RESEARCH ARTICLE

Can Volunteers Provide Reliable Data for Forest Vegetation Surveys?

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ABSTRACT: Biologists, land managers, and policy makers increasingly utilize volunteer-generated data to supplement their own data collection efforts and to identify habitat degradation or land management strategies. However, many professionals who could potentially benefit from volunteer data are concerned about the quality of such data. This study examined forest data from one of the largest volunteer monitoring programs in the Midwestern United States. Illinois EcoWatch Network recruits volunteers to collect statewide trend data on the habitat quality of forests by monitoring structural dynamics (changes in the dominant tree species) and the density and spread of seven invasive shrub species known to adversely impact native flora. In order to assess the accuracy of volunteer data collection efforts, botanists collected parallel data at 14 sites for comparison to volunteer sampling of tree and shrub identification, abundance, and size class placements. We found no significant difference for 12 out of 20 species identified by volunteers at these sites ($P > 0.05$). Volunteer accuracy rates for 12 (out of 15) tree genera were 80% or higher. However, species within the *Ulmus* and *Quercus* genera presented greater difficulty to the volunteers. We also detected large discrepancies in the shrub survey counts of highly abundant species such as *Ribes missouriense* Nutt. In spite of these discrepancies, we suggest the data can provide valuable information for measuring long-term changes in forest habitat quality. Improvements in data collection methods and training in combination with strategies to inform users of potential data limitations should enhance the usefulness of volunteer-collected data for most natural resource decision-making processes.

Pueden los Voluntarios Proveer Datos Seguros en Inspecciones de Vegetación de Bosque?

RESUMEN: Biólogos, encargados de tierras, y los encargados de planificar, incrementan la utilización de datos generados por voluntarios para suplementar sus propios esfuerzos de colección de datos y para identificar la degradación del hábitat o las estrategias de manejo del lugar. No obstante, muchos profesionales que podrían potencialmente beneficiarse de los datos de los voluntarios están preocupados acerca de la calidad de los mismos. Este estudio examina datos de bosque de uno de los más grandes programas de voluntarios en el Midwestern de USA. El grupo de trabajo EcoWatch de Illinois, recluta voluntarios para colectar datos de tendencias en todo el estado sobre calidad de hábitat de bosques, monitoreando la estructura dinámica (cambios en la especie dominante) y la densidad y dispersión de siete especies de arbustos invasivos que se sabe impactan negativamente a la flora nativa. Para medir la precisión de los datos colectados por los voluntarios, los botánicos tomaron datos en 14 sitios paralelos para ser comparados al muestreo de identificación de árboles y arbustos de los voluntarios, abundancia, y tamaño de clases. No encontramos diferencias significativas para 12 de 20 especies identificadas por los voluntarios en esos sitios ($P > 0.05$). La precisión de los voluntarios en determinar 12 (de 15) géneros de árboles fue del 80% o más. No obstante, las especies de los géneros *Ulmus* y *Quercus* presentaron mayor dificultad a los voluntarios. También detectamos grandes discrepancias en los conteos de arbustos de especies altamente abundantes tales como *Ribes missouriense* Nutt. A pesar de tales discrepancias, sugerimos que los datos pueden proveer información valiosa para medir cambios en gran escala de tiempo en la calidad de hábitat de bosque. El mejoramiento en la metodología de toma de datos y el entrenamiento, en combinación con estrategias para informar a los usuarios de las potenciales limitaciones de los datos podrían mejorar la utilidad de los datos tomados por los voluntarios en la mayoría de los procesos de toma de decisiones de recursos naturales.

Index terms: data quality, forest surveys, parallel sampling, plant identification, volunteer monitoring

INTRODUCTION

The use of volunteers to collect biological data has rapidly increased in the past decade (USEPA 1998). Most of these volunteer programs are designed to survey benthic macroinvertebrates for use in evaluations of water quality and biological stream health (Firehock and West 1995, Penrose and Call 1995, USEPA 1998). However, a small number monitor terrestrial systems. Many programs utilize volunteers to assist in the evaluation of specific management concerns, such as surveys of invasive species, or to document trends in species' demographics, such as Audubon Society's Annual Christmas Bird Counts (Pashley and Martin 1988, Brown et al. 2001, GLOBE 2001). With tightening state and federal budgets, volunteers are being asked to gather biological data that would otherwise remain uncollected. Volunteers are capable of filling crucial gaps in data collection essential for making informed management decisions and allocating state resources (Penrose and Call 1995, Brown et al. 2001). However, the quality of volunteer-collected data has rarely been evaluated because few programs employ stringent quality control procedures (Firehock and West 1995, Penrose and Call 1995, McLaren and Cadman 1998). This general lack of quality control evaluations has led to skepticism among biologists about the usefulness of this data (Penrose and Call 1995). However, several studies have found that volunteers provide reliable information when monitoring species that are easily identifiable (McLaren and Cadman 1998, Brown et al. 2001). Although the number of volunteer programs continues to increase with a subsequent rise in the number of data users, few published studies examine volunteer data quality.

The Illinois Department of Natural Resources (IDNR) began recruiting volunteers to help assess the condition of Illinois ecosystems in 1995. This effort was in response to the state's *Critical Trends Assessment Report* (IDNR 2001), which recommended the state begin collecting statewide data on the condition of its ecosystems in order to determine the most effective and economical resource management policies. The IDNR recognized from the outset that it did not have the staff or the budget to collect all the necessary information. Consequently, IDNR initiated Illinois ForestWatch (FW), a volunteer-based forest-monitoring program to provide consistent, high quality data to assess baseline changes in forest condition over time. The program intended to use the volunteer data in conjunction with data collected by professional biologists. FW samples random sites distributed throughout the state to ensure the data accurately represents statewide forest conditions.

FW recognized from the outset that volunteer monitoring created a number of data quality challenges: (1) To obtain large numbers of volunteers across a wide geographic area would require recruiting some individuals with relatively little expertise in identifying organisms. (2) Plentiful and cost-effective equipment were needed because multiple groups would simultaneously be collecting data. (3) Because of the lack of volunteer experience and low-tech equipment, volunteers are expected to collect less information with lower accuracy rates than professional biologists.

The FW program utilizes a suite of ecological indicators, which, used in conjunction with professional data, will gauge overall changes at forest sites across multiple years (Schwartz et al. 1997). Parameters monitored by volunteers include the structural complexity and diversity of tree species and the density of selected invasive shrub and vine species. Quality Assurance is an elemental part of the FW program. Volunteers undergo 8 h of standardized training and submit herbarium collections of species at their sites, which are reviewed by professional biologists in order to maintain data quality. In addition, FW conducts a periodic review of all data before it is available to data users. For example, FW staff conduct site checks when volunteers record species unknown to their region. To better understand the accuracy of volunteer species identification and counting, the FW program also implemented a joint study with botanists from the Illinois Natural History Survey (INHS). The purpose of this study is to compare volunteer and botanist data results from the same sites.

We were interested in addressing three major concerns with the volunteer data during this study: (1) Were volunteers accurately identifying taxa? (2) Were volunteers accurately assigning tree class sizes and, therefore, accurately estimating forest age structure? (3) Since volunteers do not identify all plants to species level, how much information was lost when compared to complete identification by professionals?

METHODS

Volunteer Monitoring Procedures

Volunteers establish three permanent 50-m transects at each forest site, and these are monitored every other year to reduce trampling. All trees species with a diameter at breast height (dbh) > 5 cm are identified and enumerated within 5 m on either side of the transects. Volunteers identify tree saplings (dbh < 5 cm) that are > 1 m tall and count them at ground level within 2 m on either side of the transect. Volunteers follow standardized guidelines for measuring dbh based upon the U.S. Forest Service's Forest Health Monitoring Program (U.S. Forest Service 1999) protocols. Participants identify trees to species with the exception of *Crataegus, Carya*, and *Fraxinus* genera, due to volunteer difficulty with accurately separating these taxa beyond the genus level (unpubl. data). Identifying all tree saplings beyond genus level is optional; however, the majority of volunteers identify most saplings to species.

Volunteers identify and count stem abundance of indicator shrubs and vine species, including *Elaeagnus umbellata* Thunb., *Lonicera japonica* Thunb., *Lonicera maackii* (Rupr.) Maxim., *Lonicera morrowi* Gray, *Lonicera tatarica* L., *Rhamnus cathartica* L., *Rhamnus frangula* L., *Ribes missouriense* Nutt., *Rosa multiflora* Thunb., and *Viburnum opulus* L. Shrubs must be > 1 m tall to be included in the survey and are monitored during the sapling survey (dbh < 5 cm). FW selected the shrubs using three criteria: the ability to invade beyond the forest boundary, shrubs thought by state biologists to have a negative impact on native forest species (competitive ability), and ease of identification (Schwartz et al. 1997). Finally, during a separate spring survey, volunteers collect data on herbaceous indicator species and on shrubs and saplings > 1 m tall.

Study Methods

The Illinois Natural History (INHS) botanists and the volunteers monitored 14 sites throughout the state in the fall of 2001. Botanists monitored the same transects as volunteers using the same methods as described previously. However, botanists identified all trees and shrubs to species. INHS botanists' herbaceous data did not parallel the volunteer's herbaceous data because volunteers surveyed spring ephemerals at a time when the botanists were unavailable. Volunteers were not informed of the exact purpose of the study so as to avoid data collection bias. All nomenclature was according to Mohlenbrock (1986).

Statistical Tests

Comparisons between botanist and volunteer observations were made using paired *t*-tests (preferred) or the Wilcoxon's matched-pairs signed-rank test for non-parametric data ($P < 0.05$). Tests for normality were performed on all data prior to analyses, and, where applicable, data were transformed using logarithmic or square root transformations to normalize the data (Sokal and Rohlf 1981). If transformations did not allow the data to meet the required *t*-test assumptions, the Wilcoxon matched-pairs signed-rank test was used. We were most concerned with minimizing Type II error to detect volunteer inaccuracy. Therefore, parameters with a sample size greater than eight were not analyzed because the *t*-test and Wilcoxon's test have little power with smaller sample sizes (Sokal and Rohlf 1981). Power tests were run using PS version 1.0.17 on all taxon sample sizes less than 20 (Dupont and Plummer 1990).

The parameters compared between the analyses were the number of individuals of each species recorded, the number of species (species richness measures), tree size classes (dbh), and importance values for species. Importance values (IV) for each species were derived using the following formula:

$$IV = \text{sum (RA)} + \text{(RC)}$$

where RA = the relative abundance of each species (number of individuals of a species divided by the total abundance for all species), and RC = relative coverage (the sum of the basal areas for individual trees for each species divided by the total coverage for all species).

Finally, accuracy rates for each taxon were derived by dividing the botanist mean count by the volunteer mean count and multiplying by 100.

RESULTS

Tree Survey Results

Volunteers recorded significantly different frequencies of *Carya* species, *Morus rubra* L., *Ostrya virginiana* (Mill) K. Koch., *Quercus alba* L., *Quercus velutina* Lam., *Quercus rubra* L., *Ulmus alata* Michx., *Ulmus americana* L., and *Ulmus rubra* Muhl. than did the professional botanists (Table 1). However, when *U. americana* and *U. rubra* data were pooled and analyzed at the genus level there was no significant difference between volunteers and botanists (mean 4.45 versus 4.40, respectively; Z = 1.00, $P = 0.97$). The same situation occurred when combining *Q. rubra* and *Q. velutina* data (volunteer mean 3.9 versus botanist mean 4.1; Z = 2.5, $P = 0.85$). The mean difference between volunteer and botanist frequency counts was > 15% for 11 tree species. However, another 10 species had a mean frequency count difference greater than 30%. The standard deviation of the mean difference between both groups for all trees observed was 2.18.

There was no statistical difference between volunteer and botanist results for *Fraxinus*

Table 1. Comparison of mean tree (dbh > 5 cm) species frequencies across all transects by both groups (volunteers and botanists) in Illinois, 2001. NT = no test: sample size was insufficient to test; NS = not significant. Species present at < 5 transects are not listed.

Species	Mean Count (Botanists)	Mean Count (Volunteers)	No. of Transects	Probability
Acer negundo L.	5.42	5.28	7	NT
Acer rubrum L.	2.33	3.33	9	0.37[b]
Acer saccharum Marsh.	9.35	9.20	20	0.76[b]
Carya species	5.11	5.85	34	0.03[a]
Celtis occidentalis L.	4.30	4.60	10	0.81[a]
Cornus florida L.	2.71	3.0	7	NT
Crataegus species	2.71	4.42	7	NT
Fraxinus species	5.08	5.00	23	0.78[a]
Gleditsia triacanthos L.	3.8	2.2	5	NT
Juglans nigra L.	1.75	2.0	8	0.75[a]
Morus rubra L.	1.41	1.91	12	0.0001[b]
Ostrya virginiana (Mill) K. Koch	4.13	5.13	15	0.0001[b]
Prunus serotina Ehrh.	10.8	10.2	13	0.43[a]
Quercus alba L.	3.28	3.85	21	0.004[a]
Quercus bicolor Willd.	3.0	3.8	5	NT
Quercus imbricaria Michx.	2.90	2.63	11	0.76[a]
Quercus muhlenbergia Engelm.	3.6	2.8	5	NT
Quercus rubra L.	0.76	2.17	17	0.03[a]
Quercus stellata Wang.	3.83	0.83	6	NS
Quercus velutina Lam.	3.88	2.27	18	0.01[a]
Sassafras albidum (Nutt.) Nees	2.16	2.16	6	NT
Tilia americana L.	2.0	2.0	5	NT
Ulmus alata Michx.	3.0	1.6	10	0.0001[b]
Ulmus americana L.	3.5	1.9	31	0.0001[b]
Ulmus rubra Muhl.	1.5	3.23	30	0.00[a]

[a] Wilcoxon matched-pairs signed-rank test
[b] Paired *t*-test

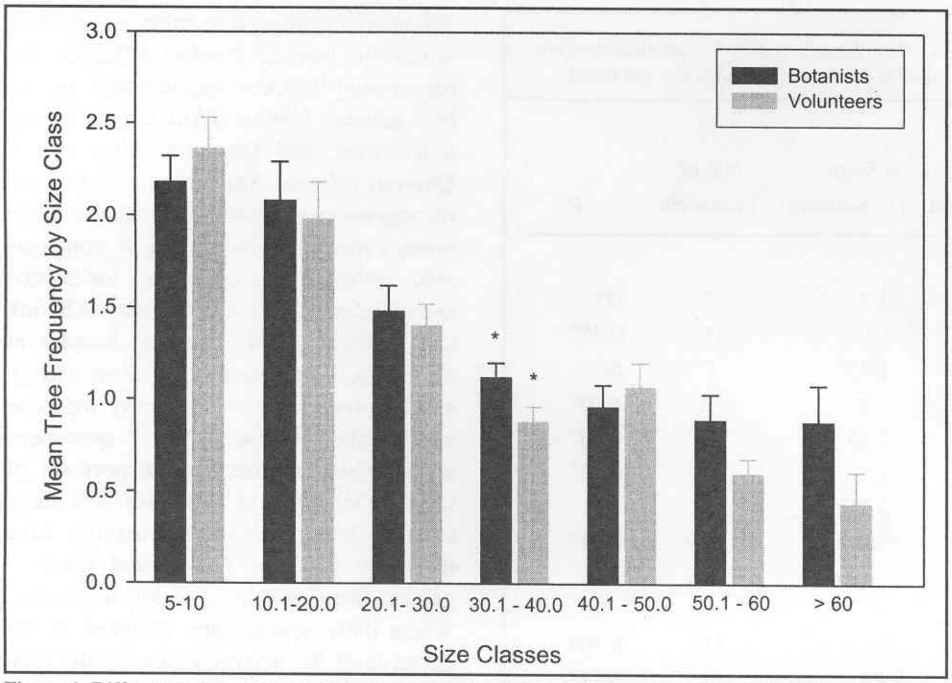

Figure 1. Differences between botanists and volunteers in assigning tree size classes (dbh in centimeters) using either Wilcoxon's signed-rank test or the paired *t*-test (N = 14); * denotes significance at the 0.05 level.

species, *Celtis occidentalis* L., *Acer saccharum* L., *A. rubrum* L., *Prunus serotina* Ehrh., *Juglans nigra* L., and *Q. imbricaria* Michx. (Table 1). However, a power test run for *A. rubrum* was only 0.164, suggesting that the Wilcoxon's signed-rank test was not detecting actual differences.

There was no significant difference between volunteer and botanist results for tree size class measurements with the exception of the size class ranging from 30.1 to 40 cm (Figure 1), where volunteers tended to undercount individual trees in this age class when compared to botanists.

There was no statistical difference between volunteer and botanist importance values for trees with the exception of *U. americana*, *U. rubra,* and *Q. rubra* ($P < 0.05$; Table 2). However, if importance values for *Ulmus* were analyzed at the genus level, there was no statistical difference in mean importance values (T = 1.7, P = 0.10). A similar situation was found for *Q. velutina* and *Q. rubra* (T = 0.13, P = 0.89).

Sapling and Shrub Results

There was no significant difference between volunteer and botanist results for saplings or shrubs (Table 3). On average, the mean stem density differences between the two groups were > 15% for most species. However, *Lonicera japonica* Thunb. and *Ribes missouriense* Nutt. had mean stem density differences greater than 30%. The standard deviation of the mean difference between both groups for all shrubs and saplings observed was 5.27. The power for *Lonicera* shrubs, *R. missouriense, Lonicera japonica, Prunus serotina*, and *Ulmus rubra* suggested that the means tests were not detecting actual differences. For example, the volunteer mean stem count for *R. missouriense* was 3.7 times lower than the botanist count (power of the means was only 0.14). Neither group found *V. opulus*, *R. frangula*, *R. cathartica*, and *E. umbellata* at the study sites.

Species Richness Measures

Botanists found a significantly greater number of tree and shrub species than did volunteers (Figure 2). On average the volunteer counts underestimated a site's tree species richness by 18% and its shrub species richness by 33%.

After excluding the botanists' species data for *Carya, Fraxinus*, and *Crataegus* (volunteers identify these to genus only) we still found a significant difference in mean tree species richness values between the two groups (Figure 2). With all factors

Table 2. Comparison of tree (dbh > 5 cm) species importance values for all sites by both groups (volunteers and botanists) in Illinois, 2001. NT = no test: sample size was insufficient to test. IV = Importance Value. Species present at < 6 sites are not listed.

Species	Mean IV Botanists	Mean IV Volunteers	No. of Transects	Probability
Acer saccharum	38.8	39.0	8	0.88[b]
Carya species	26.8	29.0	14	0.62[a]
Celtis occidentalis	15.3	17.5	6	NT
Fraxinus species	18.5	19.8	10	0.16[b]
Prunus serotina	30.4	31.3	6	NT
Quercus alba	26.0	27.7	10	0.27[a]
Quercus rubra	5.09	15.8	8	0.08[b]
Quercus velutina	26.7	13.4	7	NT
Ulmus americana	12.7	5.70	13	0.004[b]
Ulmus rubra	5.29	10.3	13	0.01[b]

[a] Wilcoxon matched-pairs signed-rank test
[b] Paired t-test

Table 3. Comparison of shrub/sapling (dbh < 5 cm) stem density results for all sites by both groups (volunteers and botanists) in Illinois, 2001. Species present at < 5 sites are not listed.

Species	Mean Stem Density (Botanists)	Mean Stem Density (Volunteers)	No. of Transects	*P*
SAPLINGS				
Acer saccharum	10.1	11.2	7	NT
Carya species	5.45	6.0	11	0.35[b]
Celtis occidentalis	2.14	1.42	7	NT
Fraxinus species	5.08	5.33	12	1.00[a]
Prunus serotina	2.00	2.75	8	0.50[b]
Sassafras albidum	2.0	2.5	8	0.22[b]
Ulmus americana	4.00	4.57	7	NT
Ulmus rubra	10.2	10.0	9	0.94[b]
INDICATOR SHRUBS/VINES				
Lonicera japonica	1.71	0	14	0.50[a]
Lonicera shrub species	20.7	18.7	14	0.87[a]
Ribes missouriense	5.85	21.5	14	0.25[a]
Rosa multiflora	4.14	3.57	14	0.81[a]

[a] Wilcoxon matched-pairs signed-rank test

[b] Paired *t*-test; NT = no test: sample size was insufficient to test

Note: Neither group found *Viburnum opulus, Rhamnus frangula, Rhamnus cathartica*, or *Elaeagnus umbellata* at the sites.

held equal, on average, volunteers detected 12 tree species per site while the botanists found 13—a significant difference ($P < 0.05$).

DISCUSSION

Volunteer monitoring programs continually struggle to balance acceptable accuracy levels with encouraging involvement of as many people as possible (Firehock and West 1995). FW deliberately sacrificed a certain level of accuracy in order to expand participation and to increase the number of monitored sites. However, the introduction of error does not necessarily mean the data are still not useful for their intended purpose (Firehock and West 1995). Several studies have supported the validity of volunteer-generated data for specific uses (McLaren and Cadman 1998, Obrecht et al. 1998, Brown et al. 2001). Our study provides additional evidence that volunteer data are acceptable for evaluating baseline changes in forest structure and tracking the spread of invasive plant indicators.

In answer to our first research question (Were volunteers accurately identifying species?), we found that volunteer and botanist results were in high agreement for easily identifiable species (e.g. *Acer saccharum*). However, our study also found volunteers to be more adept at identifying problematic species to the genus rather than the species level. There was a significant difference between volunteer and botanist results for 8 (out of 20) of the species tested. Genera with high species diversity and subtle and/or highly variable characters for distinguishing species were often misidentified. Therefore, the data were reliable for some species but not for others.

Whether examining the sapling or tree data, volunteers had the greatest difficulty distinguishing between species pairs in just two genera: *Ulmus rubra* versus *Ulmus americana,* and *Quercus rubra* versus *Quercus velutina*. Separating *Ulmus* based on vegetative characters (especially when young) has been the source of considerable confusion and inaccuracy for experienced botanists (for discussions see Swink and Wilhelm 1994, Sherman-Broyles et al. 1997). Furthermore, *Q. rubra* and *Q. velutina* hybridize so frequently with one another that relatively "pure" specimens are considered infrequent in portions of the state (Swink and Wilhelm 1994). Considering that professional botanists have difficulty with the *Ulmus* and *Quercus* genera these results are not surprising. When these species are analyzed at the genus level the accuracy rate for the total number of tree taxa identified correctly increased from 52% to 76%. Another tendency was for volunteers to misidentify species with limited or highly localized distributions across the state. This was true even when the species was relatively easy to identify (i.e., *Ulmus alata*). This is probably the result of inadequate training, since species with statewide distributions are emphasized more often than locally common species.

Unfortunately, small sample sizes ($n < 10$) and the resulting low statistical power (high probability of Type II error) made it difficult for us to confidently report accuracy levels for 11 tree species. For example, power for *Q. alba* and *Acer saccharum* was 0.06 and 0.05, respectively. Additional study is warranted for determining accuracy levels for these species.

Statistically, there was high agreement between volunteer and botanist results for saplings and indicator shrubs. On a practical level, volunteers completely missed *Lonicera japonica* and underrepresented the mean stem density of *Ribes missouriense* by 350%. *Lonicera japonica,* as a vine species, is fairly inconspicuous (when in low abundance) in comparison to the other invasive indicator species that were monitored. The results for *R. missouriense* were somewhat troubling because volunteers monitor only a small number of shrub

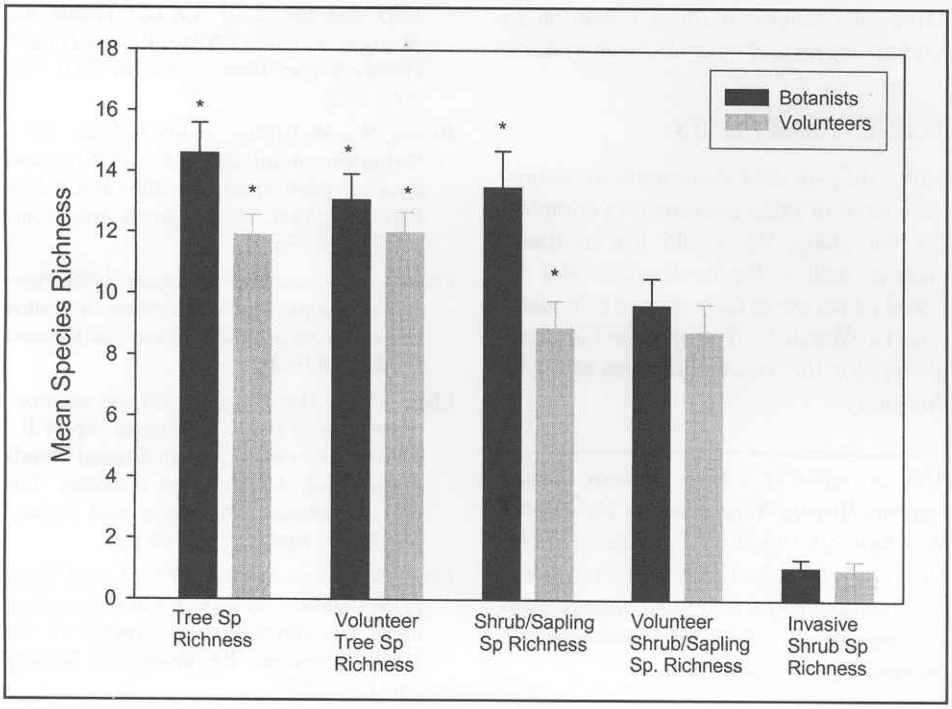

Figure 2. Difference between botanist and volunteer richness measures using either Wilcoxon's signed-rank test or the paired t-text (N = 14). Volunteer measures exclude results for species not identified by volunteers (Carya, Crataegus, Fraxinus) and limps these data at genus level. * denotes significance at the 0.05 level.

species selected for ease in identification. However, volunteers detected *R. missouriense* at all sites where it was present. Therefore we conclude that this discrepancy in stem density count numbers is a consequence of disparate logistical consideration (i.e., what constitutes an individual stem to be counted and what is a multistemmed individual?). Thus, miscounting, along with observer variability affect the results.

Systematic differences between observers have been detected in professionally collected ecological data (Innes et al. 1993, McLaren and Cadman 1999, Solberg and Strand 1999), and we assume this applies to volunteers as well. Solberg and Strand (1999) found observer bias to be approximately 10% for single trees and 5% for plot means when professionals conducted pairwise assessments of tree crown density. The volunteer shrub survey results compare well to those documented for professional data (with the exception of results for *Ribes missouriense*).

Currently, volunteers count every shrub stem along the transect. The shrub survey can take volunteers over 2 h when stem density is high. This probably introduces error as fatigue sets in and volunteer counts become less precise. Adopting an estimated density protocol may be necessary to reduce observer variability.

Neither volunteers nor botanists reported *Viburnum opulus, Rhamnus frangula, R. cathartica*, or *Eleagnus umbellata* at the study sites. FW records from 1999 and 2000 indicate *Rhamnus* spp. to be frequent at forest sites in Northern Illinois; however, *E. umbellata* and *V. opulus* were reported at < 7% of the sites and in very low densities. This raises the dilemma of whether it is wise having volunteers monitor these species. *E. umbellata* is relatively shade intolerant (Hensley and Carpenter 1986) and may never be encountered at Forest Watch sites because the program requires forests to have > 50% canopy cover. Perhaps resources would be better employed sampling shade-intolerant species or those with a clearer record of invasiveness in forest with > 50% canopy cover.

To answer our second research question (Were volunteers accurately gauging forest age structure?), we found FW volunteers were able to provide reliable data concerning forest age structure across most age classes. A significant difference was detected for one size class (30.1 to 40.0 m). However, at a practical level, the accuracy rate for this size class was 80% and the mean difference was only 0.24 cm.

Previous studies indicate that volunteers or inexperienced observers tend to detect fewer species than do experienced observers (McLaren and Cadman 1999). Our findings support this assertion. Volunteers detected 8% fewer tree species than did professional biologists when all factors were held equal. Additionally, we found FW sampling methods underrepresent mean woody vegetation diversity by an average of 53% (includes both shrub and tree diversity). If data from the southern tip of Illinois are analyzed alone, this rate jumps to 71% due to the diversity of *Carya* and *Quercus* species. FW sampling methods were never intended to assess a site's woody species richness; however, we now have a clearer understanding of what is lost by this level of identification.

In answer to our third research question (How much species diversity information is lost using volunteer methods?), we found the volunteer methods lost a large amount of information concerning woody species richness at forest sites in comparison to professional methods.

CONCLUSIONS

Every year more than 150 FW volunteers collect data at over 50 sites, thereby greatly augmenting IDNR ability to monitor forest quality. By comparison, professional botanists with the Critical Trends Assessment Program monitor 30 forest sites annually (Bailey et al. 2001). Current training standards provide credible data for readily identifiable species of both trees and shrubs. Additional training will be necessary if FW expects accuracy rates to improve for the more difficult species such as the *Ulmus* and *Quercus* genera. Other programs have seen an increase in data quality and a reduction in observer variability the longer a person participates and the more familiar they become with the species monitored (Friedel and Shaw 1986, McLaren and Cadman 1999). FW volunteers have a maximum of 3 y monitoring experience, with the majority having 1 y or less. Most sites have 15 or fewer tree species, giving volunteers a manageable number of species to learn. Therefore, we expect data quality to increase over time as volunteers become more familiar with their site and further improve their skill.

Since the program's purpose is to track major changes to the forest structure as measured by dominant canopy trees, it may be irrelevant whether or not volunteers can distinguish *U. americana* from *U. rubra* or *Q. rubra* from *Q. velutina*. While oak and hickory species play different ecological roles in distinguishing forest habitats, there are few situations in which the combination of these species would allow for a misclassification of forest habitat or a misinterpretation of overall changes to forest dynamics (Schwartz et al. 1997). For example, data users could track the age distribution of *Quercus-Carya* relative to that of *Fagus-Acer* across multiple sites using the FW data. This type of analysis has the potential of being highly useful to state biologists because they have been increasingly concerned with the drastic changes in Illinois forest composition from oak-hickory to maple-beech since the 1960s and with its implications for wildlife species (ENR 1994; IDNR 2001).

The same situation is apparent with the volunteer shrub survey data. As long as the same volunteer uses consistent techniques the data over time should assess the spread and abundance of these species whether the exact number of shrubs counted is highly accurate or not (Schwartz et al. 1997). Therefore, data quality is probably sufficient for its intended use. It is highly advisable, however, that FW continue to intermittently monitor and publicize error rates to effectively communicate the program's strengths as well as its limitations. Generally volunteers will not collect data at the same level of identification or accuracy as professional botanists. But volunteers can still play a key role in detecting and relaying information on fundamental changes in forest condition to land managers and other decision makers.

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