West St. Paul Volunteer Urban Tree Survey Proposal

ESPM 4041W: Problem Solving for Environmental Change

Report Number 4/9

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Executive Summary

The City of West St. Paul seeks to gather tree survey data through organizing a volunteer urban tree survey. West St. Paul needs updated data for the trees on its public lands. Tree inventories provide insight into the state of a city's urban forest. Analyses related to tree management needs and ecosystem services, as well as cost analyses, can then be derived from this data. Particularly important is that inventories can help the city respond to the Emerald Ash Borer (EAB) through locating its presence, identifying what trees may be at highest risk of infestation based on location and condition.

Urban tree inventories can be created through surveys conducted by volunteers. Volunteers are a great resource the city can use to conduct the on-the-ground survey work. Volunteers often provide a similar level of survey accuracy to professional foresters in key tree attributes. Additionally, using volunteers helps boost civic engagement and civilians' commitment to their community's well-being.

There must be effective recruitment, retention, and training of volunteers, as well as the facilitation of the survey, to produce a successful tree survey. To conduct a successful volunteer urban tree survey, West St. Paul should consider what the most important tree attributes needed to be measured are, provide in-classroom and in-field training, have an image heavy and text-short training manual, provide appropriate measurement tools, and provide on-site support for volunteers throughout the survey.

The urban tree inventory resulting from the volunteer tree survey allows the city to conduct several analyses and queries related to the urban forest's tree health, diversity, management, and then social and cost implications.

Introduction

Overview

Urban forests include all trees growing within a city's boundaries. When properly managed and healthy, urban forests provide many benefits to the community such as the promotion of human health and the health of local ecosystems (Arnlund et al., 2018). Valuable ecosystem services are provided by urban forests such as carbon sequestration and the filtering of air pollutants (Nyelele et al., 2019). Economic and aesthetic value within a city can be increased by healthy urban forest ecosystems (Jenkins et al., 2020). Urban forests can even provide psychological benefits by reducing stress and anxiety while also encouraging physical activity in the community (Turner-Skoff & Cavender, 2019).

Having an inventory and established process of collecting tree data, known as a tree survey, allows urban forestry managers to observe tree populations and their benefits in an objective manner (Bancks et al., 2018; Arnlund et al., 2018). Tree surveys can collect a wide range of quantitative and qualitative data of the various characteristics of city-owned trees which creates a valuable resource for city management. A tree inventory may include the exact locations of trees, tree species, tree size (i.e., diameter at breast height or tree height), assessment of tree health, maintenance needs, or need for removal. The tree inventories created from tree survey data are composed of three different concepts: features, attributes, and values (Bond, 2013). Features are the items that are surveyed--the individual trees. Attributes refer to the qualities of a feature that are being collected—the height, species, diameter, etc. Values are the data that is recorded under an attribute for each feature—the "measurement" that is recorded (Bond, 2013).

There are multiple approaches as to how a tree survey may be conducted, as all "urban forests are unique" so "a single inventory approach cannot be applied universally" (Bond, 2013). The specific data collected during an urban tree survey may differ depending on the objectives of the organization or municipality, though each conducted tree survey should standardize data collection techniques (Elmendorf, 2015). Tree surveys can be conducted to produce a complete inventory, partial inventory, or sample inventory to meet management objectives within budget constraints (Table 1).

Table 1. Types of different tree survey methods.

Inventory type	Explanation	Source
Sample	● Data gathered from a subset of trees from the entire population. ● Considered representative of the larger population. ● Inherent variation can be reduced by increasing the sample. ● Often used when money is limited.	North, 2014
Partial	● Measures trees that meet a predetermined condition. ● High degree of accuracy, but only for the trees measured.	North, 2014
Complete	● Measures all trees in a city. ● Most accurate, but also time consuming.	Bond, 2013

No matter which method is selected for an inventory, it can be conducted using paper data collection sheets, or devices with more sophisticated software. While these technological solutions do have an array of benefits, the more traditional method of paper sheets is often utilized due to lesser expense and increased user accessibility. Data can then be entered into a database for easy access and analysis of the completed inventory. Inventory data with location information can be displayed through a Geographic Information System (GIS) when the use of spatial analysis is needed for various urban forestry applications. GIS can be helpful for quantitatively assessing an area for a specific purpose, such as land use development, natural resource management, and engineering application (Earth Observing System, 2019).

Pest management plans are an increasingly relevant use for urban forest inventories, specifically considering the invasive insect threat of the emerald ash borer (EAB), in the city of West St. Paul. Trees infested with EAB have nearly a 100% mortality rate (Haynes, 2016). A substantial loss of trees due to EAB is a loss of ecosystem services, societal benefits, and human health degradation. A tree inventory allows municipalities to be aware of portions of their tree populations that are in declining health, or affected by EAB, to slow the spread of tree disease or infestations and improve management response to emerging issues.

In some situations, producing an urban tree inventory may be most successful when volunteers are used to collect data, as opposed to municipality workers or contracted services. Volunteer urban tree surveys can be especially helpful for small communities where keeping costs low is a priority. Municipalities can recruit residents and provide training, then send volunteers out into the area to survey trees. Training may include introductory classroom training regarding the basics of tree identification and measurement practices, and then in-field training (Bancks et al., 2018). Tree surveys conducted by municipalities alone can be difficult, costly, and time-consuming to conduct, and municipalities may resort to contracting the work out to a forestry company (Bancks et al., 2018). Volunteer-conducted tree surveys hold many benefits not gained through contracting a forestry company including a similar level of work quality at lower cost, and increased community engagement (Bancks et al., 2018). Lewandowski & Specht (2015) found that data collected by volunteers was similar in variability to professionally collected data. There must be adequate training and tools used in volunteer surveys to ensure accurate data (Bancks et al., 2018). Volunteer accuracy increases when they are provided classroom and in-field training, imagery that describes actions and trees, and on-site support from professionals (Bancks et al., 2018).

Another benefit of volunteer tree survey is increased community engagement. While conducting an urban tree survey, volunteers are engaged in direct action with their community, and making "people-to-land" and "people-to-people" connections that promote awareness and care for the surrounding environment (Tretheway et al., 1999). The resulting increase in community involvement and empowerment can be used to obtain increased "funding or impact policy that benefits the urban forest" (Bancks et al., 2018).

The following report will analyze the recent tree distribution of the city of West St. Paul, what makes a volunteer tree survey successful, and make recommendations to the city of how a future volunteer tree survey can be successful, as well as what neighborhoods are more in need of future tree plantings. There can be many challenges in conducting a volunteer urban tree survey and this report will outline solutions to these key hurdles, proving volunteer tree surveys as the most effective method for gaining an inventory of an urban forest.

Issue Description

The city of West St. Paul does not have an up-to-date boulevard tree inventory, nor a complete set of data that includes all municipal trees in right of ways and public parks. Tree inventories are valuable for many city operations, such as general pruning and removal, as well as monitoring longer-term trends in the urban forest and management of invasive pests. The last formal tree survey conducted by the city of West St. Paul occurred in 2014. The 2014 tree survey successfully gathered information regarding the trees located on the boulevards and right-of-way spaces. A previous 2015 volunteer tree survey was less successful and attempted to catalog trees in public parks. This volunteer urban tree survey proposal will focus on all public trees located in the boulevard and right-of-way areas, and public parks in West St. Paul.

Visions

West St. Paul Vision

"The City of West St Paul strives to insure a safe, pleasant and affordable environment for residential, commercial, industrial and public activities and to promote the public health, safety and general welfare of its citizens. West St. Paul will be a friendly, safe, walkable and well-connected City for its residents and visitors. As we grow, adapt and change, we will preserve green spaces, high quality infrastructure and the community feeling that makes West St. Paul a desirable City (West St. Paul, n.d.c.)."

Class Vision

Through collaboration with the City of West St. Paul and our independent research, the values of conservation, equity, and community engagement were integrated to develop solutions which are effective and innovative. With these integrated values as a guide, West St. Paul can promote safe and sustainable public growth to serve the community and its future generations.

Group Vision

To provide West St. Paul with relevant information and guidelines to conduct a future volunteer urban tree survey, this report will provide West St. Paul with the necessary framework to host a successful volunteer urban tree survey that collects data that can be referenced for years to come, that is easily accessible, manageable, and analyzable, with a capacity to be easily updated. This report will increase West St. Paulites' understanding of their urban forest, allowing effective responses to environmental changes, through active engagement of residents, fostering a greater sense of community.

Goals and Objectives

The final product of this project will provide recommendations for the City of West St. Paul to follow when conducting a future volunteer urban tree survey. This report will conduct an initial investigation into the current state of the tree data and management within West St. Paul, including details about the successes and/or failures of the 2014 and 2015 surveys, discuss the validity of volunteer surveys and how they are generally successful or conducted in natural resource settings, review volunteer tree surveys conducted in comparable cities to determine successful or unsuccessful strategies from their experiences, and ultimately offer recommendations to the City of West St. Paul on how to conduct a successful volunteer urban tree survey that aligns with their needs and goals. This project will:

- Assess the tree distribution in the city in relation to different socioeconomic groups: race and income distribution, using the 2014 inventory data.
- Determine successes and challenges of past 2014 and 2015 tree surveys within West St. Paul.
- Determine successes and challenges of volunteer urban tree surveys in comparable cities.

Methods

Site Description

The City of West St. Paul is located in the southeastern part of the metropolitan Twin Cities area in Dakota County within the state of Minnesota in the upper midwestern United States. West St. Paul is located directly south of St. Paul and directly west of South St. Paul with an area of 5.01 square miles (Figure 1).

According to the 2020 census, the population of West St. Paul is 20,615 (U.S. Census Bureau, 2020). Within the last decade, West St. Paul has seen a demographic shift from a predominantly retired and aging population to an increased number of single-family homes, family homes, and rental units (Schletty, 2021). West St. Paul has also experienced a boom in the rental population. Roughly about 40% of households are rented (Schletty, 2021). This has led to a growing population and increased use of public parks and green spaces.

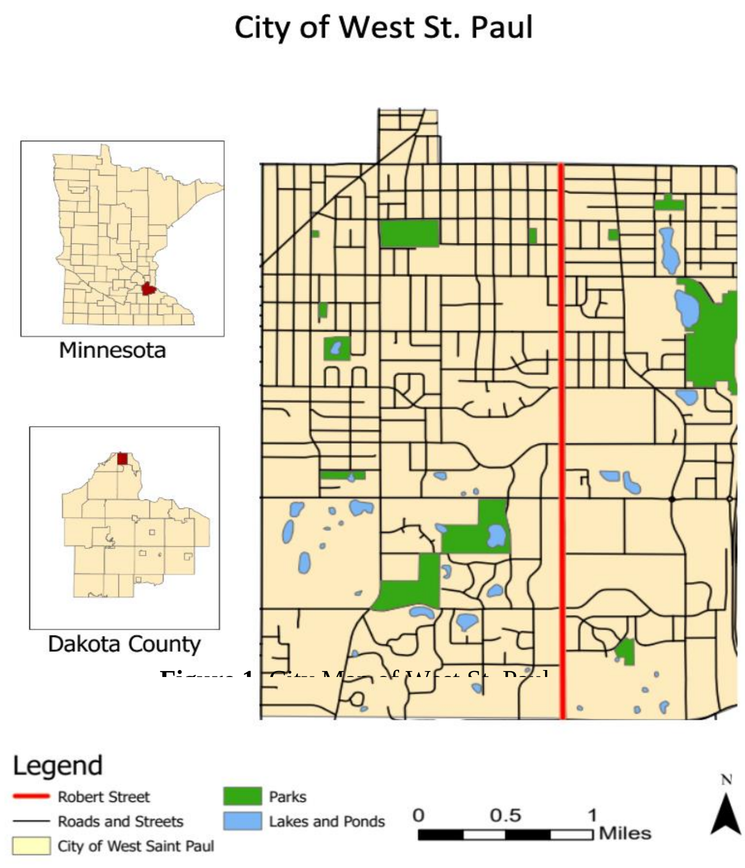

Figure 1. City Map of West St. Paul. Source: ESPM 4041

West St. Paul is 97% developed, yet the city has a high commitment to maintaining and encouraging the use of public parks and green spaces. Roughly 10% of the city is green space and parks (Schletty, 2021). West St. Paul has 13 public parks and one county park within city limits. Thompson Park (a Dakota County park) is the largest park within city limits (57 acres). The public trees in West St. Paul are located primarily in two area types: right-of-way areas and public parks.

Remote Sensing Data

The remote sensing data will be used to address the tree distribution in the city in relation to different socioeconomic groups: race and income distribution, using the 2014 inventory data objective. Using the 2015 Twin Cities Classification Map, we clipped the map to only include West St. Paul city boundaries. The classification map of West St. Paul became the base map for our remote sensing data to compare to other data. The Twin Cities Classification Map uses high-resolution multispectral National Agriculture Imagery Program (NAIP) data, multispectral derived guides, LiDAR data, LiDAR-derived products, and other thematic additional data. All of the data sets were combined using an Object-Based Image Analysis (OBIA) approach to classify 12 land cover classes: Deciduous Tree Canopy, Coniferous Tree Canopy, Buildings, Bare Soil, other Paved surfaces, Extraction, Row Crop, Grass/Shrub, Lakes, Rivers, Emergent Wetland, Forest and Shrub Wetland (Knight, 2015). We then used the 2019 American Community Survey (ACS) census data of West St. Paul block groups based on income and the 2020 decennial census data race for race to analyze the distribution of the tree canopy, shrubs, grasses, impervious surfaces ratio (TCSGISR). Because the block groups were redistricted in 2020, the zones don't match up perfectly, but they are relatively close. Conducting an income and race analysis allows us to see if there are areas that are not receiving as many ecosystem services due to the TCSGISR inequality.

Interviews

West St. Paul

The goal of the interviews was to identify previous methods of volunteer recruitment and data collection in tree surveys to provide well-rounded recommendations. The subjects interviewed were found through connections with city staff or organizations that took part in other local tree surveys. City staff from West St. Paul were interviewed along with City staff of Maple Grove concerning their previous tree survey. The two West St. Paul staff members interviewed were Karen Zumach and Dave Schletty. Karen is the Director of Community Forestry at Tree Trust in St. Paul. Dave Schletty is the Assistant Parks and Recreation Director for the city. Hennepin County forester Jen Kullgren was also interviewed based on her experience helping other cities plan and conduct tree surveys. The individuals interviewed were asked various questions on their previous experience with tree surveys surrounding how volunteers were recruited, methods of data collection, and retention of volunteers.

Literature Review

Volunteerism

A literature review on volunteerism, volunteer recruitment and retention, and volunteer incentives was conducted. The main areas of focus of the research were general volunteerism, best volunteer management practices, and how to effectively recruit and retain volunteers. A 2019 City of White Bear Lake report as a starting point to identify literature on volunteerism and a list of scholarly and review articles about volunteer recruitment, management, and retention was collected using the University of Minnesota Library Databases. A 16-step literature review process was conducted, which included identifying explicit definitions (e.g., volunteerism) and major patterns in results of previous studies (Galvan, 2009). A broad overview of volunteerism and why people volunteer, step-by-step processes to recruit and retain volunteers, best management practices of volunteers, and volunteer incentivization was gathered from the selected articles

Urban Tree Surveys and Inventories

In addition to the volunteer-focused literature review, a literature review on methods relating to urban tree surveys and inventories was conducted. A literature review on urban tree surveys and inventories provided valuable information about the strategies involved in “on the ground” urban tree surveys. A process similar to the volunteerism literature review was conducted on urban tree surveys and inventories.

Findings

Remote Sensing Data

The findings from the remote sensing and GIS data show that the TCSGISR (Figure 2) is not distributed evenly across the city. TCSGISR is unevenly distributed across block groups when compared to income (Refer to Figure 4 and 5 in the appendix). High income block groups have a higher TCSGISR, and lower income block groups have a smaller TCSGISR. Block group 1 has the largest percent of white individuals of all block groups, the second highest income of all block groups, and has the largest TCSGISR. Block Group 2 has the largest income of all block groups, is in the top third for largest percent of white individuals and has second highest TCSGISR. Block group 3 has the lowest percent of white individuals, is in the lower half for income, and has the lowest TCSGISR. This area will experience urban heat island effect more than any other. Block group 4 has the lowest income of all block groups, is in the lower half for the percent of white individuals and is in the lower half of TCSGISR.

Table 2. What block groups benefit most and least regarding TCSGISR

Block groups benefiting most	Block groups benefiting least
1	3
2	4

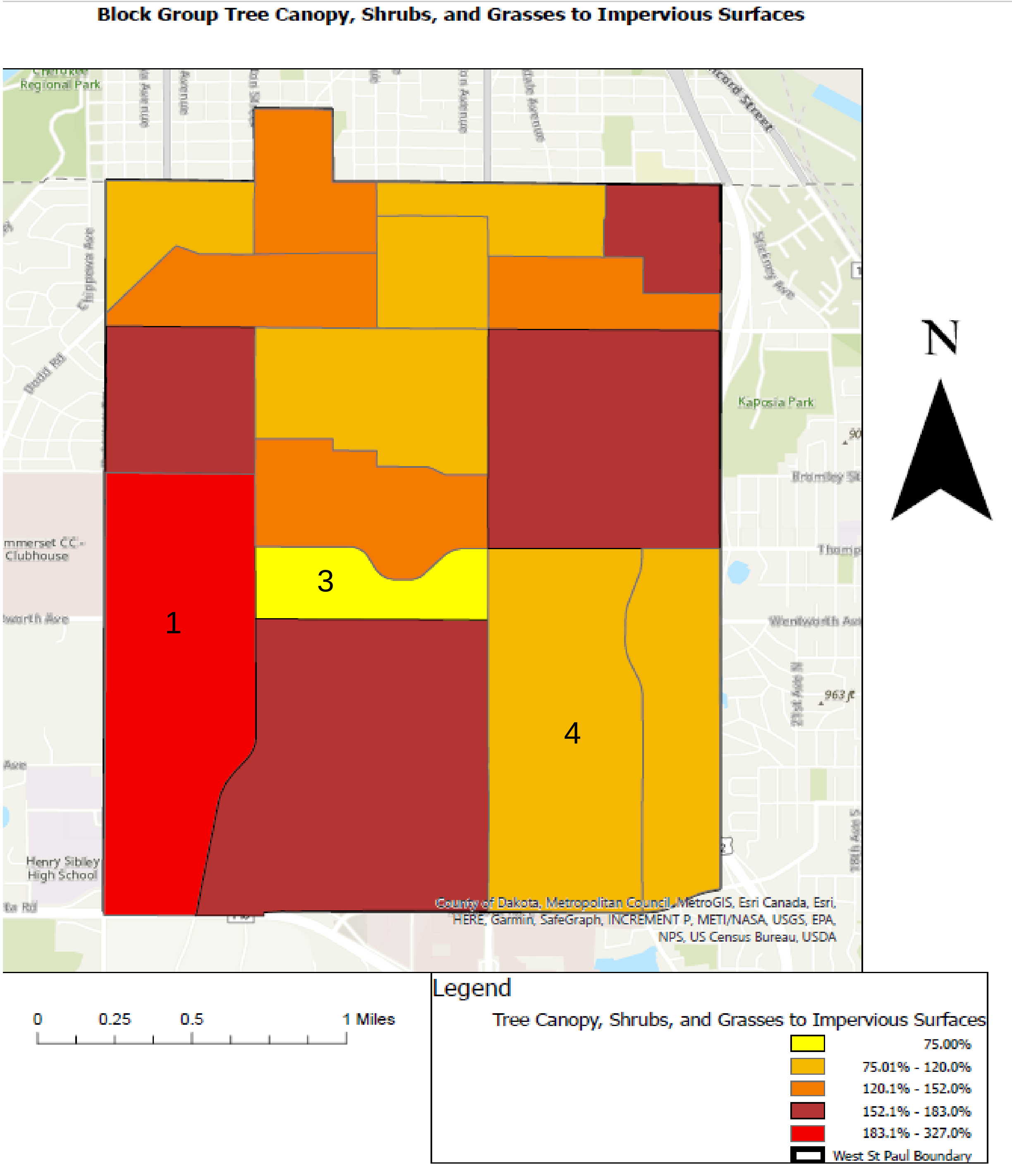

Figure 2. Block group tree canopy, shrubs, and grasses to impervious surfaces in West St. Paul

Interviews

From our interviews with Maple Grove, Jen, and Karen, we found effective ways to train volunteers, advance action to alleviate problems, possible mapping systems, how to recruit volunteers, and how to retain volunteers.

Training is an important aspect of gaining and maintaining volunteers. A city can gain and maintain volunteers by making training accessible to all. The more simplistic the training is, the better. Karen informed us that the volunteers were trained on data collection in two separate afternoon sessions where she used a training presentation and samples that she brought in to represent what may be seen in the field. It was found that keeping the areas assigned to volunteers in groups of two to three small was the best method according to Karen Zumach. This way, the sections were able to be completed and the volunteers could pick up another self-driven section if they desired. Volunteers on Karen's team also found it helpful to be able to reach out to supervisors in case they had questions about a sample during data collection.

Some of the possible mapping tools to document tree survey data would be Arc Collector and GIS Cloud, QGIS, or a city can work with a company (such as planet geo, with tree plotter) to develop software to map the data. For example, Maple Grove used an app called tree steward that was developed for them by a company. A main advance action that can be taken to alleviate problems that can occur during or after a volunteer tree survey would be staying in close collaboration with an IT staff to ensure that the goals in the project are possible from a technological standpoint. The initial and refresher training that was conducted also helped alleviate problems from occurring. Lastly, having a clear path for how the survey will be conducted from start to finish was very helpful to make sure they stayed on track, but a city always needs to be flexible as events come up that may change that initial plan.

Through these interviews we found that figuring out why people want to come to the volunteer events (such reasons could be to meet other people, have food, have an enjoyable experience, and just to have a COVID safe actively) will help to recruit volunteers. Another way the city can recruit individuals and gain recognition of the event (especially financially) was through contacting local business, tree service companies, and arboriculture companies, which was done by the City of Maple Grove and they gained funding to purchase high visibility safety vests and bright safety yellow t-shirts for their survey. Volunteer's from the city's environmental committee is another way to recruit volunteers for this event. Postings on social media was a common theme, and these social media posts can specifically highlight the opportunity to learn more about the trees in the community through this type of volunteer work. Contacting Universities is another effective way to recruit volunteers. Maple Grove had volunteers from outside of Maple Grove show up to their tree survey because they contacted Gary Johnson, a faculty member at the University of Minnesota, who spread the word to university students. Lastly an effective and important step to recruit volunteers is to gain a base group of people and then grow from there and allow that base group to bring in more people.

Retaining volunteers is an important part of volunteer tree surveys, as the surveys take a long time to complete. One of the most common and effective ways we found to retain volunteers was to incentivize volunteers by giving them items for coming back, such as a t-shirt and pruners. Another effective way to retain volunteers is to create a competition-like setting, which was done by Maple Grove. This competition-like setting would highlight which team inventoried the most trees and post it in the city newspaper. Then, constantly updating volunteers on the progress they had made, helped motivate the volunteers and it led to higher retention rates. A final strategy to retain volunteers is to organize evening meetings with volunteers, which was done by Maple Grove and the evening consisted of cookies and stories, which helped build community engagement and helped motivate the volunteers to continue.

Table 3. Key points from city staff interviews

Category	Key points
How to recruit volunteers	● Why people want to come ● Contacting local businesses ● Social Media ● Universities ● City's environmental committee ● Gain base group
How to train	● Simplistic ● Accessible to all ● Many training sessions at various times. ● Classroom and Field
How to retain volunteers	● Created a competition-like setting ● Posted top achievers in city newspaper ● Incentives to come back ● Organized volunteer meetings
Mapping systems	● Arc Collector ● GIS Cloud ● QGIS ● Privately produced through company
Advanced action taken to alleviate problems	● IT staff approval ● Initial Training ● Refresher training

Literature Review

Volunteerism can be broadly defined as a formalized, public, and proactive way to donate one's time, to benefit another person, group, or organization (Dutta-Bergman, 2004). There are multiple reasons why people volunteer. Some people may volunteer for self-interest, such as gaining career experience, networking, or learning more about a particular industry (Snyder & Omoto, 2008). Using recruiting material that is specifically targeted towards certain motivating factors is an important consideration for effective recruitment (Carvahlo & Sampaio, 2017). The three main areas necessary for a successful volunteer program are "screening, training, and ongoing management and support." (Grossman & Furano, 1999).

Screening is important to initially select individuals who are suited to the task at hand. Volunteers may bring prior knowledge and skills with them, while others may require more training. Most volunteer programs try to find volunteers that are somewhere in between these two categories to have a large pool of potential volunteers. (Grossman & Furano, 1999). Once volunteers have been recruited, the most effective forms of training are content- and process-focused (Grossman & Furano, 1999). Content-focused training teaches volunteers the base knowledge they need to be successful and is often done in a tutor-based setting, while process-focused learning ensures volunteers know how to apply their knowledge to the specific environment they will be working in (Grossman & Furano, 1999).

The most important part of a volunteer program is the retention of volunteers. Three important aspects for retention are providing well-defined tasks, regular support and supervision, and communication (Grossman & Furano, 1999). Having clear instructions for volunteers ensures that they are done properly and conveys to the volunteer that the task is worthy of their best effort (Grossman & Furano, 1999). Supervision is also important to ensure proper implementation in the field. Attendance and proficiency among volunteers are both improved when staff members interact with them regularly (Grossman & Furano, 1999).

Lastly, the element of ensuring retention is communication. The most essential area of communication to volunteers is scheduling. It is important for volunteers to be aware ahead of time when, where, and how long they will be needed for (Grossman & Furano, 1999). Every volunteer program is different and may include unique challenges with varied solutions. However, by applying this knowledge and these general strategies, it is possible to effectively utilize volunteers in multiple applications.

After the discussion of volunteerism, the literature review turned to understanding the methods used to conduct successful volunteer urban tree surveys.

Volunteers conducting urban tree surveys require training, access to appropriate tools for identification and measurement, and continual support from trainers. Volunteers are often most successful at assessing broader tree variables, such as genus and mortality status (Bancks et al., 2018; Crown et al., 2018), but less successful at more specific variables such as diameter at breast height (DBH), crown width (CRW), and need for maintenance (Bancks et al., 2018). Bancks et al. compared two different training methods for volunteers, finding that a 1:1 ratio of classroom instruction and fieldwork, and access to proper DBH and CRW measurement tools increases the accuracy of the collected data. To assess the quality of volunteer collected data, Bancks et al. compared sample volunteer data from the two different training methods (2018).

In both methods of training, volunteers were trained by the University of Minnesota (UMN) Department of Forest Resources and provided with training manuals. Volunteers collected more accurate tree data when they had a manual that included illustrative images (Bancks et al., 2018). In the first training method, volunteers collected field data with UMN researchers for a few training sessions. After the training sessions, the volunteers were sent out to collect data with no assistance from UMN researchers. For method one, volunteers only had linear tape to measure tree circumference, which they used to calculate diameter to determine DBH. Also in method one, volunteers converted their walking pace to a linear measurement, and then in the field would walk from the trunk to the drip line of the tree to determine its CRW.

In the second training method, UMN researchers joined the volunteers during their first two weeks of fieldwork, so that they could provide assistance to volunteers and answer their questions (Bancks et al., 2018). For method two, volunteers had access to more appropriate measurement tools, such as diameter tapes to measure DBH. Also in method two, volunteers had a long linear measuring tape in-field to measure a tree's CRW.

Method two proved to yield much more successful volunteer survey data. In comparing these two training methods, the second method provided a “greater frequency of accuracy for all assessment metrics”, including significantly higher accuracy for DBH, CRW, and condition measurements than those measurements gathered by method one volunteers (Bancks et al., 2018). In the five attributes measured by volunteers in this case -- species, genus, DBH, CRW, and condition -- method two volunteers had a higher accuracy rating than method one volunteers.

The volunteers who received a 1:1 ratio for in-classroom and field training, appropriate tools for measurement, and a continuous level of support from trainers and experts while working in the field provided the most accurate volunteer tree survey data, which was demonstrated by volunteers trained under method two in this case study (Bancks et al., 2018).

Table 4. Items of a successful volunteer urban tree survey

Category	Items included in a successful volunteer urban tree survey
Training format	● 1:1 ratio of classroom and field instruction time ● Training supervision first few instances of data collection
Tools needed	● Manual with images ● Diameter tape ● Linear tape ● Data collection sheet ● Surveyor's wheel
Methods of measurement	● Using a surveyor's wheel to locate trees along a city block ● Diameter tape to collect DBH ● Linear tape to measure crown width

Recommendations

Using the findings from the literature reviews, interviews, and remote sensing analysis, recommendations are summarized in Table 5.

Table 5. Summary of recommendations

Category	Recommendations
Recruitment and retention of volunteers	● Recruit from pools of individuals with higher likelihood of interest and prior knowledge (e.g. WSP Green Thumbs) ● Utilize targeted recruitment advertisements that appeal to varied motivations for volunteering (e.g. community involvement, networking, etc.) ● Incentivize continued participation through rewards such as certifications or sponsor-provided items. ● Maintain hands-on supervision and contact between volunteers and project managers to reinforce importance.
Training volunteers	● Focus on the most important attributes ● 1:1 ratio for in-classroom and in-field ● Visual-heavy manual ● Trainers provided guidance during first few surveys
Conducting the survey	● Complete survey ● Volunteers have a method of contacting trainers for questions ● Volunteers work in small groups (2-3 people) ● Volunteers work on specific sections of area at a time ● Paper data sheet and GPS device/surveyor's wheel or tablet application

Recommendations on how to recruit volunteers

To find volunteers passionate about conducting a volunteer tree survey, we recommend reaching out to relevant organizations for support, such as West St. Paul Green Thumbs. Hennepin County Forester Jen Kullgren reports this is an effective technique to gain volunteers. Connecting with such groups allows for an increased recruitment of volunteers with existing knowledge beneficial to survey work.

Another important consideration in recruitment is that differing recruitment materials can be used to attract volunteers with varying motivations. It is beneficial to appeal to volunteers with materials targeted to those with specific motivations (Carvahlo & Sampaio, 2017). When advertising recruitment for the project, attention to all motivating factors should be given either together or separately. For example, flyers may advertise the project as a way to get more involved in the community, in conjunction with social media posts highlighting the potential for volunteers to learn more about their local ecosystem.

After volunteers begin signing up, we recommend a screening process to identify their prior knowledge., to determine the rigor of training necessary. This initial screening may be a survey where respondents provide any notable education or experience relating to tree identification, measurement taking, or other scientific data gathering projects. From these initial responses a more thorough process of follow-ups and interviews could be conducted depending on the time and resources available to the project team. The goal of this process should not be to only select those volunteers with a great deal of relevant experience, but to ideally find a mix of these volunteers with others who may need more training prior to beginning the project. In this way there is more likelihood of finding an appropriate total number of volunteers as well as those who bring useful prior knowledge (Grossman & Furano, 1999). Once volunteers have been identified and selected as being well suited for the task of the volunteer-based tree survey the process of training can begin to ensure accurate data collection.

Another benefit of this screening process is that it helps understand the individual's needs and reasons for volunteering. After understanding their needs and why they are volunteering, they can be better matched to a specific volunteer activity which will help initial recruitment and to have individuals actually show up to the first event, as well as increase future volunteer retention (Moskell et al., 2011).

Recommendations on how to train volunteers

Once volunteers have been recruited, it is recommended that they undergo training in both the field and in a classroom environment for equal periods of time. West St. Paul will first have to determine what attributes it considers the most crucial. More training time should be spent on the assessment of these tree attributes than others. It is recommended that focus should be directed most to tree genus identification, tree species identification, DBH, CRW, and identification of key problems. These listed attributes were collected in the 2014 formal survey conducted by S&S Tree Specialists, attributes routinely used by Dave Schletty in consideration of tree needs and issues that are called-in by community members.

Volunteers should be trained in both the field and in a classroom environment for equal periods of time, as determined effective by Bancks et al. (2018). The in-class training provides a basis of knowledge, and field training provides volunteers time to see hands-on application of that knowledge. In-class time can take a variety of formats, but it is recommended that volunteers are guided by trainers through a manual. Trainers may be West St. Paul city staff, or the city could request forestry professionals from a university, such as the University of Minnesota Twin Cities Department of Forestry, to come in and facilitate training. Alternatively, Karen Zumach led the effort and facilitated training in West St. Paul's 2015 volunteer tree survey. The existing connection, experience, and enthusiasm held by Karen Zumach makes her a potential candidate to lead the training efforts. To instruct effective volunteers, the manual used in training should be not-so text heavy and instead consist of a decent amount of imagery to assist understanding. On the use of visuals, Karen Zumach has in the past brought in tree leaf samples which allows volunteers to practice their identification skills in-class. The training given to volunteers should be as simplistic as possible, as this helps retain volunteers as described by Hennepin County Forester, Jen Kullgren.

After in-class training, the initial in-field training should consist of demonstrations of taking measurements and collecting data, and then time for volunteers to practice this experience with the assistance and guidance of trainers (Bancks et al., 2018).

In the pursuit of acquiring the measurement tools necessary for volunteers to use during surveying, as listed in Table 6, West St. Paul may reach out to local business, tree service companies, and arboriculture companies that are willing to sponsor equipment. In exchange, these companies can get their name/logo on any t-shirts, safety vests, or tools provided, which acts as free advertising for these companies. Maple Grove showed that this can help to save a lot of money as well and spread the word of the volunteer tree survey which can help to recruit volunteers (Arnlund et al., 2018). It is also a method of recruiting volunteers through making connections to these organizations and their associates.

Table 6. Items needed to conduct a successful complete volunteer urban tree survey

People needed	Support items	Attribute measurement tools
• Volunteers • Trainer(s)	• Image-heavy manual • Sample leaves to be shown in training • Method of communicating with trainer(s) • T-shirts or hi-vis vests	• Datasheets • Writing utensils • Diameter tape • Linear tape • Surveyor's wheel

Recommendations on how to retain volunteers

After volunteers have been recruited and trained, it can be difficult for organizations to retain volunteers. To retain volunteers, West St. Paul can offer a method of "certification" after the completion of training, incentivize volunteer participation, and ensure that quality instruction materials and tools are provided along with meaningful supervising support.

Volunteers are encouraged to complete training and participate once their post-training certification is earned. This does not necessarily have to be an officially licensed certification, but rather an acknowledgement of proficiency in conducting a tree survey that the volunteers earn after training. This may be a document stating: "The City of West St. Paul certifies (*Volunteer Name*) as an urban tree survey volunteer", with additional language as relevant.

Throughout the conduction of the survey, volunteers will be more easily retained if incentivized for their participation. This participation should be measured based on total time spent surveying trees, as opposed to number of trees surveyed. Prize incentives may be used after volunteers reach a certain time benchmark for surveying. These prizes could be provided by sponsors that the city has teamed up with for the procurement of equipment and outsourcing of volunteers. This incentivization strategy was a theme Jen talked about that she saw help increase retention of volunteers. Another strategy is to set a competition-like setting for total survey time, like the city of Maple Grove did. The top surveyors would be highlighted, and they would be posted in the city's newspaper.

West St. Paul could pay its volunteers for their work, if the funding was available, to help incentivize work and demonstrate the city's appreciation towards volunteers. Paying volunteers provides a more tangible sense that they have invested in their community, and that they live in a community where their dedication to the well-being of the community is appreciated. Additionally, by paying volunteers, West St. Paul could use this payment towards the application of grant funding, as some grants ask municipalities to match a certain amount of funding. In some cases, this match by the municipality can be matched through counting the funding that goes towards volunteers. The current estimated national value of a volunteer hour at the time of writing is $28.54 (Independent Sector, 2021).

Recommendations on how to conduct the survey

When volunteers are conducting surveys, they must have access to proper tools and on-site support; and the work should be divided into manageable portions. Volunteers should work in small groups, work on a specific assignment of a small portion of the city at a time and set their own pace and schedule.

Firstly, it is vital that volunteers have a supply of proper assessment tools to use in-field to produce accurate results following their training. These tools may include a training manual, tree species identification sheets, diameter tapes to measure DBH, and linear measurement tapes to measure CRW.

During the first two weeks of surveying there should be supervising training staff present on-site to assist and answer questions from volunteers in the field. This allows for more accurate data collection as well as conveying to the volunteers that their task is important, thus helping with volunteer retention. Throughout the conduction of the survey, volunteers should have a method of communication with training staff that they can ask questions of. For example, during the conduction of the 2015 volunteer tree survey, volunteers were able to text or call their training supervisor Karen Zumach for questions, and this was helpful for both the volunteers' tasks and provided insight to Karen as to what the concerns of volunteers were.

In the field, volunteers should work in groups of 2-3, which they can choose or be paired up with by training staff. In groups, volunteers can pool their knowledge and efficiently manage the varying measurements and assessments conducted for each tree. If possible, more experienced volunteers should be placed with those less experienced to help improve their skills. Volunteer groups should be assigned different parts of the city that have been divided into parcels that make their task more manageable. This provides for a systematic sweep of the city, where each volunteer team is assigned an area to cover. After completing an assigned area, volunteers would report to the training/West St. Paul staff to be assigned a new area until the survey is complete. Upon receiving an assignment, volunteers can tackle the work at a self-directed time and pace. Additionally, this method of grouping and assignments is flexible for when volunteers may leave, or new ones join. If a volunteer wants to discontinue, the completion of an assignment gives them a good exit point, and if a volunteer wants to join, the assignment structure gives them a great entry point. Any volunteers newly recruited after volunteers have started surveying can receive training and then be assigned to a group of existing volunteers the next time an assignment is completed. If there are enough new volunteers starting at the same time, they can all start an assignment together.

In collecting data, volunteers can utilize paper and pencil datasheets, or use tablets. Either method of collection has advantages and disadvantages. Paper and pencil datasheets can be procured easier and at a much cheaper cost, and using analog means is more accessible to a larger population than knowledge surrounding digital programs and navigation may be. Location can be recorded in paper and pencil data collection via a surveyor's wheel, or utilization of a device with a GPS signal. The use of a surveyor’s wheel to determine location makes sense in measuring trees along a city block but is not as feasible in city park space. Comparatively, utilizing a paper datasheet potentially sacrifices time and accuracy in comparison to using a digital program. In using a digital program such as Open Tree Map, volunteers would simply tap the location of a tree on a map on a tablet, and then can enter in tree attributes. This resolves the difficulty of determining how to record location which may come with paper and pencil data collection. Additionally, using a tablet program quickly allows data to be condensed into a single inventory, and easily transferred to programs that can be used to analyze the data. In paper datasheet collection, the information entered will need to be manually typed into a digital database before conducting analysis. Overall, we recommend the use of paper data sheets because of their ease of use, as preferred by volunteers, and their compatibility with the scale of the tree survey.

The 2014 survey done by S&S Tree Specialists failed to link the data collected to a geographic map to analyze tree and tree species diversification distribution across the city. Also, having a picture linked to each tree can help future management when a tree needs to be trimmed or removed. It is recommended that West St. Paul works with the county GIS department to develop a mapping software for the tree survey, but if they are unable to, West St. Paul can also work with a private company to develop a mapping software that incorporates everything desired by West St. Paul.

West St. Paul should have their IT staff involved from the beginning of the planning process. As stated by Maple Grove without a strong IT staff, the volunteer tree survey would have failed. Having the IT staff say that all desired actions, such as the storing of data and desired analyses, can be conducted from the beginning will help alleviate many future problems and help the volunteer tree survey be more successful.

Conclusions

The overall goal of this report is to provide West St. Paul with a set of recommendations on how to conduct a Volunteer Urban Tree Survey that is based on the research findings. Firstly, the recommendations outline how the city can recruit, train, and most importantly, retain volunteers. Secondly, the final recommendations outline specific guidelines for West St. Paul concerning the on-the-ground work that is to be conducted by the volunteers. Lastly, the final recommendations also outline what management and analyses can be done with the collected tree data in the form of a tree inventory.

While these recommendations based on the research findings are the primary goal of the report, they are not the only goal of the report. Other goals included an investigation into the current tree distribution of West St. Paul and how it relates to socioeconomic factors such as race and income, the successes, and challenges of the 2014 and 2015 tree surveys conducted in West St. Paul, and how other cities in the Twin Cities metro area have conducted volunteer urban tree surveys of their own. Through the analysis of remote sensing data, the current tree distribution in West St. Paul was determined. Through interviews, the successes and challenges of the tree surveys conducted in 2014 and 2015 in West St. Paul and volunteer urban tree surveys in comparable cities. Knowing the successes and challenges of the tree surveys conducted in 2014 and 2015 in West St. Paul and how other cities in the Twin Cities metro area conducted volunteer urban tree surveys provided numerous pieces of information that helped form the final recommendations.

Through the synthesis of all the findings from the remote sensing data, literature review, and interviews, the final recommendations presented and discussed in this report were formalized. Through the recommendations and potential implementations listed in this report, residents and city workers of West St. Paul should be well prepared to actively participate within their community through the conduction of a volunteer urban tree survey.

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Appendix A

List of potential tree variables that volunteers could collect data on			
Tree identification	Tree location	Tree conditions	Infrastructure
Assigned tree ID number[2]	Address[3]	Overall condition[1,2]	Overhead wires present[3]
Genus[1,2,3]	Latitude, longitude	Diameter at breast height (DBH)[1,2,3]	Tree system[3]
Species[1,2,3]	Cross streets[3]	Crown width (CRW)[1,2,3]	Stewardship evidence[3]
	Qualitative description of location of tree relative to landmarks[3]	Stump diameter[3]	Sidewalk damage from tree[3]
	Distance to tree from point[3]	Stagheading[1]	
		Tip dieback [1]	
		Symmetry[1]	
		Ratio of crown to tree[1]	
		Cambium loss[1]	
		Sprouts or suckers presence[1]	
		Stem cracks[1]	
		Included bark[1]	

[1]Arnlund, M., Kampel, F., & Gawtry, D. (2018). *City of Maple Grove Tree Inventory*.

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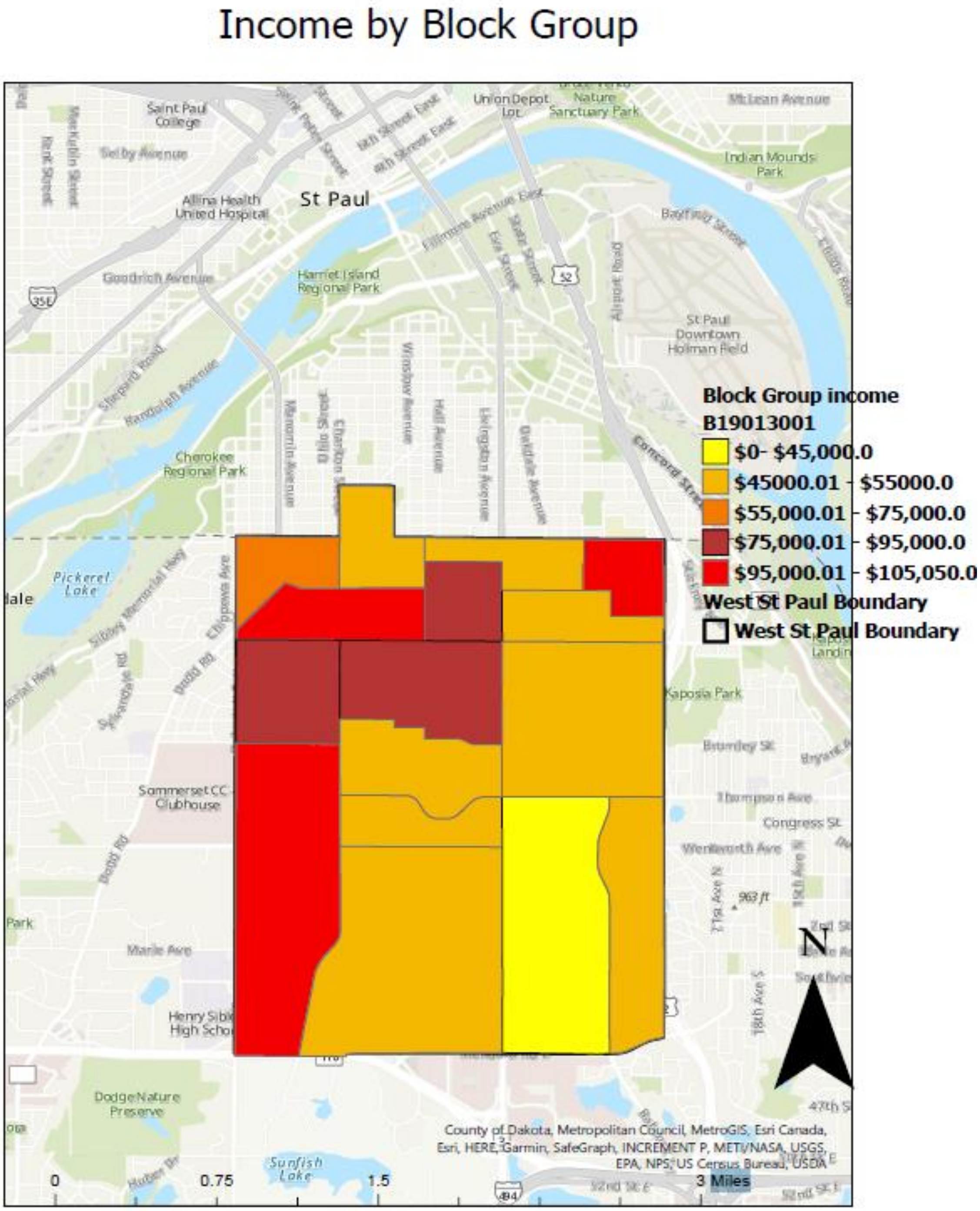
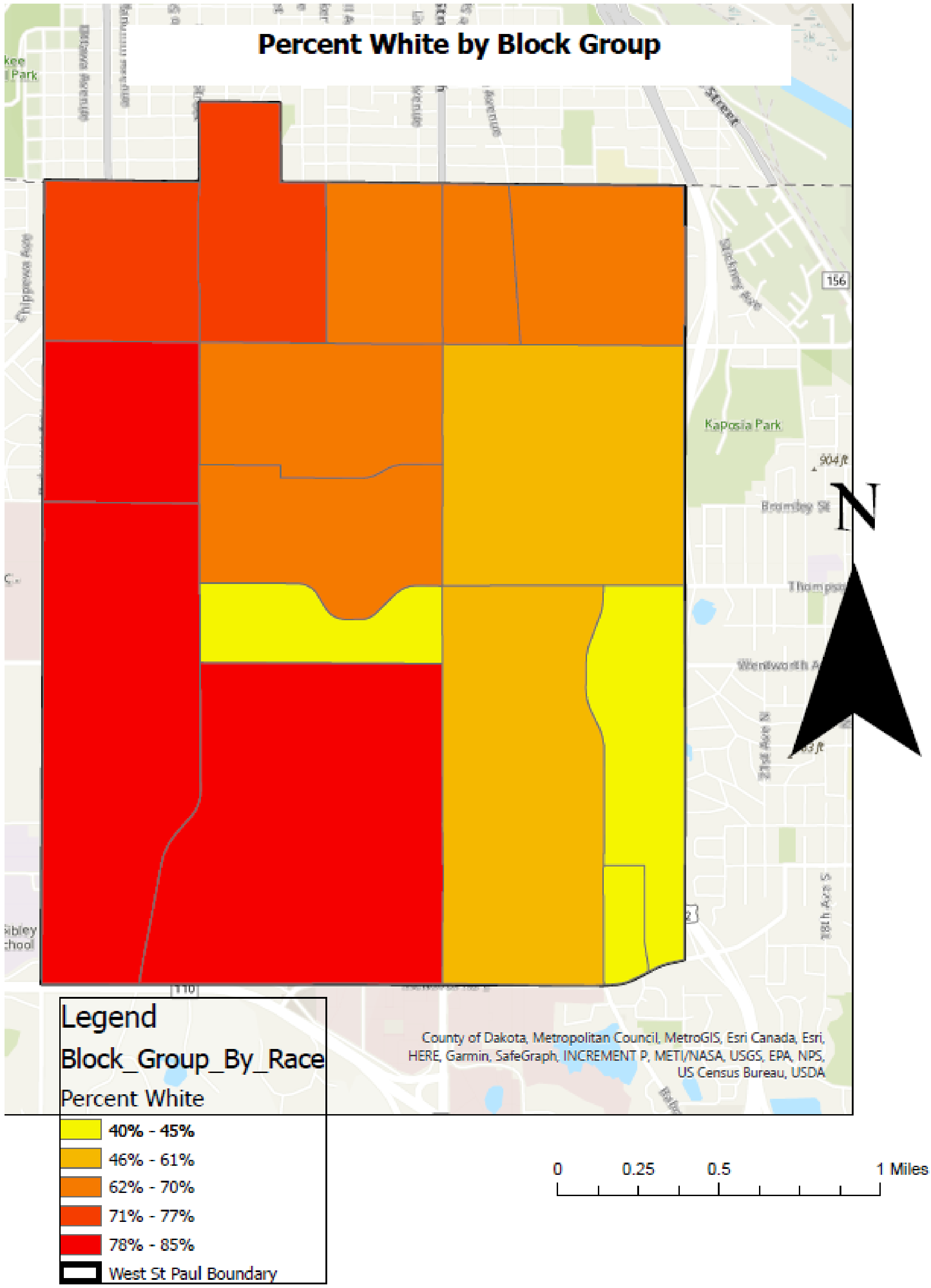
Appendix B

Income by block group for West St. Paul



Appendix C

Percent White by block group for West St. Paul



Appendix D

West St. Paul Tree Data from S&S Tree Specialists 2014 Survey. This map marks the locations of trees as surveyed by S&S Tree Specialists, which the city of West St. Paul contracted out to conduct a tree survey in 2014.

West St. Paul Tree Data from S&S Tree Specialists 2014 Survey