Barking Up the Right Tree: An Analysis of City-Owned Trees in Keene, NH

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Abstract

Trees in urban centers bring ecological, economic and aesthetic benefits to a city and its residents. Tree City USA is an urban tree program, which supports the planting, and maintenance of city trees. Keene, New Hampshire has been a 'Tree City' since 1979 but overtime this program has suffered from a lack of City resources and waning public attention. The purpose of this research was to assist the City in identifying, locating and assessing city trees through the use of GPS units and through the creating of an updated GIS map and database. Also involved was a survey of the public to determine their awareness of and level of support for the Keene's Tree City USA Program. Results from the public survey demonstrated that city residents overall had a lack of knowledge of the program, however, the majority surveyed had an interest in learning about and/or participating in the future the program. This work will serve multiple city departments by providing them with the information that will facilitate monitoring and maintaining city-owned trees.

Keywords: urban forestry, Tree City USA, GIS, public awareness

Introduction

Nestled in the center of Cheshire County, Keene is a small city in southwestern New Hampshire (Figure 1). The City of Keene is home to approximately 23,000 residents, three institutions of higher learning, and multiple public parks. Keene is a community that still has the nostalgic feel of a small New England town but with the amenities of a larger city. Known for its sense of community which the Greater Keene Chamber of Commerce defines as a combination of "safe streets, good schools, neighborliness and people who care" (2010 Para 1).

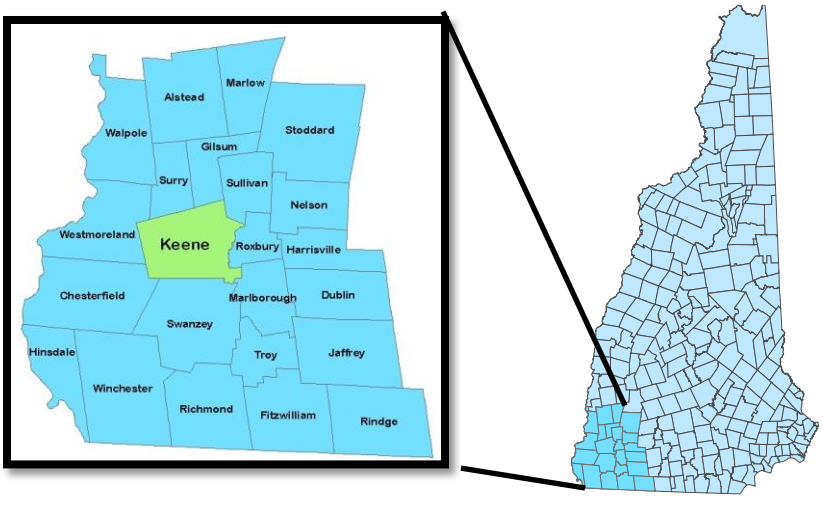

Figure 1: Map of the State of New Hampshire with an inset of Cheshire County.

Keene has long been nicknamed and known as the "Elm City". It received this nickname because of the large number of elm trees that were once a main part of the downtown Keene tree population. The decline in the number of elm trees, however, started in 1938 when a hurricane swept through the area taking many old healthy trees down with its powerful winds. Several decades after the devastating hurricane, Keene trees fell victim to the Dutch Elm Disease which claimed the lives of the remaining elms in the city. Today, in tribute to its "Elm City" legacy, Keene is home to the Elm Research Institute which has been attempting to cultivate an elm tree

resistant to the Dutch Elm Disease. These new trees, known as American Liberty Elms, are now being planted throughout Keene to help make Keene the "Elm City" once again.

Trees and vegetation surround the heart of Keene's downtown Main Street center turning lane. These natural features have been a part of Keene's charm for many decades. In 2009, Keene's Central Square (Figure 2) was designated one of the top 10 Great Public Places by the American Planning Association's (APA) Great Places in America Program (American Planning Association 2009). This designation is awarded to

> places of exemplary character, quality and planning. Places are selected annually and represent the gold standard in terms of having a true sense of place, cultural and historical interest, community involvement, and a vision for tomorrow (American Planning Association Para. 1 2009)

Figure 2: Central Square. Photo by Jeffery Newcomer

Without argument, the trees of Central Square along with the trees lining Main Street help to enhance the overall urban environment in downtown Keene.

Keene's historic Main Street is the City's center for business, community and culture. Since the 1950's Keene has also laid claim to having the widest paved Main Street in the world. A 1960 photograph of downtown Keene illustrates how busy Main Street has been in the past decades (Figure 3). While apparently vital, few trees were present in the downtown area compared to the numbers that exist in Keene's current downtown landscape (Figure 4). The 2009 photograph shows how much greenery surrounds Main Street on all sides. While the City

has a well known rich history much less is known about the trees that help to make Keene the city that it is today.

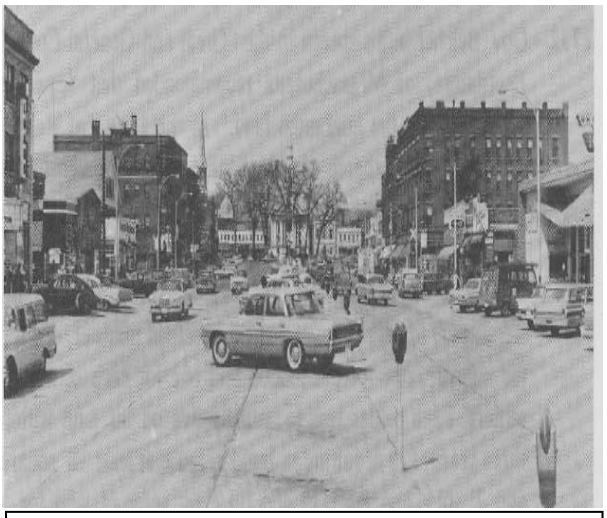

Figure 3. Main Street Keene, 1960. *Upper Ashuelot*.

Figure 4. Main Street Keene, 2009. *Cheshire County*.

The benefits of trees in urban landscapes are extensive and can be an advantage to the communities economic, ecological and aesthetic ways. Research has demonstrated that trees can: lowering crime rates, lessen the carbon footprint of a city, lower heating and cooling costs, as well as reducing the need for road re-pavement. In recent years attention has been drawn to reducing carbon dioxide in cities because it is the number one greenhouse gas of concern fueling global climate change (Chunhua, Tabin and Wagoner 2010). This concern has lead to studies on and the further development of urban forests across the country.

The Tree City USA Program is designed to promote the planting and maintenance of trees in urban communities. The program, sponsored by the Arbor Day Foundation and the United States Department of Agriculture, assists cities around the country with developing, funding, and maintaining urban forestry (Arbor Day Foundation 2010). Keene has been a member of the Tree City USA Program since 1979, and through this program the City has

planted thousands of trees on both private and public property. Though Keene has been a Tree City for many years it has struggled with maintaining up-to-date records on the location and health of its city-owned trees. Additionally, the level of community member's awareness and support of the Tree City USA Program is also unknown.

Our research seeks to provide City officials with key information on the location, species and condition of the city-owned trees; to determine the amount of knowledge residents have about the Tree City USA Program in Keene; and to identify a way of increasing community involvement in the program. To provide local officials with important and correct information on city-owned trees, the team collected data on hundreds of trees in downtown Keene. The GIS analyses conducted on field data gathered will be beneficial to the City to help update and correct their out of date tree records. The survey data collected and analyzed on the resident's knowledge of and interest in Keene's tree's will also provide information of importance to key City government officials when looking to the future of the Tree City USA Program in Keene.

Literature Review

Visual Benefits

Urban forests can positively influence the social and economic environment of a city. These influences can range from greater visually pleasing sidewalks and increased property values to a stronger sense of community and a greater connection between people and the natural environment (Dwyer 1992). The urban forest may be the only forest that some urban residents will ever experience. Urban forests can provide a forest-like setting for inner-city environments, with trees that naturally change colors with seasons and a habitat for a variety of wildlife.

Urban trees that transform with spring and fall foliage create a visually soothing environment for drivers and pedestrians moving through a city. Trees are associated with improved visual quality of roadsides leading to positive perceptions about a community's character (Wolf 2003, Wolf 2006). Trees are also visually appealing features within cities because of the stark contrast they provide with human-made structures such as signs, buildings, and streetlights. Trees placed along city streets are not just aesthetically pleasing for drivers, trees may also improve how comfortable drivers feel behind a wheel. If urban trees are placed in medians, they prevent an intense cross glare with their canopies, thus improve safety for night drivers (Neale 1949).

Many commercial areas welcome trees as a consumer-oriented advantage. However, small business owners and managers can sometimes overlook the contributions of trees to retail success (Wolf 2003). They focus on the annoyances of trees such as: reduced signage visibility, seasonal debris, and safety issues. As a result, business owners and managers can be biased against the placement of trees in front of their shops. This bias may lead to a failure to recognize the district-wide benefits that can be attained by developing a quality urban forest.

> "Business districts having trees were characterized as being higher in visual quality and comfort, as providing more positive interaction with merchants, as having higher-quality products, and generally appearing to be better maintained and kept up. Such evaluations are reinforced by respondents' claims that they would be willing to travel further and longer, visit more often and for longer periods of time, and pay more for parking when visiting retail places that have trees (Wolf 2003, 123)."

Climate Benefits

The current amount in millions of metric tons of carbon stored by urban trees is another strong argument for maintaining a healthy urban forest (Nowak 1992). Carbon dioxide is considered to be the number one greenhouse gas accelerating climate change (Nowak 2002). Trees in urban areas offer multiple benefits in reducing this gas including direct carbon storage as well as an avoidance of carbon production (Wolf 2003). Specifically, when a building is shaded, the amount energy for cooling is reduced. Shading results in reductions in carbon dioxide emitted from power plants that provide energy used for cooling (Akbari & Tal. 1997). Organizing properly chosen and placed urban trees, along with maintaining currently planted trees can result in carbon sequestering in an urban forest. The amount of carbon stored in the United States is large, but small in comparison to how much carbon is emitted. The United States' national carbon storage estimate of 400 million tons which has taken years to store, unfortunately, this is the amount of carbon emitted by the United States in only 4 months (Nowak 1992). This speaks to the need for an increase in carbon storage as well as a reduction in carbon emissions.

In addition to concerns over carbon, cities and urban environments across the country absorb great amounts of solar radiation during long summer days. Incoming solar radiation is absorbed into city buildings, streets, and sidewalks creating a sense of increased heat which is slowly released once night falls. This increased heat has given rise to the term "urban heat islands". The downtown areas may be from three to ten degrees hotter than the surrounding

region (Sampson, 1989). For this reason there are some cities that have expanded in natural shading to offset the urban heat island effect. However, Summit and McPherson (1998) found that shade and appearance played more of a role in the decision to plant trees than did concerns about energy savings and environmental benefits.

Urban trees have canopies that extend outward causing shade to fall across cement sidewalks, sides of concrete buildings, as well as paved parking lots and streets (Manning, 2008). Trees that shade dark surfaces such as streets, buildings, and parking lots are the most valuable, so older, larger trees are more effective than smaller ones (Sampson 1989). Shade casts by trees blocks incoming solar radiation and helps to reduce temperatures. While air conditioning may be used all day inside to keep cool, a reduction in outdoor temperatures can cause a noticeable decrease in the amount of energy needed to cool the interior of buildings, thus reduce energy costs.

Huang and others (1987) identifies both the direct and indirect effects of urban trees on the environment. The direct effects include: reducing solar heat gain through windows, walls, and roofs by shading, and reducing the radiant heat gain from the surroundings by shading. The indirect effects are reducing the outside air infiltration rate by lowering ambient wind speeds, reducing the heat gain into the buildings by lowering ambient temperatures through evapotranspiration in summer, and in some cases, increasing the latent air-conditioning load by adding moisture to the air through evapotranspiration. Though urban trees are helpful and effective at blocking out solar radiation, they are also helpful by blocking out wind (Figure 5). Trees act as windbreaks that lower the wind speed which may lower a building's energy requirements for cooling in the summer or heating in the winter. In certain climates, urban trees are used to block hot and dust-laden winds (Akbari & Tal. 1997).

Figure 5: *Urban Trees. Greenville, South Carolina*. Source: The Decatur Daily News

The Value of Urban Trees to Residents

Sampson (1989) notes that in some cities, the urban forest is deteriorating and the quality of life in the community is declining with it. Rather than remaining content with allowing the city's natural environment to decline, communities can decide to restore their urban forests. Although street trees are clearly valuable to a city, researchers are beginning to explore residents' perceptions of their values as well as their willingness to pay to maintain these trees.

In one such study, residents in 44 communities in Missouri were given a survey designed to investigate and determine how much money they would be willing to pay in taxes to fund inner-city tree maintenance (Treiman 2006). To answer such questions and provide an estimate of what street trees are worth to residents, the survey was administered in different sizes and

types of communities throughout Missouri. It was determined that respondents would be willing to pay anywhere from one dollar to twenty dollars to maintain their city trees (Treiman 2006). The results demonstrate that inner-city tree programs are of significant value to the residents given their stated willingness to help fund tree maintenance.

Overlooked Canopies

Keene, New Hampshire is an established classic New England small city which has a large demand and infrastructure for pedestrian travel. While there is a large interest in sidewalks and bike paths throughout the City, this restricts the amounts of space available for trees. In any city, pedestrians and sometimes trees are restricted to the limited space designated for sidewalk areas. With room for pedestrians as the main focus, urban trees, if used, are given the most limited amount of space to be planted and grow. An example of this is in the highly urbanized city of Hong Kong where 35.8% of the road-side trees exist in cramped sites less than 4 meters wide, as much as 34.3% of roadside trees had less than 1 meter of unpaved soil width, and 32.6% of the trees have trunks situated less than 1 meter from the curb (Jim 1998). While Keene's size does not compare to Hong Kong's, in both cases the space allocated for urban trees must be carefully planned.

The best time to incorporate the natural environment, including native trees and vegetation into a city's design, is during the planning and development phases (Sampson 1989). These phases have been long passed for many cities and urban areas, but there are still developing cities getting bigger. These developing cities have a sequence of both demolition and reconstruction projects which in some cases fail to replace urban trees that may have been removed. Existing trees are sometimes destroyed or removed during these demolition projects. During reconstruction periods, plantable space in the city is inadequate and trees have to be small or have little room to expand as they grow.

Additionally, without enough space or proper maintenance urban trees can fail to grow and some decline and die prematurely. In any city, about four trees die or are removed for each new one planted, and that number can go as high as eight or ten in some cities (Sampson 1989). The budget for a city's urban forest is often used for removal when trees become hazardous to pedestrians or are in poor condition. Trees may also have been poorly planted which causes a greater need for ongoing attention and maintenance. This can strain community budgets and lead to inadequate maintenance efforts.

To develop sustainable programs for urban forestry, studies focusing on how to fund and finance urban forestry activities are needed. Most community citizens are unaware that a budget is needed to maintain city trees. Depending on the individual community, responsibility for urban tree maintenance can fall to city departments of public works, engineering, planning, parks, urban forestry, or a combination of these. Public attitudes towards city trees have an influence on a town's subsequent fund allocation, public involvement and participation, the integration of tree programs, and community identity (Letson 2007). Urban tree programs often struggle for consistent and sustainable financial support, not only from government entities but also from individuals, business people, and nonprofit organizations (Zhang 2007).

Public Awareness and Attitudes towards Urban Trees

A review of earlier research on urban forestry reveals that most studies have mainly examined public attitudes toward urban forestry from an aesthetic perspective. While understanding the need for a budget, it is also important for city officials and offices to consult the public regarding their values for urban trees and their attitudes towards programs to promote these resources. It can be difficult to get the community's view on a topic such as urban trees if community members are unaware that their town participates in an urban tree program.

Tahvanainen and others (2001) assessed the public attitudes toward and perceptions of the impacts on scenic beauty and recreational value of urban forests within cities. Scenic beauty and recreational value were evaluated from slides where management measures were presented to determine which was preferred more. The results were split between the importances of scenic beauty compared with recreational preferences.

Balram and Dragicevic (2005) measured the dimensions of citizen attitudes toward urban green spaces. Geographic Information Systems (GIS) techniques and informal interviews were used to create complementary opinions about the spatial and non-spatial factors influencing attitudes toward urban green spaces. An affinity analysis was used to combine the issues into three consistent categories that guided the construction of survey items. Factor analysis and reliability analysis were applied to the items set to create an official attitude measurement scale. It was determined that attitudes toward urban green spaces have multiple opinions. The analysis showed that households were characterized by a two-factor attitude structure toward urban green spaces including behavior and worth.

Ozguner and Kendle (2005) examined the public attitudes toward urban landscapes in contrast to more formal designs of urban green spaces. Attitudes of the community were examined using a site-based questionnaire survey in comparing two public green spaces in Sheffield, United Kingdom. Results indicated that the public preferred both types of natural areas in an urban setting for different reasons. In addition, design styles seemed to have an influence on preferences.

Lohr and others (2004) surveyed residents of the largest metropolitan areas in the United States about the benefits and problems of trees in urban areas. They found that the ability of trees to shade and cool surroundings was the highest ranked benefit. Their potential to help

people feel calmer was ranked second highest. Potential problems with trees such as causing allergies were bigger concerns than the financial maintenance aspect. People who strongly agreed that trees were important to their quality of life rated the benefits of trees more highly than people who did not strongly agree. Overall, the general public's attitudes, not just the people who volunteer for tree programs, were strongly positive toward trees in cities.

Background of Keene, NH and the Tree City USA Program

Keene Trees

The City of Keene has come a long way form the "untamed wilderness, virgin forests, treacherous streams, impenetrable underbrush, and unexplored swampland," that describes the early environmental experiences' of settlers that were communicated in the early 1700s (Proper 1968, 1). Over a century later, Keene became know to many as Elm City, when in the 1840s large Elm trees lined the marketplace in central square, creating a canopy of leaves downtown (Aldrich 1989). The transition from a heavily forested environment to scenic city took place over more than a century. While today Keene remains a place of flourishing greenery, the history of trees in the City is infused with natural disasters and disease.

One of the first major documented disasters of recent history to affect a large number of trees in Keene was the "Great Hurricane of 1938". On September 21, 1938 the hurricane made landfall in Southern New Hampshire over Keene. It was said to be "one of the most destructive and powerful storms ever to strike Southern New England" (National Weather Service 2005 Para. 3). The National Weather Service categorized this hurricane as a Category 3 which produced wind guest of up to 120 mph and severe flooding throughout New England. Over 1,000 Elm trees were alone lost in the disaster, and the winds leveled most trees along streets in the city including hundred year-old pines. In total over 1,800 trees were destroyed in the hurricane (Proper 1968). Figure 6 is a snapshot of the devastation left on Union Street from the "Great Hurricane of 1938".

Following the destruction from the storm, one of the next struggles for urban trees in Keene was the emergence of Dutch Elm Disease (DED) beginning in the 1960s. Dutch Elm Disease affects the vascular system of Elm trees preventing the distribution of water through the trees causing them to wilt and eventually die. Because Elms are so suitable to varying soil types,

urban conditions and are sturdy trees, they are planted excessively in urban environments (Haugen 2010).

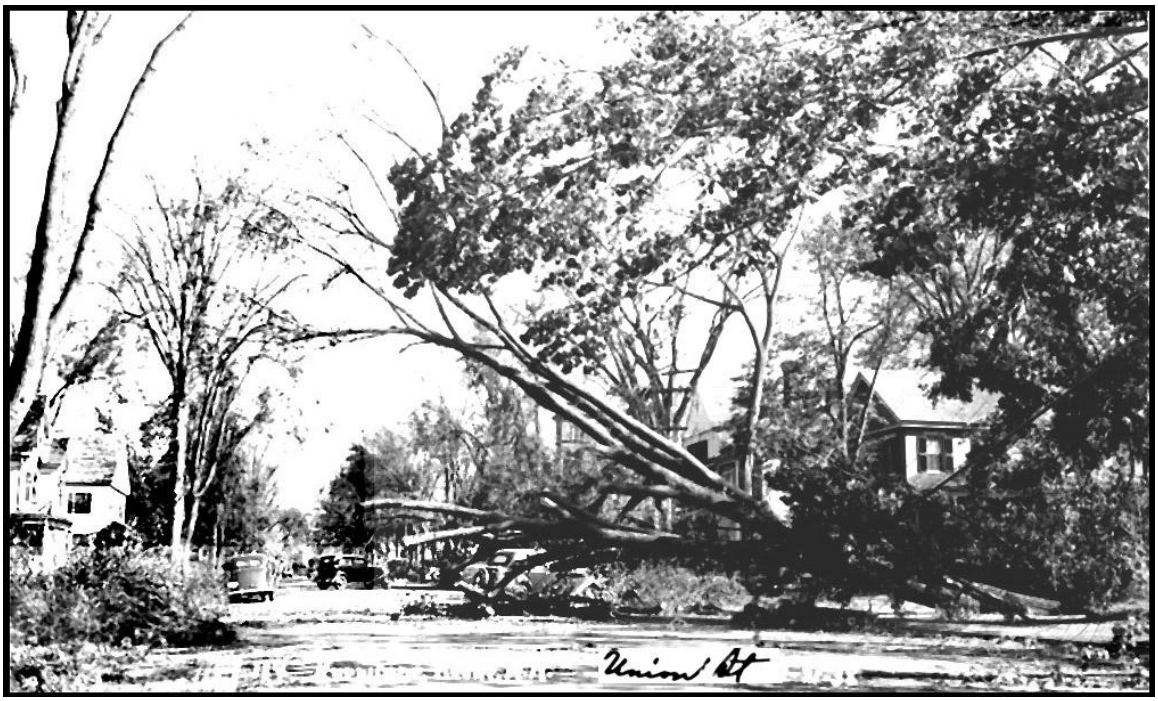

Figure 6: Union Street after The "Great Hurricane of 1938". Photograph provided by Keene Public Library and the Historical Society of Cheshire County

The spread of Dutch Elm Disease in the 1960s into New England caused many of the trees to become diseased and die. In Keene a recorded 90 trees were infected by 1963 and a year later over 95% of those trees had to be removed. In 1967, only two Elm trees stood after the disease caused the removal of 98 of the 100 trees planted the previous year in Central Square Park (Proper 1968).

This presented a problem for the Elm City known for its tree-lined streets. Out of the desire to keep Elms in Keene and develop a disease resistant tree, the Elm Research Institute (ERI) was founded in 1967. This non-profit organization is responsible for research on Elm trees in Southern New Hampshire. The most notable contribution from ERI has been the development

of the American Liberty Elm. The American Liberty Elm is a genetically modified Elm tree produced from six different cultivations (Spalthoff, 2010). These provide enough genetic diversity to make the Liberty Elm resistant to DED. Although no tree can be fully immune to the fungus, only 300 American Elm Trees out of 300,000 planted have been infected in 25 year (Elm Research Institute 2009). In the 1970s and 80s, the City of Keene participated in Elm Research Institute's (ERI) "Conscientious Injector" (CI) program, where the City was using preventive and therapeutic injections with Elm Fungicide to protect the tree from Dutch Elm Disease. The CI trees' health was recorded until 1984, when at that time 126 elm trees were alive and still being monitored in the City of Keene.

Tree City USA Program

In order to establish an organized citywide urban forestry program to benefit Keene, the City became part of the Tree City USA Program in 1979. Tree City USA is a non-profit, conservation and educational program founded in 1972. This was also the year of the first Arbor Day observance. The Arbor Day Foundation founded by Julius Sterling Morton, oversees the Tree City USA Program. The United States Department of Agriculture Forest Service, the Urban and Community Forestry program, and the National Association of State Foresters provide support to the Tree City USA Program. Additionally there is a state forestry agency for each state throughout the country.

In the first years the program was just an association of cities that recognized the benefit of trees. However, today the program has become the biggest nonprofit organization dedicated to planting trees in the country. Every state including the District of Columbia and Puerto Rico contain communities that have won awards for going above and beyond their expectations as

Tree City USA members. There are currently 3,400 communities with over 135 million people included in those communities that participate in Tree City USA (Arbor Day Foundation, 2010).

Becoming a member of the Tree City USA Program requires a city-wide commitment to quality tree care. To maintain membership in the program, each city has a list of requirements they must complete. These requirements provide a directional framework, as well as standards for each city to meet. In return, the agencies sponsoring the program provide communities with educational materials and technical assistance, as well as national recognition.

In order to become a tree city member, there are four requirements that every city must meet. The first is to designate a city department to be in charge of the trees, this department is held legally responsible for the care and management of all public trees. The city may assign a warden, and arborist, or even the Public Works Department to hold this responsibility. The second requirement is that the city must adopt and implement a tree care ordinance. The ordinance provides guidelines for planning, planting, maintaining, and removing trees on public land. Every year the ordinance is to be reviewed to assure progression in the program. Third, the program must receive an annual budget to fulfill the requirements of the ordinance. Tree City USA requires each city to provide a budget for the program, which is equivalent to a minimum of $2.00 per capita. This budget funds all of the work completed in the city including managing trees, planting and tree removal. The last of the four requirements is that the city must participate in Arbor Day Observance and Proclamation. Each town must set one day to recognize trees and educate their citizens about their importance.

Any participating cities that go above and beyond the Tree City USA requirements may receive recognition through awards. Cities that show improvement, growth, and achievements in higher levels of tree care are likely to win an award. In order to consecutively win the ‘tree city

growth award', the same amount of money that was spent on the previous year must be spent again. If a community participates in the tree city growth award program for ten years, they receive the "sterling award". There is also a Tree Line USA Utility Award that recognizes dependable local utility services, which maintained healthy trees along the streets and highways. There are three qualifications for the Utility Award. Quality tree care is the first, which requires cities to participate in proper pruning practices that eliminate tree topping. Policies that require tunneling around high value trees rather than trenching is also required. The second requirement is annual worker training that educates workers and utility customers about proper tree care. The last of the three requirements consists of tree planting and public education. Each utility service must spend a minimum of ten cents per customer on tree planting and customer education on the Arbor Day program. If all three standards are met, Tree City members receive the Tree Line USA Utility Award. Service providers are recognized for their commitment to quality tree care, and as a role model for the rest of the country. Both the Tree Line Utility Award and the Sterling Award are incentives to motivate tree cities to go above and beyond the minimum requirement of the program.

The Tree City USA awards program have helped 3,402 cities across the country experience the benefits of urban trees. Being a member of the program brings the community together through pride and social activities. It is challenging for cities with urban sprawl to maintain a healthy tree population so this program provides structure to promote urban forestry.

Keene's Tree City USA Program

In an article published ten years after the establishment of the program, "The Greening of Keene" discusses the aesthetic improvements to the downtown and surrounds areas resulting from participation in this nation-wide program (Aldrich 1989). The city planted more than 150

trees of multiple varieties that were proven to stand up to urban stressors and diseases such as DED. More mature trees were planted rather than young saplings, to aid in the immediate gratification of planting as well as take advantage of the health and stability of older trees (Aldrich 1989).

In recent years, *The Keene Master Plan* (the guiding document for the city) published for 2010 incorporates information pertaining to the importance of trees in the city. The Master Plan documents city residents' responses to surveys about the importance of trees in the city and that many residents think the downtown area is important to the city. In the "Streetscape" section, Keene trees are discussed in detail as a means to expand the green walkways and parklands within the city. In addition to providing aesthetic benefits, the city trees, "make sidewalks 5 to 15 degrees cooler, increasing both the comfort of the space and the life of concrete and asphalt pavement and reduce the negative health effects of vehicle pollution and have been shown to reduce blood pressure and improve overall emotional health"(Keene Mastery Plan, 2010, 13).

An interview with the Keene Mayor, Dale Pregent also gave insight into the Tree City USA Program in Keene. (Pregant 2/10) He stressed the importance of education in the community about the program and pointed out a tree planting ceremony that group member's attended on September 24th, 2010. The ceremony was a Liberty Elm planted on Baker Street, within our study area. The goals of the Tree City USA Program and the Master Plan align well with each other in that they both seek to enhance downtown tourism, beauty and the ten percent initiative plan, a local program to help businesses reduce their greenhouse gas emissions. The exact number of trees that have been planted through the tree city USA program is not known exactly, but it can be seen throughout the City that the tree population has made a comeback and the cities trees may someday represent the Elm City name again.

Methodology

Field Data Collection

To achieve the objectives in this study to collect and update city-owned tree records and determine the community's level of awareness- three tasks were completed. These were: 1) field data collection on city-owned trees in Keene's downtown; 2) GIS analysis of this data; and 3) a survey of Keene residents, regarding their knowledge and attitude toward city-owned trees. Each of these methods is described in detail in this section.

Field Data Collection

To update and collect needed information to further Keene's Tree City USA Program, the group conducted fieldwork to collect data on city-owned trees. Will Shoefman, a GIS technician for the City, determine the area of study which was a one-mile circle, focusing on the center of the Putnam Science Center at Keene State College, show in Figure 7. The area stretched from the edges of Court Street and Washington Street heading south toward Route 101. From east to west the circle started at Beaver Brook on Baker Street and extended west to the outskirts of Island Street.

Every city-owned tree in the study area was located and identified. This included 406 trees located on city property as well as 57 city-owned trees on private property. City trees on public properties were located along streets and in common areas.

For the city-owned trees on private property, the city had some preexisting but incomplete data including the general location and species. While homeowners have allowed the city to plant trees on their property, in some cases the property lines have changed. Additionally, the team found that a number of the trees on the private properties had been cut down, or were identified under a different common name than was used in this study.

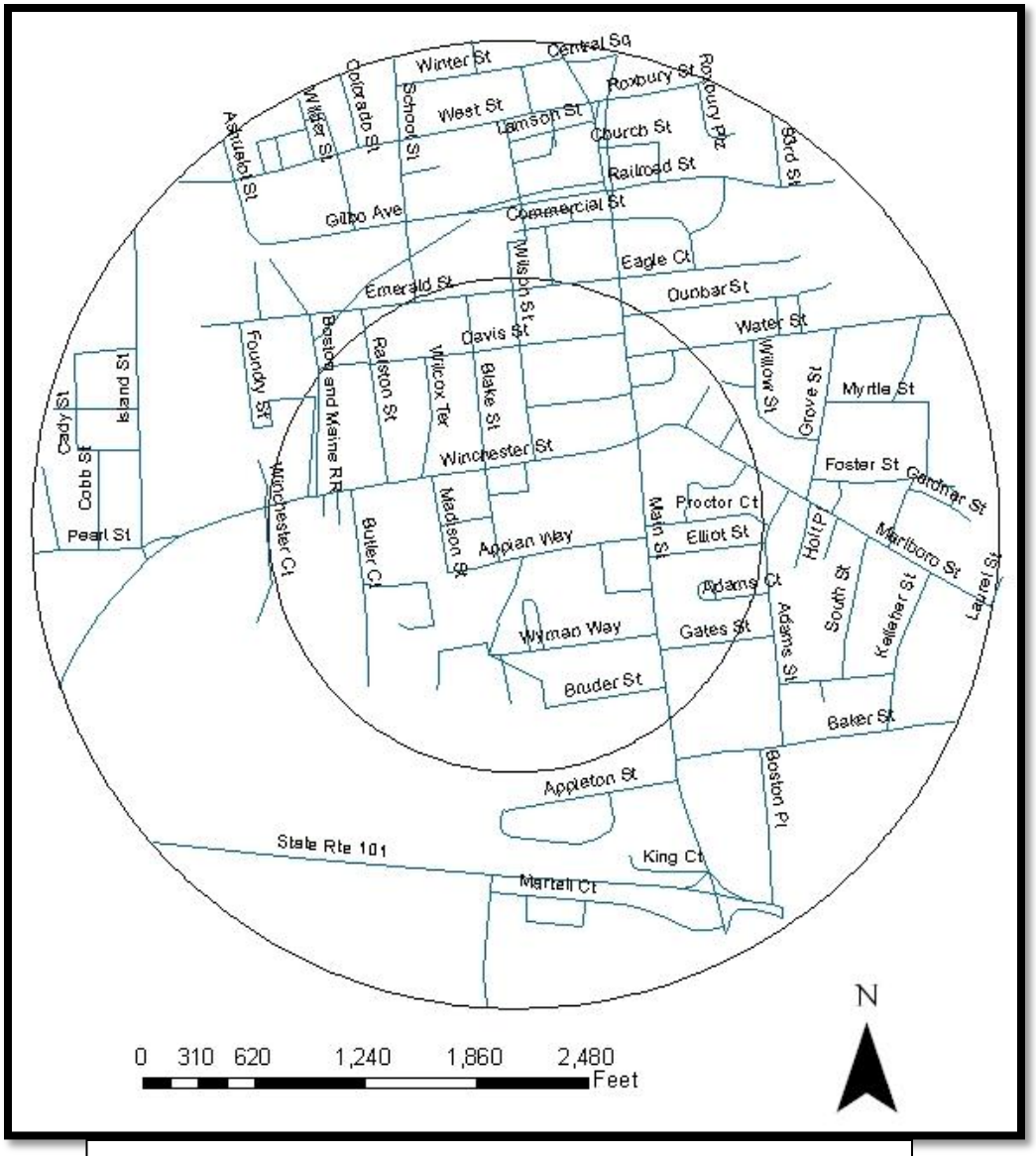

Figure 7: Study Area for Field Work on City-owned Trees

The field work was conducted between September 15 and October 12, 2010. The data collection protocol consisted of: 1) identifying the species; 2) measuring the tree's diameter; 3) analyzing the condition of the tree; and 4) collecting the tree's geographic coordinate and logging the all data into the GPS unit, a Tremble unit with Terra Sync software.

Jeff Garland, a certified arborist in the New Hampshire Arborist Association, trained the team to identify trees and rate their condition. This training provided a good introduction on tree

identification, but the group needed a method that provided more guidance in the field. Using field guides to determine species was not effective for the team because these resources were too general. Along with Jeff Garland, the group determined the best way to properly identify trees. One leaf was taken from every tree species and taped to a poster board (Figure 8). The leaves were essential to determining the species of the tree. Next to the leaf on the poster was a description of the tree's canopy, bark, size, fruits and any other useful information. This allowed the group to pick leaves and match them to local trees. Due to the limited numbered of species in Keene, every tree was identifiable by eye in a short period of time. However, it was useful to have the poster board which clearly illustrated details about each species of tree.

Figure 8: Tree Identification Board. Photograph by author.

In addition to identifying the species, the tree's diameter was estimated. To make this estimate the width of a tree is measured at chest height; a universal way of identifying the size of a tree. Next, the tree's condition was assessed and placed in one of four categories. The team rated the health of a tree based on whether the condition was in need of attention, poor, fair, good. Jeff Garland assisted the presenters in creating a method for identifying the trees condition. Lots of dead wood, v-crotches, broken limbs, or carpenter ants were some of the signs that a tree was not in good condition. The degree to

Figure 9: Example of V-Crotch Tree. Photograph by author.

which these negative features existed helped the group categorize the tree's condition. If a tree was in need of attention or in poor condition, additional notes were taken and pictures when needed (Figure 9).

Team members conducted the field work in pairs. One person would identify and measure the tree, while the other stored the data into the G.P.S. units. Every road was highlighted on a map as the group moved through area of study.

As noted, most city-owned trees were located between the road and sidewalk. However, some of the side roads in Keene did not have sidewalks, but did have trees close to the road. After contacting Harry McKelvey about the issue, he produced a list of the City boundary line measurements for every road. For each road, there were a set number of feet from the center of every road that was considered City property. The amount of feet varied for every road, so physically measurements for each road with city trees but without sidewalks was necessary.

Survey of Keene Residents

In addition to collecting and analyzing the large amount of tree data, we also focused on the need for city officials and staff to determine community resident's awareness of the Tree City USA Program, as well as the residents' value in maintaining city trees and the Program itself. To determining the level of knowledge that city residents have, we administered a survey to 153 individuals in Keene.

A public survey was the most efficient way to gather numerous responses from community members about their level of awareness as well as willingness to help with the Program in the future.

The survey was designed to test for two hypotheses. Our first hypothesis stated in the null is: there is no difference between homeowners and non-homeowners in their willingness to

participate in the Tree City USA Program in Keene. Our second hypothesis in the null states: Keene residents feel trees are not an important part of the City of Keene.

The survey was broken down into three sections, the first to gather descriptive data about residents; the second to determine residents' knowledge about the Tree City USA Program in Keene; and the third to explore residents' feelings towards the importance of trees in their urban community (Appendix A). The first section consisted of four questions used for descriptive statistics (age, gender, residential status and years lived in the community) and to determine whether a correlation exists between these variables and respondents' awareness of the Tree City USA Program. The second section of the survey asks respondents to indicate whether they were aware of the Tree City USA Program in Keene. Following this question, a brief description of the Program was provided. The next three questions in this section were about respondents' willingness to participation in future Tree City USA related activities in Keene. The final section asked respondents to indicate their level of agreement with various statements regarding the possible ecological, economic and aesthetic benefits of trees in their community. Respondents rated their level of agreement to six statements using a 5-point Likert scale.

After a pilot test of the survey was given out to Keene State College geography classes and modifications were made, the survey was distributed in various locations throughout Keene. The survey was distributed in downtown Keene, at voting locations on election day, local parks, theatrical events and local sporting events. These locations were targeted because of the likelihood of encountering Keene residents as well as the low-key atmosphere of the selected places and events that would allow time for the participants to fill out the two-minute survey. The surveys were distributed between September 16 and November 1, 2010, with a total of 153 collected.

When research team intercepted community members, it was protocol to greet them and ask if they would be willing to participate in a short anonymous survey for a project being conducted by geography students at Keene State College in cooperation with City of Keene. The surveys were only given to current Keene residents the target population of the research. Most participants became engaged in the survey, asking follow-up questions and expressing their willingness to get involved, independent of their prior knowledge about the program. Much of the survey information will directly assist the City of Keene in determining where to next take the Tree City USA Program.

GIS Analysis Methodology

Being able to represent large amounts of data in a visually appealing and informative manner can be a difficult task and it is one that our research had to deal with. For our GIS, work we used ESRI's ArcMap 10. While collecting data in the field, we made numerous notes on information that was inaccurate in the city's current database that we needed to change while completing our spatial analysis with the data. The data we collected on city-owned trees on public and private property in our study area is a large amount of information which had to be represented and analyzed spatially. Whether looking for commonalities in tree size or looking for the trees in poor condition, this analysis can all be done through the use of GIS software.

The spatial display and interpretation of our data began with the GPS units used and the way in which they collected, stored, and exported the data. As was discussed, we recorded our data in Trimble GPS units that used a software package, TerraSync, to store the locational coordinates and relational information allowing us to compile it into a database. Due to the fact that our department could not afford such high-tech and specific GPS devices, we were loaned the units from the City. The process of getting the GPS data from the units to useful shapefiles

required our team to bring the GPS devices weekly to Harry McKelvey, who would then import our data into the computer. Once the data was imported, it was geospatially rectified using computer software that the City owns and has used in the past. Once the GPS data was rectified in a working shapefile, a CD was burned with all of the information collected so that we were able to properly manipulate and spatially analyze the data.

One of the first attributes analyzed was the quality of the trees. Because the trees condition was collected in four specific categories on the GPS: in need of attention, poor, fair, and good. This method made it much simpler to display the data based on the attributes. To show the condition of each tree, the color symbolizing the tree location was changed based on the rating given in the field. The colors made it very easy to see the patterns in tree condition throughout our study area. Colors selected were used were chosen because of the connotations that come along with them, for example, red is was used to show the trees in need of attention, and green was used to show the trees in good condition.

Next, the tree species were examined. The best way to display the different species would be through assigning a different color to each species. The third spatial analysis completed was on the diameter of the trees to determine if there are spatial conglomerations of the largest, and oldest, or smallest, and youngest, trees throughout the City. A fourth analysis was the combination of the size and condition of our target trees in a bivariate map. The bivariate map is an excellent way to see the correlation between the size of the trees and their condition.

Results

Survey Results

We analyzed the data collected from the surveys through the Statistical Package for the Social Sciences (SPSS) software.

Our group collected a total of 153 surveys to understand the residents of Keene, knowledge of and attitudes towards the Tree City USA Program. We wanted our survey sample to be representative of the population in Keene. Of the 153 surveys collected, 71 respondents, 46.4 percent were male, while 82, or 53.6 percent, were female. In the City of Keene, in the year 2008, 46.9 percent of the population was male and 53.1 percent was female (Keene Chamber of Commerce 2010). Our sample is therefore representative of the City of Keene's population with regards to gender identification.

In addition to gender, our survey collected other basic demographic data on our respondents including their age range. Figure 10 shows the age distribution of our survey sample

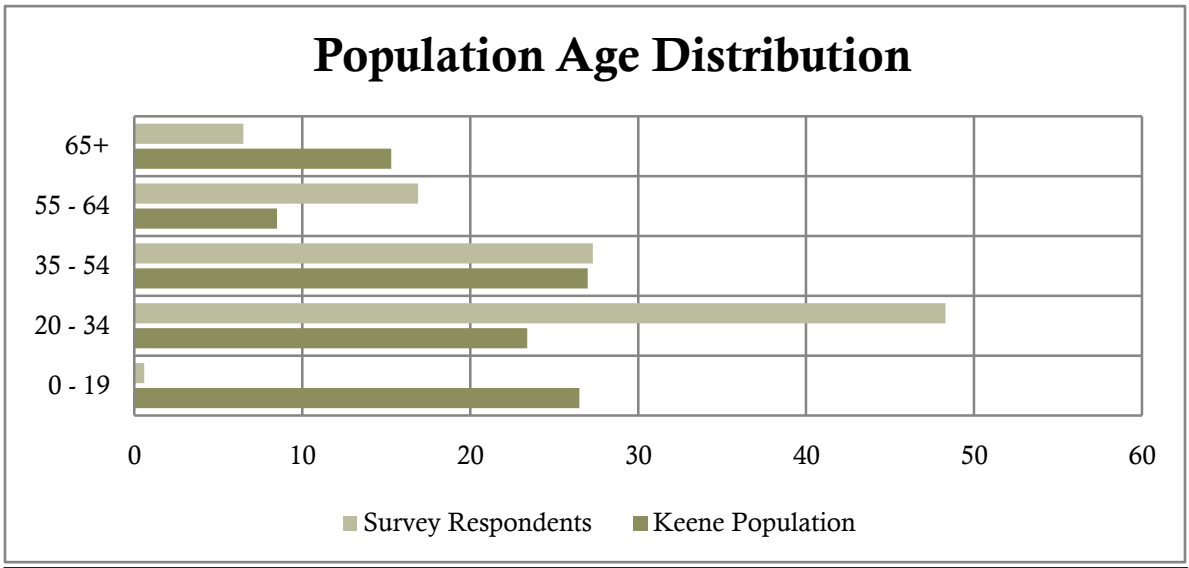

Figure 10: Graph of Age Distributions

compared to the total population of the City of Keene. We found that our survey population's age distribution is considerably different from that of the City's population, as our survey

respondents were rarely below the age of 19 and were most often between the ages of 20 and 34. This disparity could be due in large part to the location of our survey collection. We collected our surveys in and around the Main Street area which is very close to the Keene State College campus. We believe this proximity and the fact that many young professionals live in and around this area are the reasons why almost 50 percent of our respondents are between 20 and 34.

Our third question on the survey determined whether respondents owned or rented or occupied without paying rent. This information was required to test our hypothesis that there would be no difference in the willingness to participate in the Tree City USA Program between homeowners and non-homeowners. Figure 11 shows the living arrangements of Keene residents as of 2000 census data, and Figure 12 shows the living arrangements of our respondents.

We entered the data into SPSS, and we decided to combine the fields of "renter" and occupy without paying rent into the one category of non-homeowners. When examining this data there was a difference in the living arrangements of our respondents versus the 2000 data reported for Keene. Once again this is most likely due to the location selected. The majority of our surveys were administered in areas surrounding Keene State College. The area is then inherent to have a high percentage of rental properties for off-campus living. Of those who were surveyed 69, or 45.1 percent, were homeowners while 84, or 54.9 percent, were renters or those who occupied without paying rent

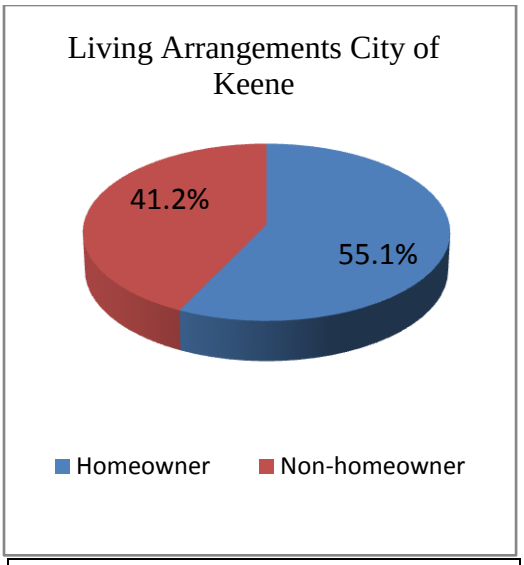

Figure 11: Living Arrangements City of Keene

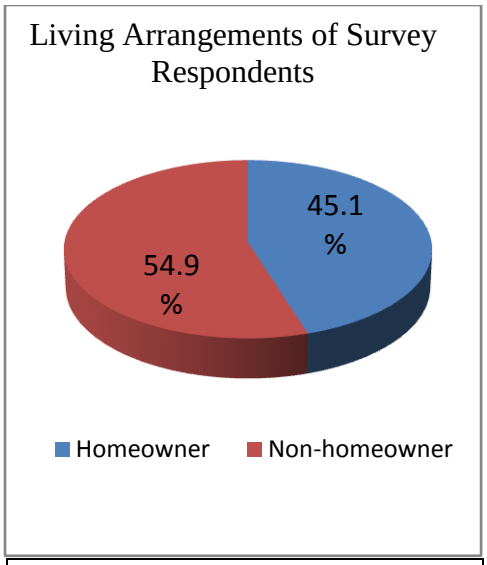

Figure 12: Living Arrangements of Survey Respondents

In our analysis we tested for two hypotheses. Our first hypothesis stated in the null is: There is no difference between homeowners and non-homeowners in their willingness to participate in the Tree City USA Program in Keene. Two close-ended questions and one Likert Scale question applied to our first hypothesis. Survey respondents ranked the Likert Scale statements from strongly disagree, (1) to strongly agree, (5), with a neutral possibility, (3). The close-ended questions that pertained to our first hypothesis were: would you be willing to have a city-owned tree planted on your property, and would you be willing to contribute funds to the Tree City USA Program in Keene. Table 1 shows an overwhelming majority of respondents (70%) stated they would be willing to have a city-owned tree planted on their property.

Table 1 : Would you be willing to have a city-owned tree planted on your property?

Response	**Homeowners**		**Non-Homeowners**		**Total**
	#	%	#	%	#
No response	0	0	3	4%	3
Yes	48	70%	57	68%	105
No	18	26%	23	27%	41
Unsure	3	4%	1	1%	4
Total	*69*	*100%*	*84*	*100%*	*153*

We next looked at a statement from our Likert Scale section of the survey. A Likert Scale is a way of quantifying the response towards a statement when provided a range of responses. Our Likert Scale needed to be codified like the previous two questions analyzed. The scale was no response (0), strongly disagree (1), disagree (2), neutral/don't know (3), agree (4), and strongly agree (5). Table 2 showed the frequencies, in percent, of responses by homeowners and non-homeowners to their willingness to monitor tree conditions on or near their place of residence.

Table 2: I would be willing to monitor tree conditions on or near my place of residence.

Response	Homeowners	Non-homeowners	Total
No response	0%	1.2%	1
Strongly disagree	1.4%	3.6%	4
Disagree	7.2%	11.9%	15
Neutral/Don't know	23.2%	33.3%	44
Agree	36.2%	32.1%	52
Strongly agree	31.9%	17.9%	37

Our second hypothesis in the null states: Keene residents feel trees are not an important part of the City of Keene. The Likert Scale section of our survey provided four statements directly addressing this hypothesis: 1) Trees are an important part of Keene's landscape; 2) Trees are essential to the city's ecosystem; 3) Trees are an attractive part of the City of Keene; 4) Trees add to property values in Keene. Again, survey respondents rated the statements in one of five categories ranging from strongly disagree, 1, to strongly agree, 5. Table 3 shows the frequency and percentages of respondents' answers to our statements.

Table 3: Keene Residents Value of City Trees

	Number of Respondents and Percentage of Total							
Response	Trees are an important part of Keene's landscape		Trees are essential to the city's ecosystem		Trees are an attractive part of the City of Keene		Trees add to property value in Keene	
	#	%	#	%	#	%	#	%
Strongly Disagree	4	2.60%	5	3.30%	4	2.60%	3	1.90%
Disagree	2	1.30%	1	0.70%	2	1.30%	9	5.80%
Neutral	2	1.30%	8	5.20%	5	3.30%	31	20.20%
Agree	47	30.70%	44	28.70%	39	25.50%	46	30%
Strongly Agree	98	64.10%	95	62.10%	103	67.20%	64	42.10%

Of the one hundred forty-five of the one hundred fifty-three respondents, 94.8 percent, agreed or strongly agreed with the statement: Trees are an important part of Keene's landscape. One hundred thirty-nine of the respondents, 90.8 percent, agreed or strongly agreed with the statement: Trees are essential to the city's ecosystem. One hundred forty-two respondents, 92.8 percent, agreed or strongly agreed with the statement: Trees are an attractive part of the City of

Keene. One hundred ten respondents, 71.9 percent, agreed or strongly agreed with the statement: Trees add to property values in Keene.

Each respondent may have varying views among the Likert Scale, and we cannot assume because the respondent answered strongly agree on one question that they strongly agree with our hypothesis. For that reason, we had to look at the data a little differently. As previously stated, a respondent could potential answer strongly disagree on the first statement, disagree on the second, neutral on the third, and so on, so we needed to take every possible scenario into account. A respondent has five responses for the four statements, so we had to look at the possible responses out of 765 because each response is independent of each other.

We then tested our second hypothesis by focusing on the percentage of respondents who answered disagree or strongly disagree to the statements. The percentage was calculated by taking the frequency, dividing it by 765, and then multiplied by one hundred. The resulting percentages are shown in Table 10. We then added the percentages of disagree and strongly disagree to find how many residents feel that trees are not an important part of the city of Keene.

Table 4: Percent of answers by respondents.

Answer	Frequency	Percent
No response	2	0.3%
Strongly disagree	27	3.5%
Disagree	20	2.6%
Neutral/ Don't know	81	10.6%
Agree	221	28.9%
Strongly Agree	414	54.1%

Once the percentages of disagree and strongly disagree are added together, we found that only 6.1% of Keene residents believe that trees are not an important part of the City of Keene while 83% agree they are. This leads us to conclude the null hypothesis should be rejected, thus

supporting that there was not a significant difference in the willingness to participate in the Tree City USA Program between homeowners and non-homeowners.

We assumed that the more time and resource a resident has vested in a place, the more likely they would be to take care of it. However, the only statement that showed statistically significant difference was in monitoring tree conditions which arguably requires the least amount of time and resources. This discrepancy with our logic could be due to the fact that the residents of Keene are not aware of Tree City USA, the City's involvement in the program, and the benefits of having trees on your property. As shown in Figure 13, only 34.6% of residents surveyed knew that Keene was a part of the Tree City USA Program. The second null hypothesis was disproven because of the extremely low percentage of people who disagree or strongly disagree with the five statements we analyzed. Only 6.1% of respondents felt that trees were not important to the city of Keene, based off of our four statements from the Likert scale.

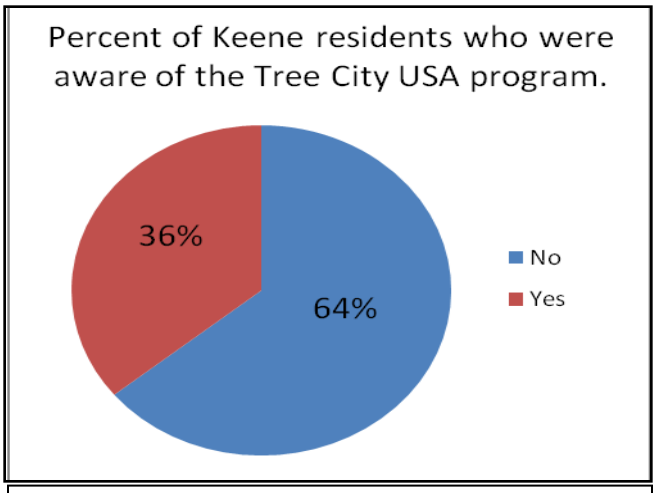

Figure 13: Awareness of Tree City USA

GIS Results

The results of our GIS analysis of the data collected on city-owned trees in our study area revealed a number of trends. When mapping the condition of the city trees, we found that many of the trees surveyed are in good condition. As noted in the previous chapter on field data collection methodology, the condition of the trees was evaluated based on several different features on or around the tree. Figure 14 shows the condition and location of all the trees in the

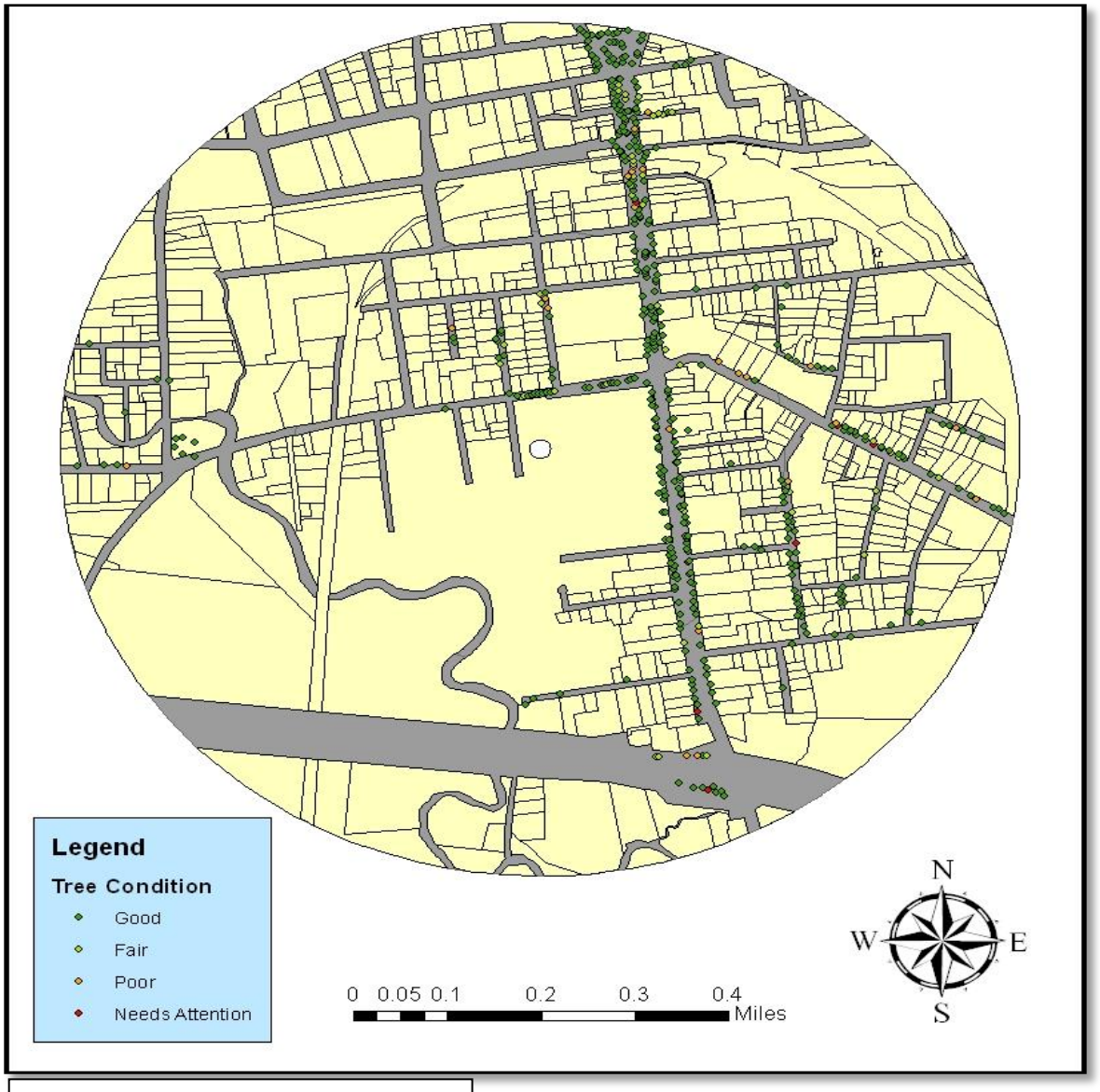

Figure 14: Map of Tree Condition

study area. We found that 82.7 percent of the trees were in good condition, 10.2 percent were in fair condition, 5.4 percent were in poor condition, and only 1.7 percent were found to be in immediate need of attention. However, the trees that are in fair condition, poor condition, or in need of attention were commonly found in clusters. The most notable cluster of trees identified as being in poor and fair condition was found on Main Street between West Street and Emerald Street. This cluster, which cannot clearly be seen in Figure 14, is more distinct at the larger scale used in Figure 15, which highlights the Main Street cluster of trees that are in poor and fair condition.

Figure 15: Close up of Trees in Poorer Condition on Main Street

In the area highlighted in Figure 14, there are a total of 90 city-owned trees. Of the 90 trees 29, or 32 percent, were found to be in fair condition, poor condition, or in need of attention. Within the same area, 11 of the 29 trees in less than good condition are Ash trees. All of the Ash trees in this area can be found in the median of Main Street. The correlation between the location of the trees in the median and their poorer condition is supported by previous studies

mentioned in the literature review. This study notes that trees in urban areas have often been found to not do well when planted in places with very little space. This is the case for median areas and sometimes for sidewalk areas. We found that of the 29 trees in fair or worse condition in Figure 15, 17 of them are planted in the median.

The second analysis that was completed on our data was to look at the tree species to find if there were any trends regarding their location. Table 5 shows the number of each tree

Table 5: Tree Species and Number of Each.

Species	Number
Ash	63
Cherry	3
Crab Apple	10
Elm	62
Linden	18
Maple	158
Oak	46
Pin Oak	9
Pine	1
Other:	93

Other:	**93**
Japanese Zelkova	*20*
Gingko	*8*
Bradford Pear	*30*

species documented in our study area. It can be noted that a few of the tree species were planted in groupings, as can be seen in Figure 16. In particular, the Japanese Zelkova trees, included in the category "other", are mainly found in the portion Main Street around the central square turning lane. In the center median on Main Street, all of the trees are either Liberty Elm or Ash.

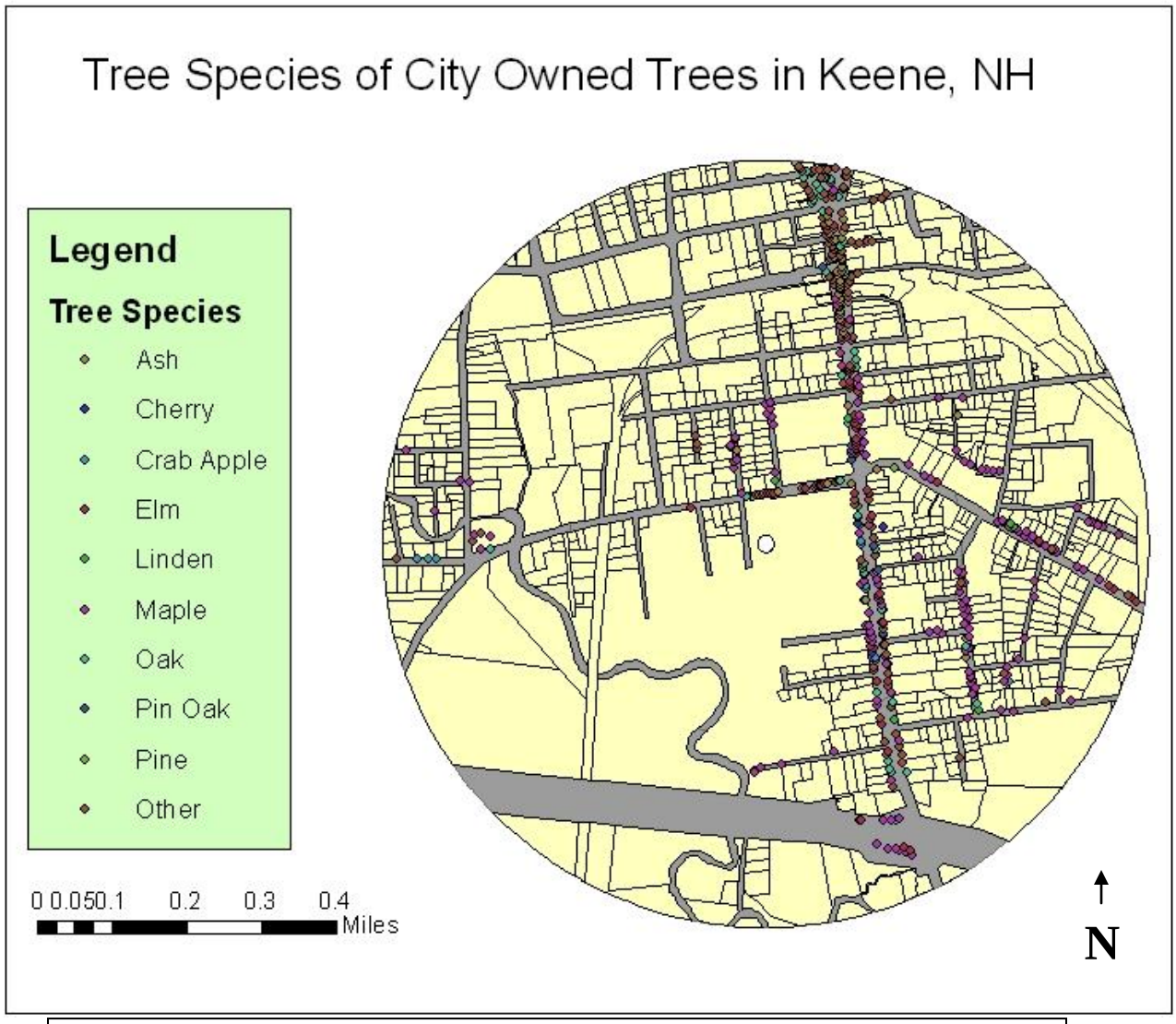

Figure 16: Tree Species of City-owned Trees in Keene, NH

Other collected data examined to determine if any trends existed, was the tree species and tree condition. It was found that seven of the twelve major varieties of tree species had 90 percent or more of their population in good condition. Three of the seven had 70 percent or less of their trees in good condition. In particular, Gingko trees only have 62.5 percent in the good category and have 25 percent in poor condition (Appendix B).

The data shows that even though Maples are the largest species in our study area, they are not in the best condition overall, with only 79.1 percent being in good condition. Another point to be made about the data is that the Ash trees have the highest percentage of their trees in fair

condition. Twenty-two percent of Ash trees are in fair condition, and only 68.3 percent are in good condition.

The third analysis examined tree condition and tree diameter. This analysis was completed through use of a bivariate map. Figure 17 highlights the Main Street area where a majority of the city-owned trees are located. This Figure shows no real relationship between tree

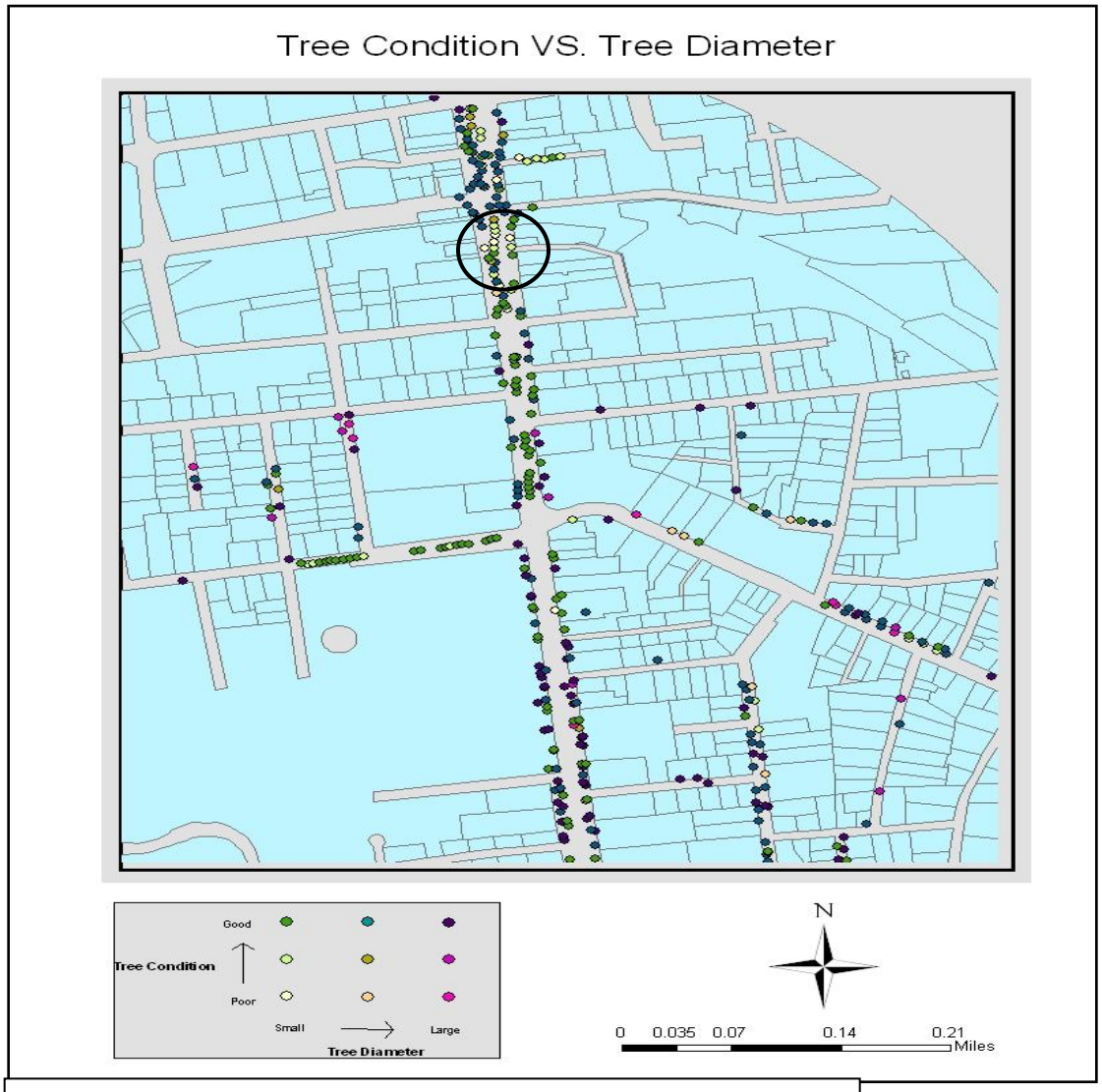

Figure 17: Map of Tree Condition vs. Tree Diameter

size and the condition of the tree. The tree diameters were broken up into three groups: small (1-10 inches); medium (11 – 18 inches); and large (19 - 90 inches). As noted before, there is a cluster of trees of small diameter in poorer condition on Main Street, where the circle symbol is located in Figure 17.

Table 12 below shows the data displayed in Figure 17 in numerical form. It is easier to see from the table that out of all the diameter groups, the smaller trees, from one inch to ten inches, were most likely to be rated in fair condition both based on percentage and number among the three categories. The data displayed in Table 12 below and in Figure 17 above also shows that over 75 percent of all the trees are in good condition. This information is especially important for the city officials to see to know that for the most part the city-owned trees in Keene are doing well.

Table 6: Tree Diameter vs. Tree Condition

	Tree Diameter					
	1" - 10"		**11" - 18"**		**19" +**	
Tree Condition	**#**	**% of Total**	**#**	**% of Total**	**#**	**% of Total**
Poor/Needs Attention	13	8%	10	6%	11	8%
Fair	26	15%	8	5%	12	9%
Good	129	77%	137	89%	117	83%
Total	168	100%	155	100%	140	100%

Based on diameter an analysis was used to determine other locations within the study area with a large number small or large diameter trees. The map below (Figure 18) shows the trees locations and the diameter category. With this map we found that there are two large clusters of small trees. One of the clusters is on the Main Street median from Emerald Street to the Winchester Street roundabout. The second is on Winchester Street from the Main Street roundabout to Blake Street. These trees have been planted in the past four years after new

construction completed on the Main Street roundabout plus the Winchester Street roadway. The City added trees to this roadway project to enhance the appearance and environment surrounding this busy section of Keene.

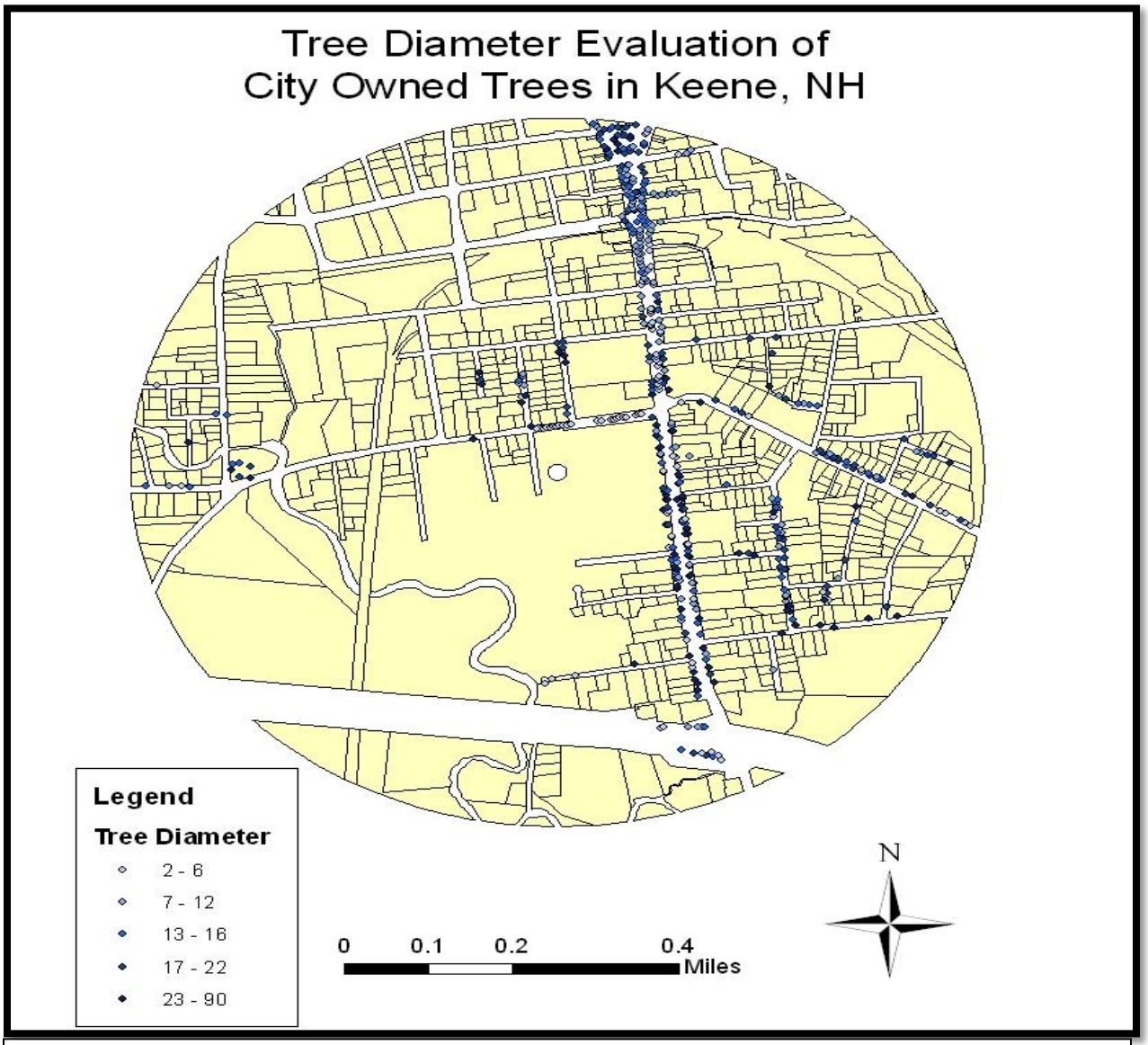

Figure 18: Tree Diameter Evaluation Map

When looking for patterns within the trees and their sizes it can be noted that of all the Ash trees in the study area, 63 total, only three are in the large diameter category, or have a diameter greater than 18 inches. Along with this, it is interesting to mention that within the past

three years many Ash trees have been planted in the medians of two major streets, Main Street and Winchester Street, around the Keene State College campus. On the other hand, Maples, the most numerous species in our study area, have 59 trees in the large category, making up 42 percent of all the large trees. Within the 158 maples found in our study area 33 percent of those were classified as having large diameters. All of our spatial analysis led us to some key conclusions about the city-owned trees in Keene, NH. It is important to note that within our study area there are a variety of tree species mostly found to be in good condition.

Conclusions

On September 16, 2010 Mayor Philip Dale Pregent endorsed the new Keene Comprehensive Master Plan. The Master Plan specifies six vision focus areas: a quality built environment, a unique natural environment, a vibrant economy, a strong citizenship and proactive leadership, a creative learning culture, and a healthy community. Our study can help in achieving success in four out of the six focus areas. Trees in the downtown region of Keene, NH create a feeling and setting that is unique and inviting. The historic buildings that line what was once the World's widest paved main street are complimented by the abundance of trees that surround them. Additionally, trees surrounding the Main Street business district provide a less urbanized environment for nearby residential neighborhoods.

Trees are the foundation of success in the areas of a quality built environment, a unique natural environment, a vibrant economy, and a healthy community, all noted goals in Keene's Master Plan. A quality built environment includes sustaining a vibrant downtown. The increased attention to tree conditions will assure a quality built environment. The second vision area focuses on a natural environment and specifically green infrastructure. The City has many green spaces that could be utilized more effectively than the present. This could be achieved by increasing the annual budget for tree planting and maintenance. A larger budget would make it possible for the city to plant new trees, and maintain their current ones efficiently. At the present time, maintenance is only done on trees if there is an immediate risk to public safety.

A vibrant economy closely relates to sustaining a vibrant downtown. The trees that attract more shoppers would increase the revenue of the businesses, potentially lowering the heating and cooling costs for local businesses. Public safety is essential to the health of a community. Increasing the number of city-owned trees lining roads could reduce the number of traffic accidents. Tree lined roads also reduce repaving costs because trees keep the surface

temperature down, keeping the oils in the asphalt from breaking down. The savings can be in the hundreds of thousands of dollars, per mile, over the life of the road. SOURCE

The 10% Challenge is an initiative created by ICLEI Local Governments for Sustainability. The goal of the initiative is to help businesses lower their green house gas emissions by a minimum of ten percent. Keene has been a member of the initiative since 2000, and the 10% Challenge is mentioned in Keene's Cities for Climate Protection Local Action Plan. One of the main ways this challenge is met is by lowering energy costs. As mentioned urban trees have the potential to lower the heating and cooling costs of buildings when placed within close proximity. This in turn lowers the need to produce and burn energy releasing carbon.

There are three key points that the City of Keene should focus on based on our study. We found that only a third of Keene residents surveyed knew that Keene was a member of the Tree City USA Program. Therefore, the City of Keene should increase its efforts to make the public aware of the Program. The City should dedicate a portion of their existing website to the Tree City USA Program so that residents can have more access to important information. Second as a result of this study, the city now has an updated and corrected database for city owned trees in which we completed our survey.

The next logical step is for the City to continue updating their records for the city-owned trees outside of our study area. Keene State College and Antioch New England Graduate School have studies that focus on geography and environmental studies. The City of Keene could train and encourage students and faculty at these institutes of higher learning to continue our groups work. The use of college students would keep costs low due to the field work being completed by volunteers. A third point for the City is a need to increase the annual funding for the Tree City USA Program in Keene to help build and sustain it into the future. Increasing the funding will be

difficult in these economic times; however, this new direction of tree management would allow the City of Keene to reach many of its goals for sustainability, vision focus areas in the Master Plan.

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Appendices

Appendix A

Thank you for participating in our survey! This survey is part of our Geography Senior Seminar project at Keene State College that we are working on with the City of Keene. As a group we are studying city-owned trees in Keene. It would be a great help to us if you would complete our brief survey. All of your answers are completely confidential.

1. Please indicate your gender:

☐ Male ☐ Female

2. How many years have you lived in Keene?

_____years _____months

3. Please indicate your living arrangement:

☐ Home owner ☐ Renter ☐ Occupy without paying rent

4. Please indicate your age:

☐ Under 18 ☐ 18 – 3 ☐ 35 – ☐ 55 ☐ 4 65+

5. Are you aware that Keene has been a member of the Tree City USA program?

☐ Yes ☐ No

Tree City USA is an urban tree program which helps to plant and care for inner city trees. It is sponsored by The National Arbor Day Foundation for cities and towns in the United

6. Would you be willing to have a city-owned tree planted on your property?

☐ Yes ☐ No

7. Do you know or think that a city-owned tree is planted on your property?

☐ Yes ☐ No ☐ Unsure

8. Would you be willing to contribute funds to the Tree City USA program in Keene?

☐ Yes ☐ No ☐ Unsure

Please rate how much you agree with each of the following statements:

Please continue on the back ⟹

	Strongly Disagree	Disagree	Neutral/ Don't Know	Agree	Strongly Agree
Trees are an important part of Keene's landscape.	☐	☐	☐	☐	☐
Trees are essential to the city's ecosystem.	☐	☐	☐	☐	☐
Trees are an attractive part of the City of Keene.	☐	☐	☐	☐	☐
I would/do enjoy planting trees on my property.	☐	☐	☐	☐	☐
Trees add to property value in Keene.	☐	☐	☐	☐	☐
I would be willing to monitor tree conditions on or near my place of residence.	☐	☐	☐	☐	☐

9. I am interested in learning more about the Tree City USA program in Keene.

☐ Yes ☐ No

If you are interested in learning more information about Tree City USA and this research project, please provide your mailing address so we may send you a one page summary at the conclusion of this project.

Mailing Address:_____

Thank you for your time and information!

Appendix B

Breakdown of Condition by Species			
Species	***Condition***	***Number***	***Percent***
Pine	Good	1	100
	Fair	0	0
	Poor	0	0
	Needs Attention	0	0
Pin Oak	Good	9	100
	Fair	0	0
	Poor	0	0
	Needs Attention	0	0
Miscellaneous	Good	33	94.4
	Fair	1	2.8
	Poor	1	2.8
	Needs Attention	0	0
Oak	Good	43	93.5
	Fair	3	6.5
	Poor	0	0
	Needs Attention	0	0
Elm	Good	56	90.3
	Fair	5	8.1
	Poor	1	1.6
	Needs Attention	0	0
Crab Apple	Good	9	90
	Fair	0	0
	Poor	1	10
	Needs Attention	0	0
Japanese Zelkova	Good	18	90
	Fair	1	5
	Poor	1	5
	Needs Attention	0	0

Bradford Pear	Good	26	86.7
	Fair	3	10
	Poor	1	3.3
	Needs Attention	0	0

Maple	Good	125	79.1
	Fair	14	8.9
	Poor	14	8.9
	Needs Attention	5	3.1
Ash	Good	43	68.3
	Fair	14	22.2
	Poor	4	6.3
	Needs Attention	1	1.6
Linden	Good	12	66.7
	Fair	4	22.2
	Poor	2	11.1
	Needs Attention	0	0
Gingko	Good	5	62.5
	Fair	1	12.5
	Poor	0	0
	Needs Attention	2	25

Appendix C

Tree Condition	Tree Species	Tree Diameter	Tree Description
Good	Maple	2	Norway
Good	Maple	15	ground hornets
Good	Elm	2	lace bark
Needs Attention	Maple	20	very bad condition
Good	Maple	2	multiple small ones
Good	Maple	20	Norway
Good	Elm	2	lace bark
Good	Maple	14	Sweiket Norway
Fair	Elm	5	
Fair	Elm	3	5 branches from trunk
Poor	Maple	9	
Good	Oak	5	Clusters of oak. 4 to 6 inches
Poor	Maple	7	
Fair	Maple	13	
Good	Other	16	honey locust
Needs Attention	Maple	25	carpenter ants bad Sugar
Good	Maple	4	
Good	Oak	25	red
Good	Oak	36	
Good	Oak	32	red
Good	Maple	3	
Good	Maple	3	red maple
Good	Other	20	white ash
Good	Oak	25	red
Good	Other	10	Bradford Pear
Good	Other	2	shad blow service berry
Good	Other	26	Yellow wood
Good	Maple	24	
Good	Elm	6	lace bark
Good	Other	15	green ash
Good	Other	25	white ash
Good	Maple	12	Norway maple
Good	Other	24	green ash
Good	Elm	3	lace bark
Good	Linden	14	
Good	Maple	24	

Fair	Other	20	white ash
Good	Maple	24	
Good	Maple	23	
Good	Linden	30	
Poor	Other	15	green ash
Good	Maple	12	Sugar
Good	Oak	15	
Fair	Oak	25	
Good	Other	28	Crimson king. check last tree
Good	Maple	16	red
Good	Maple	24	
Good	Maple	33	
Good	Maple	27	silver
Good	Oak	25	
Good	Maple	12	sugar maple
Good	Maple	22	crimson king
Good	Maple	24	
Good	Other	12	basswood
Good	Maple	12	Norway
Good	Crab Apple	2	
Good	Maple	24	Sugar
Good	Elm	7	lace bark
Good	Elm	6	Lacebark elm
Good	Maple	11	Norway
Good	Linden	8	10 trunks from 1 root
Good	Maple	10	10 leader 8-10inch
Good	Maple	22	Norway
Good	Other	2	Bradford Pear
Good	Other	14	basswood
Good	Maple	16	Norway
Good	Other	30	dog wood
Good	Maple	20	Sugar
Good	Other	70	walnut maybe leaves in 7
Good	Maple	20	
Good	Maple	11	red maple
Good	Maple	10	Sugar
Good	Maple	12	Sweiket Norway
Good	Maple	20	
Good	Ash	13	
Good	Crab Apple	8	
Good	Other	50	willow

Good	Other	28	green ash
Good	Cherry	15	
Good	Maple	15	Norway
Good	Maple	20	
Good	Elm	33	lace bark
Good	Maple	20	Norway
Good	Oak	21	
Good	Elm	70	
Needs Attention	Other	10	Green ash. bending power line
Good	Other	10	Walnut.
Good	Maple	8	Sugar
Fair	Maple	21	red
Good	Maple	15	
Good	Ash	15	green
Good	Maple	14	Sweiket Norway
Good	Maple	18	red
Good	Oak	24	
Good	Maple	24	Norway
Good	Oak	27	red oak
Good	Pin Oak	60	
Good	Maple	30	
Good	Maple	25	Norway
Good	Maple	20	Norway
Good	Other	14	green ash
Needs Attention	Maple	17	Norway fungus
Good	Maple	6	red
Good	Maple	15	
Good	Other	20	hanging groups of berries
Good	Maple	12	Norway
Good	Elm	5	
Good	Elm	4	lacebark
Good	Maple	22	Norway
Good	Maple	21	
Good	Maple	10	
Good	Maple	5	other type questionable
Good	Pin Oak	40	
Good	Oak	28	
Good	Maple	11	red
Good	Maple	13	Norway
Good	Maple	21	red

Good	Maple	30	
Good	Maple	18	red
Good	Elm	5	lacebark
Good	Other	40	Mountain Ash narrow
Good	Ash	21	green
Fair	Maple	7	Sugar 3 leader
Fair	Maple	14	
Fair	Maple	20	
Good	Elm	4	v crotch lacebark
Good	Maple	13	2 v crotches
Good	Other	20	basswood
Good	Elm	10	
Good	Elm	5	lacebark
Good	Maple	6	red
Poor	Elm	3	lacebark
Good	Crab Apple	5	
Good	Elm	33	lacebark
Good	Crab Apple	4	
Good	Elm	2	lacebark
Good	Maple	30	
Good	Maple	40	
Good	Maple	18	Norway
Fair	Maple	9	Sugar
Good	Other	13	honey locust
Good	Maple	18	Norway
Fair	Maple	26	red
Good	Maple	25	Norway
Good	Maple	20	Norway
Good	Maple	14	Norway
Good	Oak	30	
Good	Oak	30	red oak
Good	Maple	60	
Poor	Maple	13	Norway
Fair	Oak	25	
Good	Maple	12	Norway
Fair	Maple	24	Norway
Good	Pin Oak	40	
Good	Oak	24	
Good	Maple	20	in power lines Norway
Good	Oak	25	red oak
Good	Ash	16	white

Good	Other	20	green ash
Poor	Crab Apple	15	v crotch
Good	Other	14	
Good	Crab Apple	6	
Good	Crab Apple	8	v crotch
Good	Maple	15	Norway Sweiket
Good	Other	35	Mulberry
Good	Other	14	basswood
Good	Maple	16	Norway
Fair	Elm	7	lacebark
Good	Maple	16	
Good	Oak	47	
Good	Other	8	
Good	Oak	25	
Good	Maple	22	
Poor	Maple	17	Sugar
Good	Pin Oak	60	
Good	Maple	16	
Good	Crab Apple	3	
Fair	Elm	6	lacebark
Good	Crab Apple	3	dogwood
Good	Other	40	Bradford Pear
Good	Elm	6	
Needs Attention	Maple	19	
Good	Other	3	green ash
Good	Maple	22	Norway
Fair	Maple	20	
Good	Maple	13	
Good	Maple	16	
Good	Maple	23	Norway
Good	Maple	14	Sweiket Norway
Good	Maple	15	crims0N king Norway maple
Good	Other	13	honey locust
Good	Maple	14	
Good	Maple	18	Sugar
Good	Other	20	basswood 3 leader
Good	Maple	18	
Good	Maple	3	green ash
Good	Linden	20	
Good	Maple	18	

Good	Cherry	12	4 leader
Good	Other	14	3 leader
Poor	Other	3	green ash
Poor	Maple	20	Norway
Good	Crab Apple	4	multi crotched
Good	Linden	12	
Good	Cherry	10	
Needs Attention	Maple	20	
Good	Maple	11	
Good	Maple	10	
Good	Maple	12	
Poor	Maple	20	
Good	Elm	8	lacebark
Good	Pin Oak	90	
Good	Oak	30	
Good	Elm	10	
Good	Maple	24	Sugar
Good	Maple	18	Norway
Good	Elm	32	metal running through lacebark
Good	Linden	16	
Good	Other	30	
Good	Elm	60	
Poor	Linden	14	large split on trunk
Good	Other	10	maybe mulberry
Good	Other	25	dogwood
Fair	Ash	2	green
Fair	Oak	2	
Good	Oak	2	
Good	Elm	3	lacebark
Good	Ash	4	green
Good	Elm	3	lacebark
Good	Ash	4	green
Good	Maple	61	silver
Good	Elm	3	lacebark
Good	Elm	3	lacebark
Good	Elm	70	
Good	Elm	7	lacebark
Good	Elm	3	lacebark
Fair	Ash	2	green
Good	Elm	10	

Good	Ash	3	green
Good	Elm	3	lacebark
Good	Ash	4	green
Good	Elm	3	lacebark
Fair	Ash	3	green
Good	Elm	3	lacebark
Good	Elm	3	lacebark
Good	Ash	3	green
Good	Ash	21	green
Good	Elm	5	lacebark
Good	Elm	3	lacebark
Good	Maple	14	Norway
Good	Elm	4	lacebark
Good	Maple	13	Sugar
Good	Oak	2	
Good	Linden	15	v crotch 2 leader
Poor	Maple	17	Norway Sweiket
Poor	Maple	14	Norway
Good	Maple	17	Norway
Good	Maple	13	Norway
Good	Maple	16	Norway
Good	Maple	10	Norway
Poor	Maple	16	
Fair	Ash	4	green
Good	Pine	24	
Fair	Maple	28	
Poor	Maple	19	Norway
Good	Maple	18	Norway
Good	Other	2	Bradford Pear
Good	Maple	10	Norway
Good	Maple	51	silver
Good	Pin Oak	25	
Fair	Maple	30	Sugar loose branch
Good	Elm	3	American
Good	Maple	14	Norway
Good	Elm	3	lacebark
Good	Maple	35	red
Good	Pin Oak	17	
Fair	Ash	12	mo
Good	Maple	4	crimson king
Good	Other	32	Bradford Pear

Good	Elm	3	lacebark
Good	Maple	21	red
Good	Other	5	
Good	Pin Oak	18	
Good	Maple	16	Norway
Good	Elm	3	lacebark
Good	Other	17	Bradford Pear
Good	Elm	3	American
Good	Maple	28	red
Good	Maple	8	Norway
Good	Elm	3	lacebark
Good	Maple	11	Norway
Poor	Other	25	Bradford Pear
Good	Maple	10	Norway
Good	Elm	3	American
Good	Elm	3	lacebark
Good	Maple	23	Norway
Good	Oak	7	
Good	Elm	3	American
Good	Maple	21	silver
Good	Elm	3	lacebark
Good	Linden	17	
Poor	Maple	36	Norway
Good	Elm	3	lacebark
Good	Ash	18	mountain
Fair	Maple	20	red
Fair	Maple	28	Norway
Poor	Maple	21	Norway
Good	Ash	18	white
Fair	Maple	20	Norway
Good	Maple	19	
Good	Maple	10	Norway
Good	Other	20	shagbark
Good	Maple	19	Sugar
Good	Maple	20	red
Good	Maple	14	two large screws
Good	Other	3	Japanese Zelkova
Good	Elm	3	American
Good	Other	4	Japanese Zelkova
Good	Maple	8	six leader
Good	Elm	3	lacebark

Good	Elm	3	lacebark
Good	Other	10	Bradford Pear
Good	Elm	3	American
Good	Maple	10	
Good	Oak	22	
Good	Elm	3	American
Good	Elm	3	lacebark
Good	Oak	16	red oak
Good	Elm	3	not green ash
Good	Other	3	green ash
Good	Maple	12	Norway
Good	Oak	24	
Good	Maple	7	red
Good	Oak	16	
Good	Maple	3	red
Good	Maple	3	red
Good	Other	11	ginkgo
Good	Other	5	ginkgo
Needs Attention	Other	8	ginkgo
Good	Ash	10	green
Good	Ash	10	green
Good	Ash	11	green
Poor	Maple	16	
Fair	Other	8	ginkgo
Needs Attention	Other	8	ginkgo
Good	Maple	4	red
Good	Ash	12	green
Fair	Ash	9	green
Good	Ash	11	green
Good	Ash	11	green
Fair	Other	11	Japanese Zelkova
Good	Maple	9	red
Good	Ash	3	mountain
Good	Ash	10	green
Fair	Ash	10	green
Poor	Maple	10	Sugar
Fair	Other	5	Bradford Pear
Poor	Ash	9	green
Poor	Other	10	Japanese Zelkova
Poor	Ash	9	green

Fair	Ash	9	green
Good	Other	10	Japanese Zelkova
Good	Other	15	Japanese Zelkova
Fair	Ash	9	green
Good	Other	10	Bradford Pear
Fair	Ash	11	green
Good	Other	16	Bradford Pear
Good	Other	12	
Good	Other	12	Bradford Pear
Good	Other	15	Bradford Pear
Good	Oak	16	
Good	Other	8	
Good	Ash	16	green
Good	Oak	16	
Good	Oak	17	
Good	Other	13	Bradford Pear
Good	Pin Oak	12	
Good	Ash	15	green
Good	Oak	17	
Good	Other	9	
Fair	Ash	9	green
Good	Elm	16	siberian
Good	Ash	13	green
Good	Other	16	green ash
Good	Ash	12	green
Poor	Other	10	
Good	Other	12	Bradford Pear
Good	Other	15	Bradford Pear
Good	Other	11	Bradford Pear
Fair	Other	9	Bradford Pear
Good	Other	14	Bradford Pear
Good	Oak	12	
Fair	Other	8	Linden
Good	Other	14	ginkgo
Fair	Other	7	Linden
Fair	Other	8	Linden
Good	Other	7	Linden
Poor	Other	9	Linden
Good	Oak	16	
Good	Other	9	ginkgo
Fair	Other	7	Linden

Good	Other	10	Japanese Zelkova
Good	Ash	17	green
Good	Other	12	Japanese Zelkova
Good	Ash	14	green
Good	Other	8	ginkgo
Good	Other	10	green ash
Good	Ash	14	green
Good	Ash	13	green
Good	Elm	18	Siberian
Fair	Ash	9	green
Fair	Other	14	
Good	Other	8	Bradford Pear
Fair	Elm	10	
Good	Other	16	green ash
Fair	Ash	11	white
Good	Ash	21	green
Good	Other	15	green ash
Fair	Ash	12	white
Good	Other	17	Japanese Zelkova
Good	Oak	20	
Fair	Other	5	Bradford Pear
Good	Other	9	Bradford Pear
Good	Oak	20	
Good	Oak	16	
Good	Other	6	honey locust
Good	Other	21	honey locust
Good	Other	9	honey locust
Good	Oak	18	
Good	Other	16	Japanese Zelkova
Good	Other	21	honey locust
Good	Oak	34	red
Good	Other	9	honey locust
Good	Other	24	Japanese Zelkova
Good	Other	14	Bradford Pear
Good	Other	16	Bradford Pear
Good	Maple	12	
Good	Other	20	Japanese Zelkova
Good	Other	20	Japanese Zelkova
Good	Oak	33	
Good	Other	15	Japanese Zelkova
Good	Oak	24	

Good	Other	15	Japanese Zelkova
Good	Maple	20	Sugar
Good	Oak	59	
Good	Oak	14	
Good	Oak	17	
Good	Other	19	Bradford Pear
Good	Oak	20	
Good	Other	6	Bradford Pear
Good	Other	2	Bradford Pear
Good	Other	15	Japanese Zelkova
Good	Other	12	Bradford Pear
Good	Other	15	Japanese Zelkova
Good	Oak	22	
Good	Other	11	Linden
Good	Other	16	Bradford Pear
Good	Other	15	Japanese Zelkova
Good	Other	18	Bradford Pear
Good	Other	20	Japanese Zelkova
Good	Other	11	Linden
Good	Other	18	Japanese Zelkova
Good	Other	14	Linden