play an important role in shaping their environment. Probart (8) proposes that "effective volunteerism provides the community with unique opportunities that are generally unavailable to them," enabling communities to identify and fulfill their environmental goals, including urban forest resource management.

Successful strategies for utilizing volunteers to perform urban forest resource inventories are detailed in the literature (3,4,6,7,8). Buchanan suggests that limited funding is a primary reason why professionals are not always used for tree inventory data collection and proposes alternative methods including interns, volunteers, and high school youths (3). Empowerment of citizens to partake in the betterment of their own community is one of the primary benefits of utilizing volunteers to assist in an urban forest resource inventory, as outlined by Lipkis (5).

The costs associated with using a professional to gather urban forest resource data can be calculated based on studies by Buchanan (3). She estimates that in 1991 "experienced urban forestry technicians can routinely collect data on 200 to 400 trees per day depending on the amount and complexity of information collected on each tree." In this case it would cost approximately $1.00 to $2.00 per tree to collect the data, based on an average of $50.00 per hour. While the use of volunteers to assist in gathering data on urban forest resources has been described, the benefits are more difficult to quantify because the costs of recruitment, training, mobilization, and supervision must be factored into a cost/benefit analysis. These costs will vary for each community that utilizes volunteers, making cost/benefit analyses more difficult. Additionally, the benefits of empowerment and community involvement are difficult to accurately assess, but must be considered. The evolution of a group of involved citizens as urban forest advocates and a focused political voice must also be considered when discussing the benefits of volunteer efforts.

While the literature suggests that volunteers can be used to complete urban forest resource inventories, there is a lack of information that describes the reliability of the data collected by the volunteers. Strategies for utilizing volunteers in tree care programs, including inventories, have been examined, but there is little or incomplete information concerning the validity and accuracy of the data collected by volunteers. The purpose of this paper is to provide an assessment of the

accuracy of using community volunteers to complete an urban forest resource inventory, to examine the costs associated with implementing this type of inventory program, and to outline the political and organizational impacts that are likely to occur in the development of this type of program.

Materials and Methods

Volunteer data acquisition. A street tree inventory was conducted in Brookline, Massachusetts, by 97 community volunteers during the spring of 1994. Brookline was the site of one of the earliest street tree inventories in the country in the late 1800s and has an active urban forestry program in the community with a strong citizen advocacy group. The inventory program was coordinated by the University of Massachusetts Department of Forestry and Wildlife, which assembled a diverse team of cooperators including the Town of Brookline, the Arnold Arboretum of Harvard University, the Brookline Greenspace Alliance, and Boston Edison. This project was funded by the U.S.D.A. Forest Service and the Massachusetts Department of Environmental Management through an urban forestry grant. The project team included professional urban forestry personnel as well as educators, municipal officials, conservation personnel, citizen advocates, and representatives of local utilities.

Approximately 11,250 trees found along 104 miles of roads were inventoried. Inventory teams documented the species, condition, diameter at breast height (dbh), management needs, root zone cover, percentage of impervious material over the root zone, and presence of cavities, dead wood, and overhead utilities. The specific variables collected for each tree were selected based on results of the 1993 Survey of Massachusetts Urban Forest Management Programs conducted by Ryan and Bloniarz (9). This survey also reviewed inventories from communities across the country.

The inventory information was entered into a Hunter Husky 16 portable computerized data recorder provided to each team. The tree's location was also plotted on a base map that was provided by Boston Edison, the electric service provider to Brookline. The base map included streets, building footprints, and property boundaries. The spatial location of each tree enabled its position to be entered into a Geographic Information System (GIS) by the University of Massachusetts Resource Mapping Unit, providing the basis for an operational street tree management program based on GIS technology. Use of the computerized data recorders allowed for immediate use of the data and simplified incorporation into the GIS database, reducing the chance of errors that could occur during data entry and transfer. The data acquisition took place on 3 weekends during June 1994.

Volunteers were recruited from the community using a variety of methods, including the media, mailings to target environmental organizations, and presentations in public forums. The Brookline Greenspace Alliance, an umbrella organization for community-based environmental and open space groups in Brookline, assisted in the recruitment effort and provided a number of volunteers for the inventory. The Brookline Tree Planting Committee and Conservation Commission assisted in the logistical organization of survey teams and assigned specific survey locations for each team. Over 95% of the volunteers were Brookline residents and ranged from 13 to over 70 years in age.

Each volunteer completed a training program consisting of 12 contact hours with instructors from the University of Massachusetts Department of Forestry and Wildlife Management and the Arnold Arboretum. The training program was conducted in 2 parts. The first segment consisted of a 4-hour reception, orientation, and informal discussion of the overall purpose and focus of the inventory project. The second training session was primarily instructional and was conducted at the Arnold Arboretum of Harvard University. It included classroom and practical field instruction. The volunteers were trained on the specific steps needed to complete the urban street tree inventory and received training on a series of items ranging from tree identification and condition assessment to map reading skills and data entry procedures. All of the volunteers were required to attend both training sessions in order to en-

sure that all survey personnel had received a standard level of training.

The goal of the training curriculum was to introduce all aspects of the survey process to the volunteers and to develop skills in tree identification, maintenance requirements, hazard assessment, and assessing the overall condition of the tree. It was critical that the training program develop a uniform technique for gathering information on the trees in order to ensure consistency in data acquisition by the volunteers. The training curriculum was developed specifically for the Brookline inventory and contained information on situations that were likely to occur along the town's streets. A sample survey of the street tree population, made prior to the curriculum development, enabled the tree identification segment of the training to focus primarily on the trees that were expected to be found on the streets in Brookline, eliminating the need to teach volunteers about trees that they would not find while completing their surveys. Additionally, the training focused on examples of streetscape situations found along Brookline's roads and used slides and graphics containing landmarks that could be identified by community residents.

A detailed questionnaire was completed by each volunteer, prior to the training, to determine the specific experiences and strengths that would be beneficial to a survey team. The survey teams comprised 3 volunteers each and were organized with at least 1 person experienced in tree identification assigned to each team. The use of 3-member teams allowed the survey process to move more smoothly, because each member was assigned a specific task that could be completed while the other members worked on their assigned roles. Since several tasks could be completed simultaneously (dbh measurement, recording the tree's location on the map, and data entry, for example), the use of 3 volunteers reduced the amount of work required of each volunteer, thereby expediting the assessment of each tree. Using 3 team members also allowed for the formation of a consensus, if questions arose with any aspect of the effort.

Although the time necessary to map and record the required data on each tree varied, the time necessary at each tree averaged just over 2 minutes per team. Response to the team approach was very favorable among the volunteers and resulted in a camaraderie and cooperative effort that was cited by many volunteers as the highlight of the survey experience. Pilot testing, in which teams of 2 survey personnel were used, proved to be slower, more cumbersome, and less rewarding to the participants. Any tree that a team considered to be a problem or that they had a serious question about was flagged and field inspected by a certified arborist.

The survey teams were each given maps of the particular road segments that they were expected to assess and were allowed to proceed at their own pace and direction. These maps were also used to record the location of each tree as it was examined. A unique identification number was assigned to each tree and was recorded on the map. The same number was automatically generated by the data recorder for each tree and was saved along with the permanent number marked on the survey maps. This ensured that the location data for each tree were attributed to the correct tree as entered into the data recorder. The identification number enabled the trees to be accurately added to the GIS database and served as a permanent record for inventory purposes. Additionally, in one sample area, permanent tags containing the identification numbers were attached to the trees to test durability, susceptibility to vandalism, and usefulness in locating a specific tree more easily.

It was determined by Brookline city officials that only trees found from the back of the sidewalk in toward the centerline of the road would be recorded, since these are the trees that are managed by the town's Forestry Division. In areas that contained no sidewalks, trees growing within 10 feet of the curb or edge of pavement were recorded. This determination was unique to Brookline and may differ in any survey in other municipalities. Trees growing in traffic islands and small parks of less than 0.25 acre were also included in the survey.

Accuracy assessment. To determine the accuracy of the data collected by the volunteer teams, it was necessary to develop a method to

examine their work. A random sample of 473 trees was generated; these trees were re-examined by a 2-person team of Massachusetts certified arborists experienced in urban forest resource inventories. These trees were examined immediately following the volunteer effort in order to accurately assess the trees' conditions before environmental changes could occur. The same criteria used by the volunteers to assess the trees were used by the professionals. The data on the trees were collected, then compared to the data collected by the volunteers, using frequency tables or agreement matrixes to show the number of times the 2 certified arborists agreed with the volunteers. This determined the relative accuracy of data collected by volunteers.

It was also important to know how well the 2 certified arborists compared with other professionals. This was done by setting up a separate study in which a series of trees was examined by the 2 certified arborists and also by 10 other certified arborists. By determining how often they all agreed on specific variables, it would be possible to ensure that the sample data they collected in Brookline were representative of typical certified arborist work.

Results and Discussion

Project costs. The total number of volunteer hours donated for the project was 3484, of which 3124 were provided by Brookline residents. Volunteer staff from the University of Massachusetts, the Arnold Arboretum, the Brookline Greenspace Alliance, and the Town of Brookline provided 360 hours of donated services to facilitate the inventory project. Based on a conservative rate of $10.00 per hour for volunteer time, $34,840.00 in donated services was provided. This amount can be translated into direct costs saved by the town for completion of the inventory. Paid staff provided 120 hours of labor, primarily in logistical support and coordination for the project. Assuming a rate of $50.00 per hour, paid staffing totaled $6,000.00 for the project.

Each volunteer averaged 20.2 hours of field work, plus an additional 12 hours of orientation and training, bringing the average total donation to 32.2 hours. Each survey team covered an average of 2.08 miles of roadway per day, collecting data on 225 trees along the way. This resulted in 11,250 trees inventoried over a 6-day period.

The total project budget was $49,340.00, including all labor and equipment, as shown in Table 1. Costs for the inventory data acquisition included the rental of 8 computerized data recorders, as well as printing, photocopying, and miscellaneous costs. An additional 8 data recorders were loaned to the project by the Massachusetts Department of Environmental Management. Since nearly $38,000.00 of this budget was donated services, the actual total cost to the town of Brookline was $11,500.00.

Based on the actual out-of-pocket expense disbursement of $11,500.00 by the town, the cost per tree surveyed in the inventory was $1.02. This is very competitive with pricing of inventories that would be completed by professional arboriculture firms. Post-inventory evaluation of the entire project has identified several areas that could be streamlined to reduce the amount of overhead and support costs, thereby enabling future inventories to be performed at a lower cost. This would include soliciting donations for photocopying and printing costs, relying on skilled volunteers for some support services, and reduction of mailing costs.

Data reliability. To test the accuracy of the volunteer effort, the data collected by the volunteers were examined to determine how closely

Table 1. The total budget includes $37,840.00 in volunteer in-kind services, resulting in an actual cost to the town of $11,500.00.

Labor or item	Total amount of material or service
Community volunteers ($10/hr*)	$31,240.00
Volunteer support personnel*	$3,600.00
Paid staff	$6,000.00
Data recorder rental	$3,000.00
Donated data recorders*	$3,000.00
Printing & photocopying	$1,500.00
Misc. materials	$1,000.00
Total project budget	*$49,340.00*
**Volunteer services*	*-$37,840.00*
Total cost to town	***$11,500.00***

the data agreed with that obtained by the 2 certified arborists.

The first item reviewed was the level of agreement in tree identification. In this portion of the study, the most commonly occurring trees found along Brookline's streets were considered. Table 2 shows the most frequently occurring trees found in the 473 tree sample. The list contains trees that occurred more than 10 times in the sample surveyed by the 2 certified arborists and represents 84% of the trees in the sample. Since these trees were the predominant species found in the study area, they were used for the accuracy study. The remaining 16% of trees occurred less than 10 times in the sample study, and were not included in the analysis. They represented 33 different types of trees, with most occurring only 1 or 2 times.

Frequency tables were calculated for each of the trees found in the sample to determine the levels of agreement between the 2 certified arborists and the volunteers. The frequency table enables a determination to be made as to the number of times that 2 observations agree; therefore, an accuracy level for the volunteers can be established. Table 3 shows a typical frequency table. The table gives the results for identification of *Tilia cordata* in the sample. In this case, the 2 certified arborists identified 55 *Tilia cordata*, while the volunteers agreed in 41 cases, or 75% of the time. Nine of the trees were recorded by the volunteers as *Tilia americana*, which indicates that they were able to correctly identify the genus in 91% of the cases.

Table 2. Species distribution of sample trees used to verify agreement levels between certified arborists and volunteers. These species represent almost 84% of the trees found along Brookline's streets. The remaining 16% were distributed among 33 different tree types.

Tree name	Number of cases
Acer platanoides	142
Acer rubrum	40
Fraxinus pennsylvania	29
Gleditsia triacnathos	28
Platanus x acerifolia	11
Platanus occidentalis	27
Quercus palustris	19
Quercus rubra	41
Tilia cordata	55
Total	**392**

Table 3. Frequency table showing the number of times that *Tilia cordata* was identified by the certified arborists and volunteers. Note that volunteers and the certified arborists agreed on genus in 50 of 55 cases, or 91% of the time.

Response counts, *Tilia cordata*

	Tree type							
	ap	ar	fp	gt	pc	ta	tc	Total
Cert. arborists	0	0	0	0	0	0	**55**	55
Volunteers	1	1	1	1	1	**9**	**41**	**55**

KEY

ap	*Acer platanoides*	pc	*Pyrus calleryana*
ar	*Acer rubrum*	ta	*Tilia americana*
fp	*Fraxinus pennsylvania*	tc	*Tilia cordata*
gt	*Gleditsia triacanthos*		

The 91% agreement rate on genus identification compares with a 100% agreement among certified arborists when tested for the same variable, using a *Tilia cordata* sample.

Table 4 shows a summary of the agreement percentages for the most frequent tree types, arranged by genus. The agreement levels decrease when identification of both genus and species were calculated, with the lowest levels occurring among *Platanus, Fraxinus,* and *Quercus* trees. This can be attributed to the similarity of the physical characteristics among the trees found in these genera. Identification of *Platanus occidentalis* and *Platanus x acerifolia*, two of the most predominant trees found in Brookline, is difficult for even trained arborists. Likewise, the varieties of *Fraxinus* found in the sample leads to confusion, even on the part of certified arborists.

Table 4. Percentage of agreement between certified arborists' and volunteers' tree identification. Levels of agreement as to the genus of sample trees were high between volunteers and certified arborists. Agreement levels decreased when genus and species were examined.

Tree type	Genus	Genus & species
Acer	95%	90%
Fraxinus	96%	68%
Quercus	93%	70%
Platanus	92%	46%
Gleditsia	96%	96%
Tilia	91%	73%

When considering only the agreement among genera, the levels of agreement are very encouraging. The agreement scores range betwen 91% and 96%, with only *Tilia* scoring the lowest, at 91% agreement. When examining genus and species, the levels of agreement are lower, which is attributed to the similarity in physical characteristics of many of the trees.

Other variables were examined to determine the levels of agreement between certified arborists and the volunteers. These variables included condition assessment, management requirements, and occurrence of cavities or weak crotches in the sample trees. Table 5 summarizes the agreement levels between the 2 certified arborists and volunteers, and between the 2 certified arborists and the certified arborist control group, for several different variables observed in the sample.

Table 5 shows a range of agreement levels between volunteers and certified arborists, with agreement percentages between 80% and 94%. Table 5 also shows that the 2 certified arborists and the 10 certified arborists were not entirely consistent in their levels of agreement, with assessment of management needs and the occurrence of weak crotches representing areas in which there was noticeable disagreement. Agreement of the assessment of the tree's condition by the volunteers and certified arborists (83%) was nearly the same as that found within the group of certified arborists (89%). Assessment of weak crotches also showed a 20% disagreement among the certified arborists group, while only a 10% disagreement between the volunteers and certified arborists. The remaining variables were assessed fairly consistently among the certified arborists group, with less than 10% disagreement among the variables.

Table 5. Agreement levels showing percentage of agreement between certified arborists and volunteers and between the certified arborists when examining individual variables of sample trees.

Variable	Volunteers/ 2 cert. arborists Agreement level	2 cert. arborists/ 10 cert. arborists Agreement level
Genus	94%	100%
Genus & species	80%	98%
Condition	83%	89%
Management need	75%	86%
Weak crotch	90%	80%
Cavity	92%	93%
Root zone cover material	82%	98%

Another noticeable area in which the certified arborists and volunteers disagree is in the area of assessing the management needs of the trees. In 25% of the cases, the certified arborists and volunteers do not agree as to the need to prune or remove the tree. The volunteers were consistently more conservative in their assessment of the pruning and removal needs of the tree, reporting that trees were in need of pruning more often than did the certified arborists. This is probably a result of the fiscal reality that the certified arborist faces, realizing that not every street tree can receive the same level of maintenance and pruning as a tree growing at a private residence.

Table 6. Frequency tables comparing the management needs as identified by the certified arborists and volunteers. The 2 groups agreed in 75% of the cases, with the volunteers determining that pruning was needed more often than was concluded by the certified arborists.

Mgmt. need by certified arborist (boldface)	Management need by volunteers None	Prune	Remove	Consult	Total
None	**345**	94	4	13	456
Prune	7	**5**	0	0	12
Remove	0	0	**4**	0	4
Consult	1	0	0	**0**	1
	353	99	8	13	473

SUMMARY

	Management need None	Prune	Remove	Consult	Total
Certified arborists	456	12	4	1	473
Volunteers	353	99	8	13	473

Table 6 is a complete frequency table comparing responses between certified arborists and volunteers when assessing the management needs of the sampled trees.

As shown in Table 6, the volunteers recommended pruning in 99 cases, while the certified arborists observed only 12 trees that needed trimming. This reinforces the concept of the volunteers being more conservative in their assessment of the tree's management needs. Additionally, the

volunteers listed 13 trees that needed consultation by the town arborist, while the certified arborists recommended only 1 tree that was in need of a second professional opinion. This represents agreement in 75% of the sampled cases. Subsequent review of the trees determined by the volunteers to be in need of pruning found some dead wood in the crown, indicating that the volunteers were very cautious in their determination of management needs.

Condition assessment is a critical component of a tree inventory, providing some of the most useful information to be used in the development of an effective urban forest management system. When examining how often the volunteers and certified arborists agreed on the trees' condition, one finds that in 83% of the cases both groups agreed. Table 7 is a frequency table for condition assessment of the trees. It can be noted that in most cases there is agreement as to condition, with the most noticeable exceptions being that the volunteers are more conservative in their assessment of the condition.

Table 7. Frequency table showing condition assessment as identified by the certified arborists and volunteers. Agreement between the certified arborists and volunteers occurred in 83% of the cases.

CONDITION ASSESSMENT

Cert. arborists (boldface)	Volunteers Good	Fair	Poor	Dead	Hazard	Total
Good	**381**	51	8	0	1	441
Fair	12	**6**	4	0	2	24
Poor	0	2	**1**	1	0	4
Dead	0	0	0	**2**	0	2
Hazard	1	0	0	0	**1**	2
	394	59	13	3	4	473

SUMMARY

	Condition Good	Fair	Poor	Dead	Hazard	Total
Cert. arborists	441	24	4	2	2	473
Volunteers	394	59	13	3	4	473

If the ranges of assessment were collapsed into 2 coarser sets based on observations of Good/Fair and Poor/Dead/Hazard, then the level of agreement between the volunteers and certified arborists increases to 96%. This level of agreement is higher than the agreement levels among the certified arborist control group and indicates a stronger level of agreement between the volunteers and the certified arborists than is suggested when reviewing the finer condition frequencies illustrated in Table 7.

Comparison of agreement levels between arborist/arborist and arborist/volunteers shows that for most of the variables assessed, the agreement levels are nearly consistent. Identification of cavities, assessment of management needs, and identification of weak crotches had agreement levels that were nearly the same. This indicates that the data collection for these variables, by the volunteers, was nearly as accurate as the professional data acquisition. The validity of the data, as collected by the volunteers, compares favorably to the quality of the professionals' assessment of these variables.

Conclusions

Based on the procedures outlined in this study, it can be concluded that the use of community volunteers for acquisition of data on trees found in an urban ecosystem can be substantiated and validated. The use of volunteers offers communities a viable and economically competitive alternative to contracting for professional inventory services. While the total cost of recruitment, training, mobilization, and logistical support for a volunteer effort can be significant, the overall costs of this type of inventory can be lower than a survey carried out solely by professionals and provides a valid assessment of the location, condition, and type of trees found in an urban area.

Agreement among certified arborists often varies considerably when specific inventory criteria are examined, and this variability can be used for establishment of baseline measures from which to determine the accuracy of volunteer data collection. The results of this study indicate that the urban forest resource data collected by community volunteers compare favorably with data collected by certified arborists, when agreement levels are used as the accuracy criteria.

In addition, the use of community volunteers allows for the establishment of a network of proactive constituents who provide a strong political voice that can be used to strengthen urban forest

management programs in a community, while empowering the volunteers to play a critical role in the development of a better community. The political strength that a group of community volunteers can provide is difficult to quantify, but it is clear that they provide a voice that represents a strong advocacy for urban forestry issues and includes individuals who have proven their effectiveness through action and involvement.

The involvement of the community's citizens in helping to shape the quality of their neighborhoods becomes a primary benefit of volunteer staffing efforts. Utilizing the energy and commitment of trained volunteers, directed by a trained professional arborist or urban forestry professional, builds momentum for future projects and efforts and establishes a framework for organizational development. Volunteers may be called upon to assist in future actions related to greenspace within their community, become involved in other citizen forestry programs, assist in future inventories, or become involved in other activities that can improve the quality of their community. The use of community volunteers to assist in gathering data on urban forest resources may serve as the start of a long-term commitment by the residents of a city or town to become involved in urban forest issues and to assist in the development of an effective urban forestry program within their community.

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Résumé. La participation de groupe de citoyens volontaires pour effectuer des inventaires de la ressource forestière urbaine est décrite dans cet article; il inclut les conclusions d'une étude récente qui a évalué l'efficacité d'employer ce mode d'acquisition de données d'inventaire. La précision et la validité des données recueillies sur la ressource forestière urbaine par des volontaires entraînés a été établie à partir d'une étude de cas à Brookline au Massachusetts. Les résultats indiquent que les données recueillies par des volontaires entraînés sont valides. Le coût relié à l'emploi de groupes de citoyens volontaires pour conduire des inventaires de la ressource forestière urbaine se compare à des programmes similaires menés par des arboriculteurs professionnels.

Zussammenfassung. Die Unterstützung durch freiwillige Mitarbeiter bei Bestandsaufnahmen städtischer Waldresourcen wurde jetzt dokumentiert und festgehalten. Darin enthalten sind die Ergenbnisse einer kürzlich erstellten Studie mit dem Ziel, die Effektivität dieser Art der Datenermittlung festzustellen. Die Korrektheit und Stichhaltigkeit der von freiwilligen Mitarbeitern zussammengetragenen Untersuchungsergebnisse wurden anhand einer kürzlich in Brookline Massachusetts erstellten Fallstudie ermittelt. Die Studie zeigt deutlich, daß die von freiwilligen Mitarbeitern ermittelten Untersuchungsergebnisse einwandfrei und exakt sind. Die Kosten einer auf diese Art durchgeführten Bestandsaufnahme sind vergleichbar mit einer professionell ermittelten Bestandsaufnahme.