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Tree Inventory Report: SOMA District

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Portland State University 2014: Photo Courtesy of USDA

Portland State College Circa 1955: photo Courtesty of Army Corps of Engineers

INTRODUCTION: WHO WE ARE AND WHY WE ARE HERE

The SOMA tree inventory project was taken on by a group of fourteen students as a senior capstone at Portland State University, in September of 2015. Many of us came to this class with GiS background, however, there are others representing the diverse collection of studies offered at PSU, such as film, communication, and general sciences. Capstone courses are PSU's requirement for all seniors that allow each student to take part in helping those in the surrounding community, by providing a benefit to organizations in need of a large group of volunteers. Our capstone course was designed to impart the importance of street tree conservation by recording and cataloging the trees in downtown Portland surrounding the university. The information collected will provide a platform for the Instute of Sustainable Solutions to work with in their endeavors to improve the canopy, air quality, and reduce energy costs in the city of Portland.

This project will not end with us, but be continued for the years to come to ensure that Portland stays green, and the information on the many benefits of trees is made public. As a group, we accomplished a lot, but it is merely the beginning of what could be a never ending project. We managed to collect the genus, breast height diameter, condition, height restrictions, and location of nearly every tree in downtown Portland. As a group we experienced a few set-backs, which will be discussed later but the data which remained happened to be quite useful. Extrapolating maps in the appendix, we can see areas low in tree density, diversity and quality, to help focus our energies in sustainability on the areas that need it most.

BRIEF HISTORY OF PUBLIC TREES IN PORTLAND

Portland, Oregon is known for its plentiful expanses of green infrastructure, public parks, and wonderful trees lining the city streets. Yet historically, Portland's origins are rooted in an effort of mass deforestation by early pioneers. The city's earliest settlers cut down trees to use as lumber for home building, as well as fuel for keeping warm during the cold winter. The first major community in the Portland area was referred colloquially to as Stumptown, for the masses of trees that were chopped down in order to allow for its development. The settlers stripped downtown of its trees, as well as the neighboring West Hills.

The first known effort toward restoration was the planting of the Park Blocks in 1871, with elms being planted in two lines stretching the length of the young city (Friends of Trees, 2009). It was also in this year that Washington Park was developed, with exotic species from other regions being planted alongside native ones. As the 1800s came to a close, the people of Portland had planted street trees along familiar downtown stretches, such as Jefferson and 6th Avenue.

However, as the 20th century began, the advent of the automobile came to town and worked to greatly change the makeup of the town again. With an increasing demand to widen streets to accommodate the cars, trees were once again cut down. Downtown Portland rapidly turned from green to grey. The Oregonian characterized Portland during this time as "the most filthy city in the Northern States," (MacColl, 1976) due to unclean sewers and gutters, and faulty sidewalks. It gained a reputation a tough and dangerous city populated with saloons and bordellos. In the early 1900s, Portland was known more for crime and corruption than progressivism and environmentalism.

A shift began to take hold around the 1960's, as in many parts of the country, hippie culture began to shake up current institutions and allow for new ideas to emerge. During this period, inspired by southerly neighbor San Francisco, initiatives for socially conscious movements began growing in Portland for civil rights movements for African Americans and Native Americans, and environmental efforts to better support the natural environment. In the 1970s, 5th and 6th avenues were lined with London Plane Trees and the City Forestry Division planted thousands of trees throughout the city. In the 1980s, a lack of funds stalled these tree planting efforts (Friends of Trees, 2009).

Friends of Trees was founded in 1989. This nonprofit organization assembles volunteers to plant street trees. They have planted thousands of trees in neighborhoods that are lacking in trees.

In 1993, the Portland City Council enacted the Heritage Tree Code. There are over 300 such designated trees in Portland (Hedberg, 2014). These trees are recognized for their exemplary size, age, and historical significance. These trees must have city approval before being removed.

At the beginning of 2015, the city enacted a new tree code called Title 11 Trees. This is a set of rules and regulations that apply to both commercial and private property owners regarding their planting or removing of trees. One main feature of the code is that any tree with a 12 inch or larger diameter that is to be removed must be replaced by a tree of equal diameter or trees that add up to that tree's diameter, or to pay the city what it would cost to plant a tree of equal size (Portland Tree Permit Series, 2014).

Clearly, Portland has gone a long way in prioritizing their efforts toward ensuring a lush and thriving urban tree canopy, one that can ensure a healthy and beautiful lifestyle for generations of Portlanders to come.

BENEFITS OF TREES

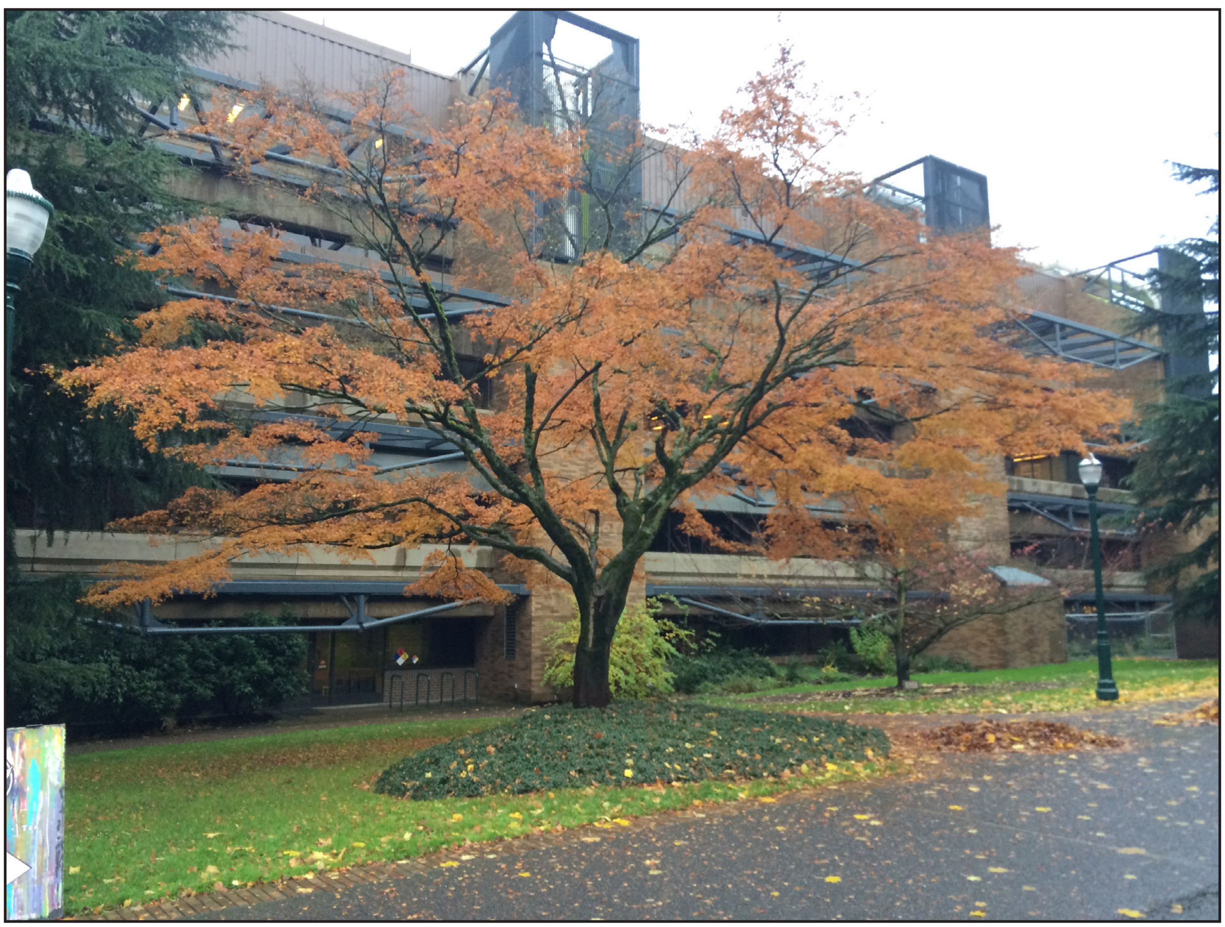
The Portland metropolitan area consists of 25 cities and three counties, and contains over half of Oregon's population (Population Research Center, 2011). Between 2010 and 2014, the metro area's population rose by 5.2 percent, the 20th fastest growth amongst major cities within the United States (Christensen, 2015). As the Portland metro area continues to grow, maintaining the city's infrastructure continues to be a challenge for urban developers. Preservation of the natural environment has long been a priority for state legislators, with bills such as the Senate Bill 100 in 1973 and the Oregon Resource Conservation Act in 1996 illustrating the state's commitment to environmental conservation. But with current estimates predicting that the Portland region will reach 3 million people in the next 20 years (Metro Research Center, 2014), it is prudent to acknowledge the role that nature preservation will play in the planning of our city's future.

Trees are intrinsic to the history of the Pacific Northwest, and lie at the very core of Portland's cultural identity. For over a century, Oregon's lumber industry was a primary component of the state's economy, and trees have since come to represent the region's preoccupation with outdoor activities and environmental activism. Besides being an important cultural symbol to the city, trees also provide integral services to urban areas such as rainwater and heat diversion, as well as carbon sequestration and the removal of other air pollutants (Page, Winston & Hunt, 2015; Sheng, Lu, & Huang, 2015; Chen, 2015; Nowak, Hirabayashi, Bodine & Greenfield, 2014). Additionally, the installation of trees can raise the value of housing properties (Mansfield, Pattanayak, McDow, McDonald & Halpin, 2005), reduce the cost of heating and cooling homes (Chen, 2015) and increase the attractiveness of urban areas. Summarily, trees are crucial for the balance of economic and environmental sustainability as well as the promotion of social wellbeing.

Coinciding with the rising population in the region, carbon emissions continue to increase in Portland's urban areas. Research has shown carbon dioxide emissions to be one of the largest contributors to global climate change, which is fast becoming the most important environmental issue of our lifetime. Trees planted in urban areas remove carbon dioxide from the air and store carbon in their biomass (Russo, Escobedo, Timilsina, Schmitt, Varela & Zerbe, 2014), offering a means of mitigating the effects of climate change through urban infrastructure. Additionally, trees have been shown to remove other toxic pollutants from the atmosphere (Nowak et al. 2014), as well as benefit urban microclimates by providing shade and blocking wind (Chen, 2015). By providing shade and shelter in urbanized areas, trees also stabilize energy and water processes and reduce the effects of urban heat islands, places where the thermal climate is warmer due to extensive urbanization (Sheng et al. 2015). For local watersheds, trees also play a crucial role in stormwater management. Trees prevent stormwater runoff by detaining water within the soil and roots, and increase water quality by filtering out pollutants found in runoff through tree root networks (Page et al. 2015).

While the environmental benefits of trees in urban areas are significant, they have also been found to provide countless economic benefits to urban areas. Planting trees on residential properties can increase property value anywhere from 1.9% to 7% (Mansfield et al. 2005), and can reduce the cost of energy in homes by providing insulation from the thermal climate (Chen, 2015). The shade and wind protection that trees provide decreases the need to cool buildings during the summer and the need to heat buildings in winter, and reduces the costs of stormwater treatment by preventing runoff from overloading storm drains (Page et al. 2015). According to the World Health Organization, air pollution is responsible for the mortality of seven million people around the world every year (2014). A recent study quantified the annual value of pollution removal of U.S. trees at $86 billion (Nowak et al. 2015). Studies have also been conducted to measure the impact of trees on personal motivation and physical activity. Researchers found that in 15 states affected by deforestation related to the emerald ash borer, the amount of deaths from cardiovascular and respiratory illnesses increased significantly (Donovan, Butry, Michael, Prestemon, Liebhold, Gatziolis & Mao, 2013). This correlation suggests that trees are a large motivator for physical activity, and provide mental health benefits in addition to reducing healthcare costs.

Further research backs up the claim that trees enhance psychological wellbeing. Medical researchers have found that hospital rooms with views of trees can increase the recovery rate of some patients and reduce their dependence on pain relieving medication (Ulrich, 1984). Other studies indicate that trees have the capability to reduce stress (Cimprich, & Ronis, 2003), increase concentration (Kuo, & Taylor, 2004), and even reduce property and violent crime (Kuo, & Sullivan, 2001). In a study of Chicago public housing conducted in 1998 (Kuo, Sullivan, Coley, & Brunson), buildings with more trees and grass were associated with larger community engagement and socialization amongst neighbors. When urban spaces interact with the natural environment, they become more attractive and encourage communities to spend more time outside and take better care of their properties. The results of this engagement are multifarious, with numerous benefits for mental health and community building.



FIELD METHODOLOGY

Trees data collection was conducted using the ESRI Collector application in the Fall of 2015. Trees inventoried include trees that are located in the public right-of-way and secured assess points across the Portland State University Campus.

Data Collected: Data collected included tree genus, condition, size (diameter at breast height), presence of overhead high voltage wires, Portland State University ownership, survey date, and the initials of the surveyor.

Tree Genus: Trees were identified to the genus of the tree. Examples of the variety of tree identified include *Acer, Alnus, Betula, Cedrus, Cornus, Pinus, Populas,Quercus, Taxus and Ulmus* (Not all encompassing list).

Tree Condition: Trees were rated as very poor, poor, fair, good, very good, and excellent. The general ratings depended on the current state of the tree; whether it was near the end of its life (very poor = dead tree).

Please refer to Street Tree Inventory Report: Downtown Neighborhood, Appendice A, for a more detailed explanation of how to classify tree conditions http://www.portlandoregon.gov/parks/article/469287.

Tree Size: Diameter at breast height (4.5' above ground) was measured with a diameter tape. Measurements where trees with branches forks or swell were taken lower on the tree. Trees with multiple stems were measured based on the largest stem at 4.5' above ground.

High voltage wires: The presence of voltage wires was recorded.

Tree ownership: If a tree was located on Portland State University property, or was the responsibility of the institution to maintain ownership was recorded: If ownership was questionable "other" was selected.

Last Update Date: The date that the tree was inventoried was recorded.

Last Editor: Initials of the surveyors were recorded

DATA COLLECTION METHODS

Students were grouped into teams of 2-3 members and assigned a 3-square block area. Once completed with this area, groups were reassigned to other areas. Groups were given a diameter tape, data entry sheets, tree identification documents, and tablets to record tree points.

Students with prior tree identification and inventory experience were also available to assist students with questions regarding tree identification. Accuracy was stressed and surveyers were instructed to apply asterisks(*) or come back to any point where they had questions. The collected data was later digitized in ArcGIS by Portland State students and faculty verified for accuracy based on uploaded pictures.

DATA PROCESSING METHODOLOGY

Background

i-Tree is a free software program created for urban forestry programs. The program was created by the USDA Forest Service in 2006 to help promote, manage, and advocate for urban forest through a benefit and analysis report. This report is able to take data from individual trees and quantify it into a monetary value to encourage groups from small communities to states to support urban forests. More information on i-Tree can be found at http://www.itreetools.org.

Process

The original data was collected through Collector, a free software program offered by ESRI. The data (i.e. genus, species, DBH, date recorded, tree condition) was then extrapolated from the attributes table as a .csv file and loaded into excel.

In Excel, the data was refined and formatted into a specific requirement for an i-Tree analysis. The majority of the time was spent labelling specie codes (provided by i-Tree) and formatting the columns to i-Tree requirements. Through Excel, the new file was saved as an .xlsx file to load into Microsoft Access.

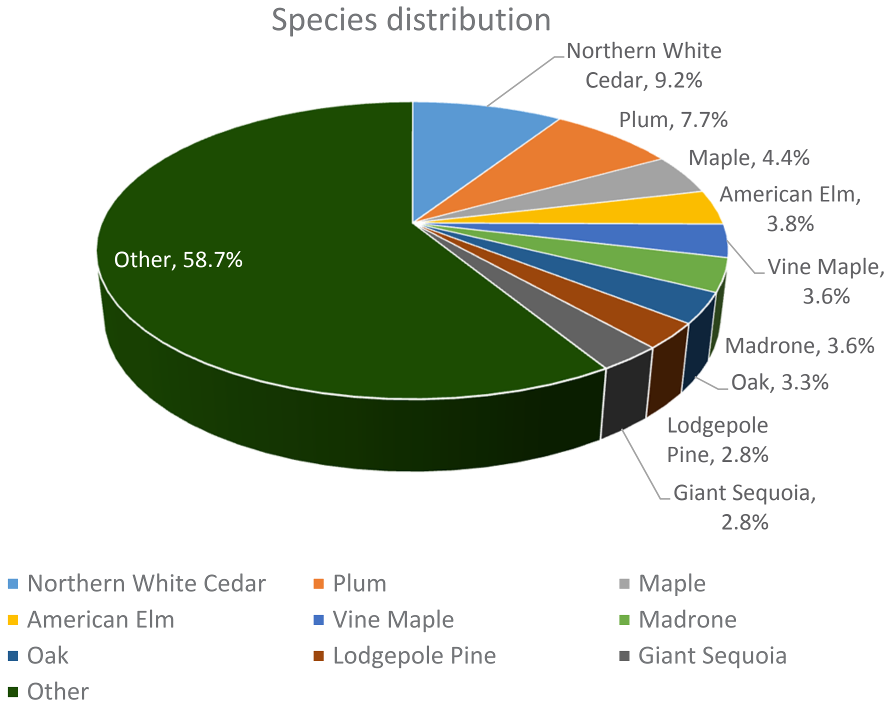
The data from Excel is processed into a Microsoft Access table for importing a streets-formatted inventory, compatible for the i-Tree software. Strictly speaking, this portion of the process was to change the file from an excel table to a Microsoft database file (.mdb) required for an i-Tree analysis.

The .mdb file was then loaded into the i-Tree software for an analysis. Before then analysis could begin, some trees had to be reclassified. This is due to the fact that i-tree recognizes trees native to the Pacific Northwest, while Portland has trees that are non-native to the region. After correcting these problem trees, a full analysis of our data ensued.

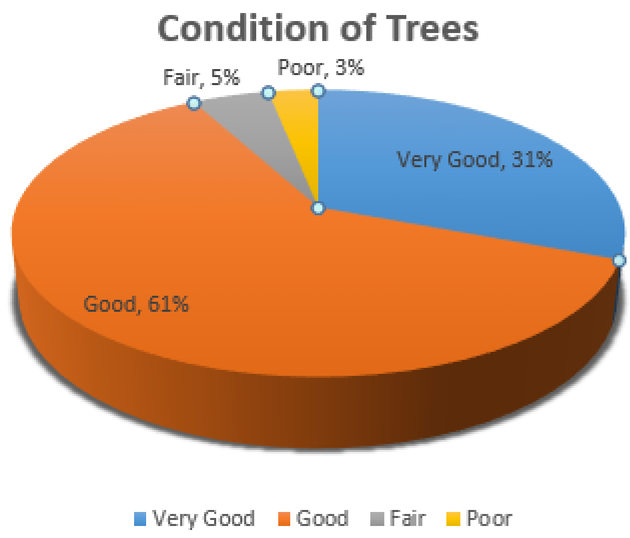
Results

There were three outputs of the i-tree inventory: annual benefits of public trees by species ($/tree), total annual benefits of all trees by species ($), and replacement value of all trees. The two benefit analysis provides a monetary value for each tree species by identifying how much energy they save, CO2 consumed, air quality, stormwater infiltration, and aesthetic/other. They total these amounts and give the percentage of each species within our defined area. The replacement cost table groups together each species into a specified DBH range. The output of each cell is the total cost to replace all trees that fall into the specified categories.

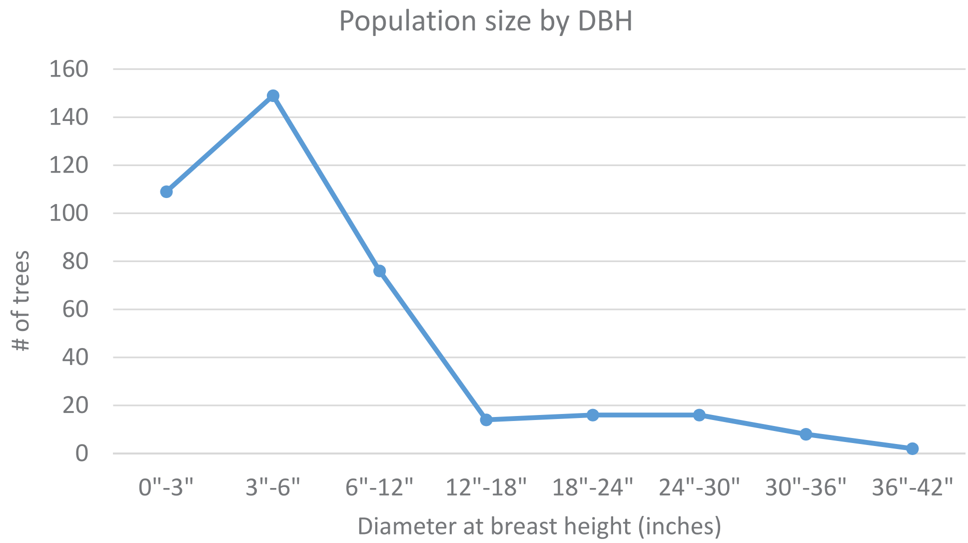
FINDINGS



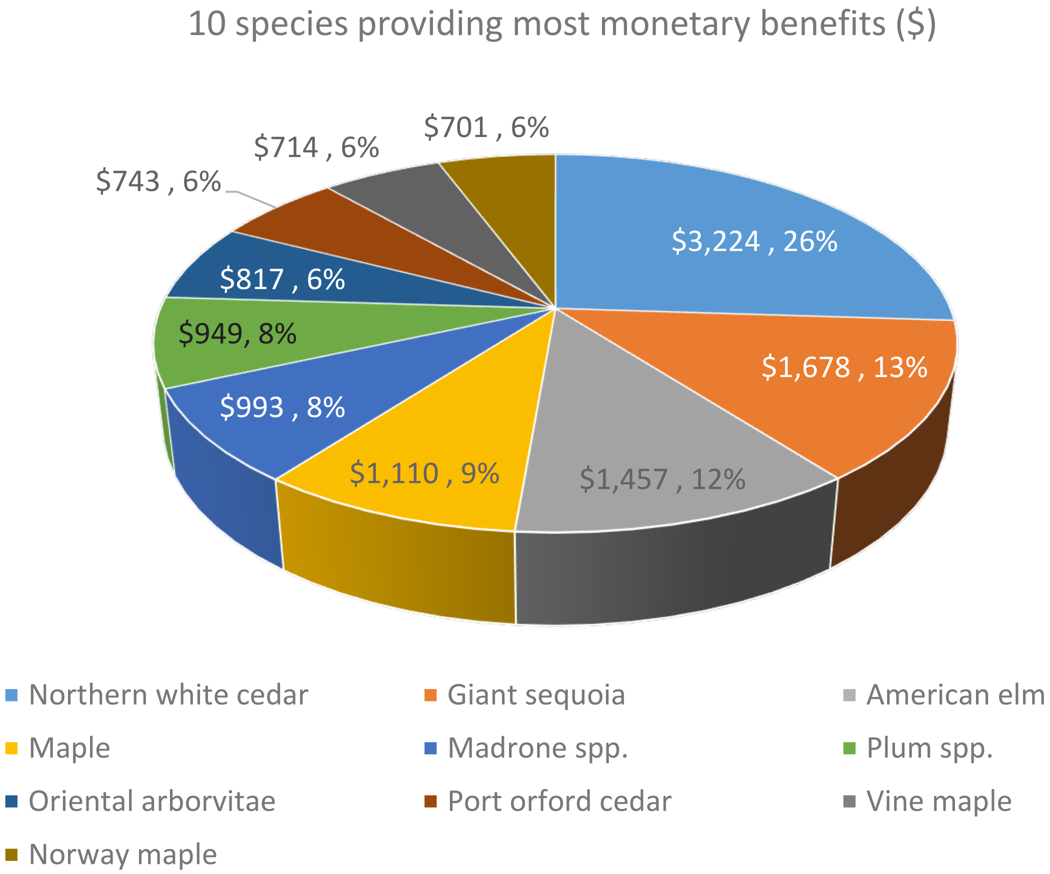
Species Distribution: Inputting data into i-Tree is a complex process that involves identifying each species with its corresponding species code provided by i-Tree. Problems occur with species identified in the field that are not within the software. This can be noted in the tree species distribution chart, as more than half (58.7%) output as "Other" species. From the data collected, there is no abundance of any one species. These percentages will change as the other half of campus trees will be collected in the spring of 2016.



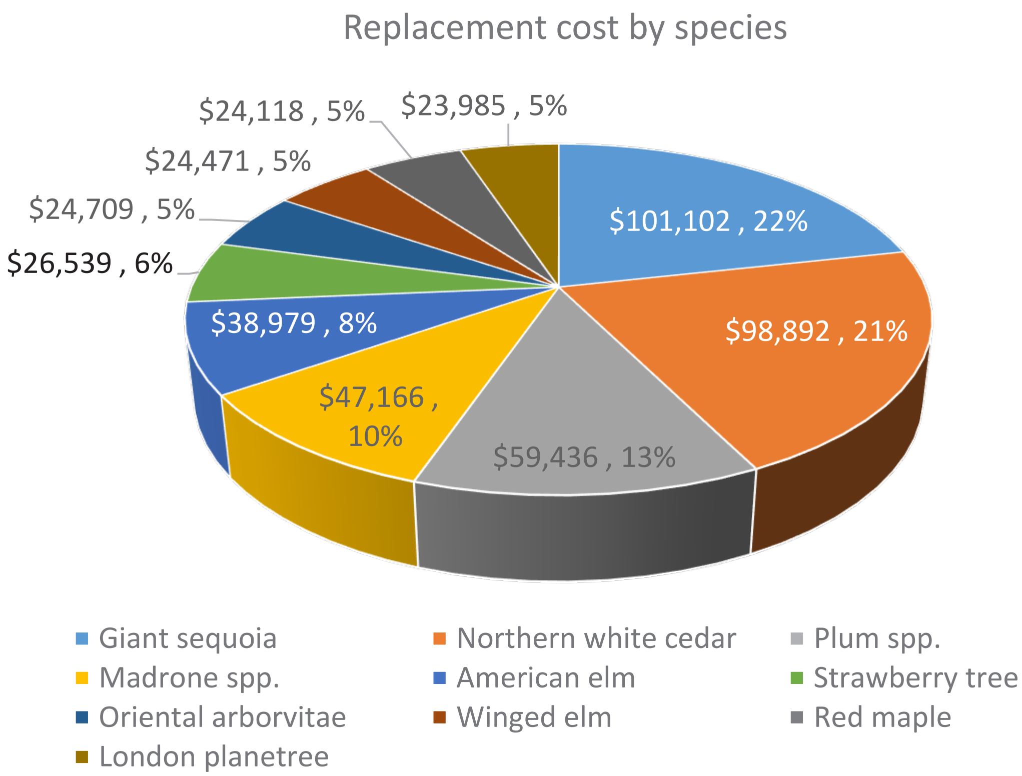
The state of Portland's canopy is in good health. The figure shows that a large majority (92%) are good or very good. A healthy canopy has been found have many positive effects on their surroundings such as filtering the air of pollutants, cool the climate, conserve energy, and increase property value.



The pie chart displays the average cost of replacing the top ten most expensive species. Certain species, such as Giant sequoias and Northern white cedar, are the most expensive than others to replace and should be those cost should be considered and prioritized when it comes to care and maintenance. With cost in the tens of thousands to a hundred thousand for replacement of each tree, careful evaluation should take place when performing cost-benefit analysis and deciding where and what trees to plant.



This figure depicts the monetary benefits to the PSU community from the 10 most valuable species. The northern white cedar accounts for 26% percent of the total value amongst the top 10 species.



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LESSONS LEARNED

Worked well

- The fieldwork section size of 3-4 blocks was very do-able.
- Non-technical backups (paper maps and pen and paper notations) of data turned out to be a good idea. Not all groups did this.
- Tree identification know-how for the groups that had experienced members, although students learned over time. The ID sheets that were available were helpful.

Not so well

- Group size. Three per team were too many; two worked best.
- Not requiring non-technical backup (drawings, printed maps) turned out to be a problem when ESRI's Collector Cloud service failed.
- Additional tree identification know-how and aids (The Book of Leaves, for example) helped some groups move a lot faster.
- Data was inconsistently collected in field; some left out important i-Tree inputs (DBH, condition, canopy).
- Photographs slowed down the process of data collection.
- Approximately 50% of the data that was collected couldn't be retrieved from Collector. In other words, the data was lost.
- The City of Portland's data of tree locations appear to be incorrect.
- ESRI Collector uses proprietary Geo-databases that can only be accessed by the origninal map file. As result if you lose your data or map file, you cannot sync or extract data.

Course Recommendations

- Data should be collected and uploaded or entered one block at a time.
- After each data collection session the data should be downloaded to avoid data loss.
- Because of the problems with ESRI's Collector, explore other data collection software/apps.

Tablet Benefits

- The larger screen size for location, zoom, photo attachment with Collector was beneficial and seemed to work better than the phones.

i-Tree Lessons Learned and Recommendation:
i-Tree's processes are complex and the data must be properly formatted in order to fit the criteria for correct output results. Some difficulties and challenges with i-Tree are:

- i-Tree does not use GPS location for each tree.
- i-Tree data output exported only as PDF or Rich-text.
- i-Tree is a software suite; we only focused on i-Tree Streets due to time constraints.
- Some specific species are not found within. i-Tree, so these were assigned monetary value at the rate of generic species.
- Data collected had to be classified into groupings, such as DBH.
- Output from i-Tree contained limited collection data due to missing inputs.
- such as location, canopy size, canopy shape, and health due to collection methods.
- Data input for an optimal output report became extensive and very specific.
- requiring exact i-Tree formatting.

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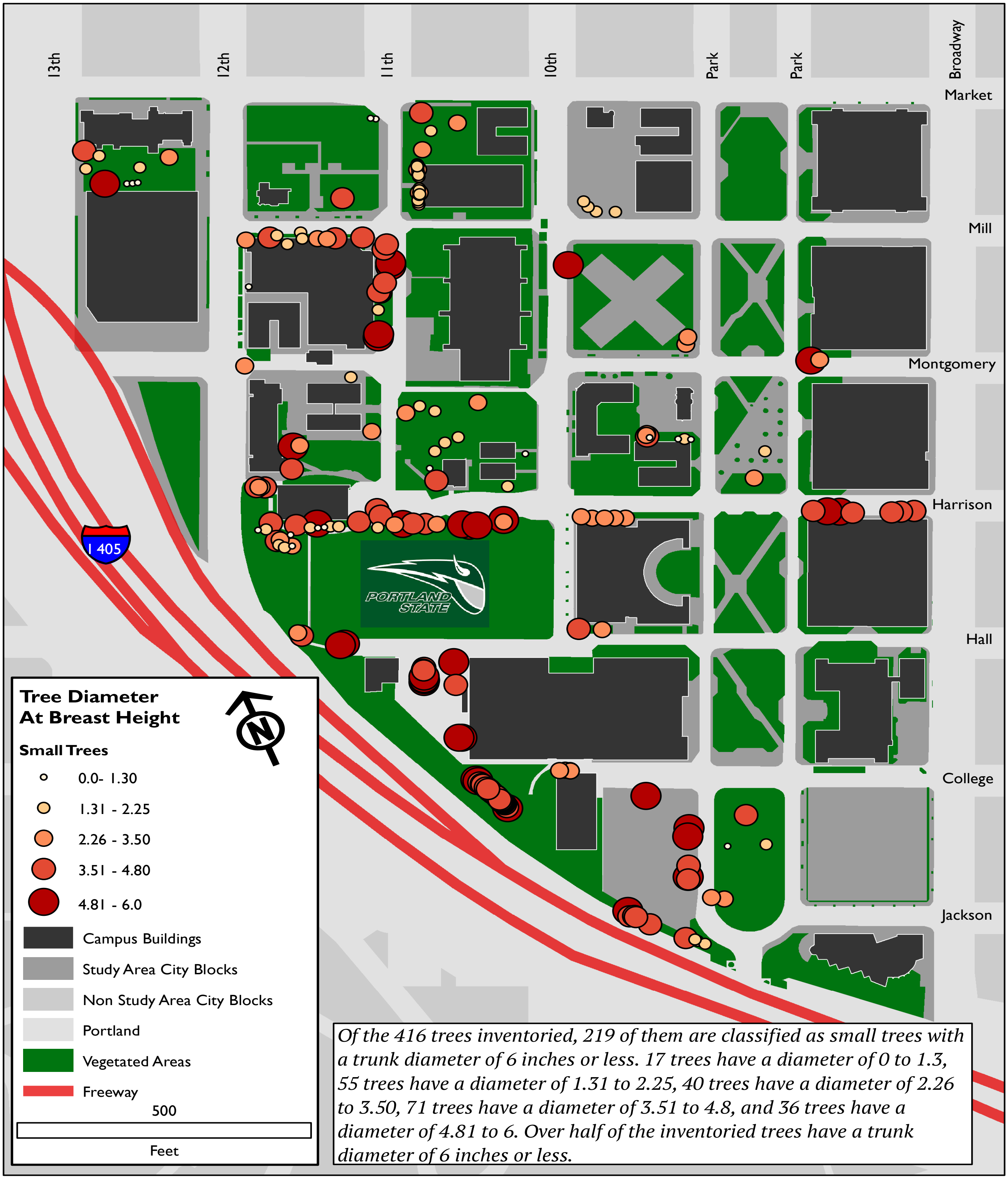
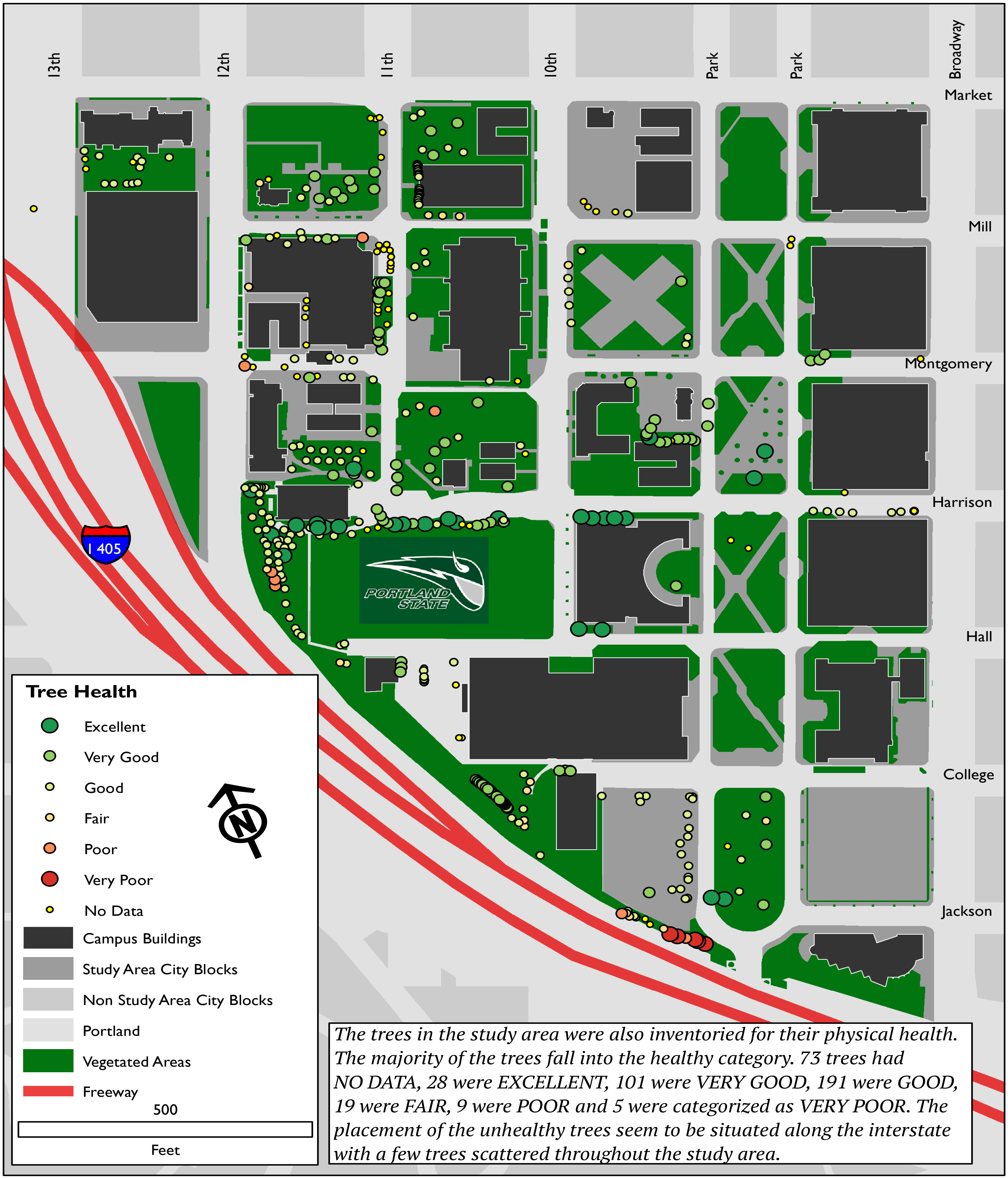
APPENDIX A: TOP TEN TREES



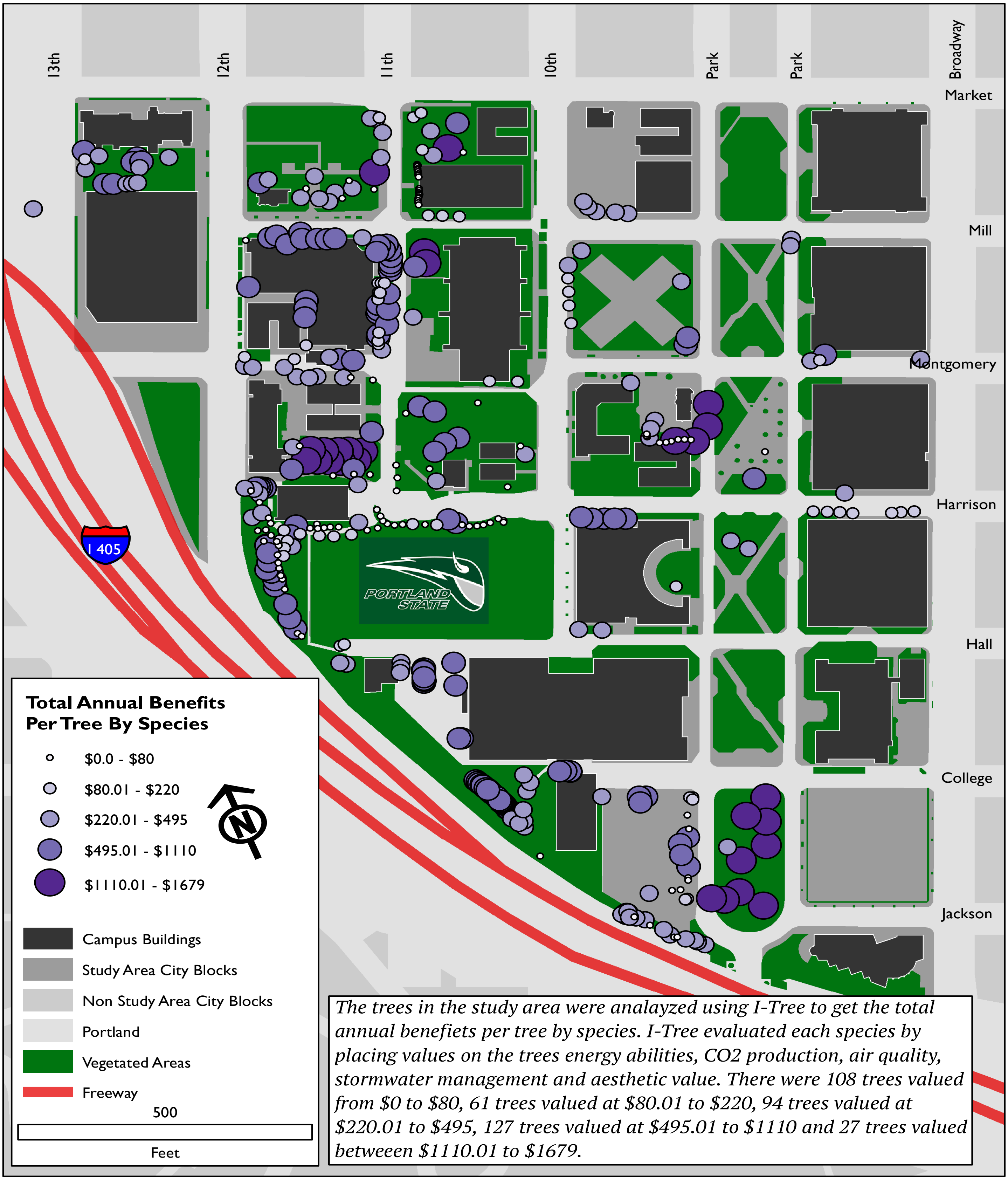
Of the 416 trees inventoried, 219 of them are classified as small trees with a trunk diameter of 6 inches or less. 17 trees have a diameter of 0 to 1.3, 55 trees have a diameter of 1.31 to 2.25, 40 trees have a diameter of 2.26 to 3.50, 71 trees have a diameter of 3.51 to 4.8, and 36 trees have a diameter of 4.81 to 6. Over half of the inventoried trees have a trunk diameter of 6 inches or less.

APPENDIX B: TREE HEALTH



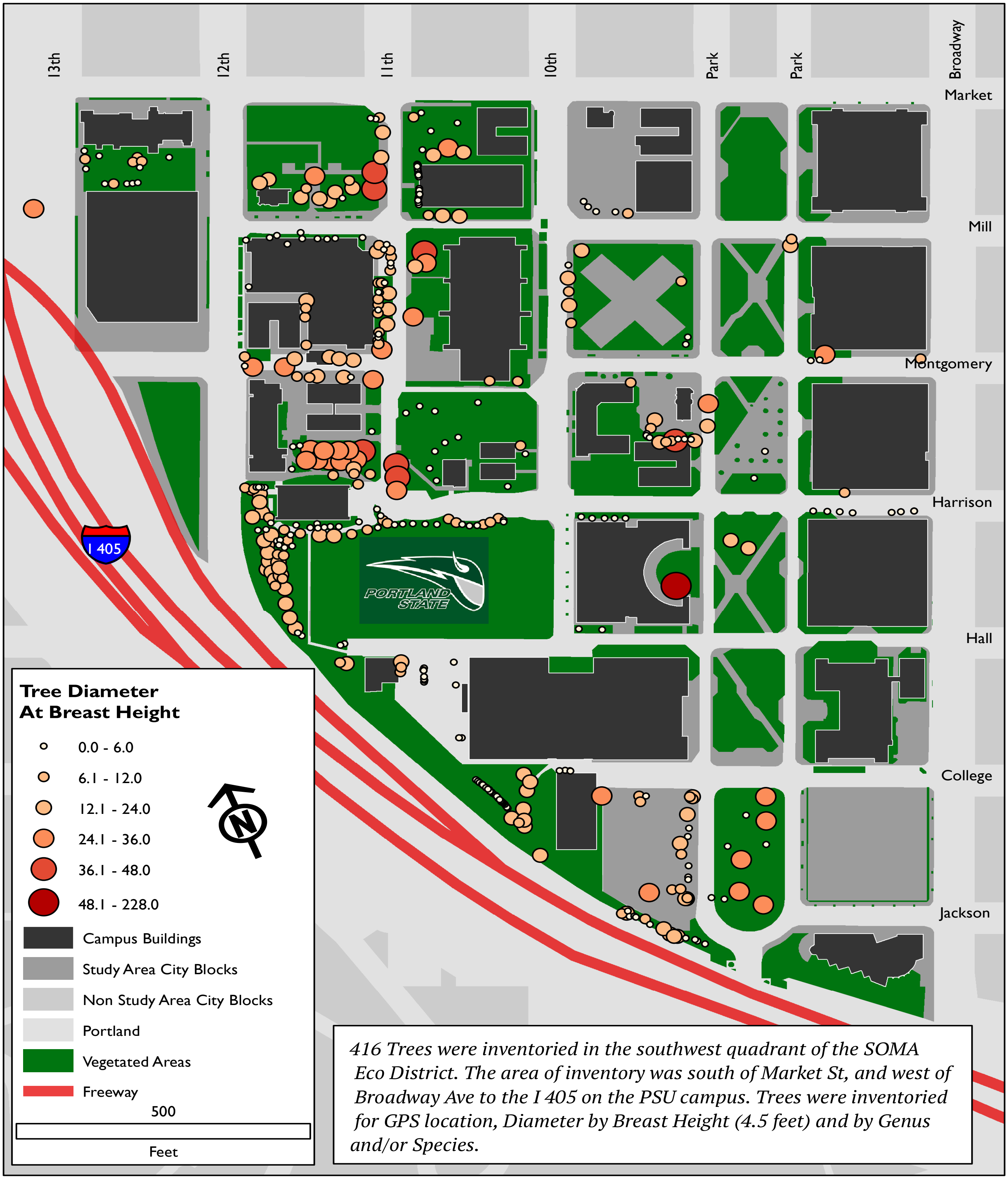
The trees in the study area were also inventoried for their physical health. The majority of the trees fall into the healthy category. 73 trees had NO DATA, 28 were EXCELLENT, 101 were VERY GOOD, 191 were GOOD, 19 were FAIR, 9 were POOR and 5 were categorized as VERY POOR. The placement of the unhealthy trees seem to be situated along the interstate with a few trees scattered throughout the study area.

APPENDIX C: ANNUAL BENEFITS



The trees in the study area were analayzed using I-Tree to get the total annual benefits per tree by species. I-Tree evaluated each species by placing values on the trees energy abilities, CO2 production, air quality, stormwater management and aesthetic value. There were 108 trees valued from $0 to $80, 61 trees valued at $80.01 to $220, 94 trees valued at $220.01 to $495, 127 trees valued at $495.01 to $1110 and 27 trees valued betweeen $1110.01 to $1679.

APPENDIX D: DIAMETER AT BREAST HEIGHT ALL

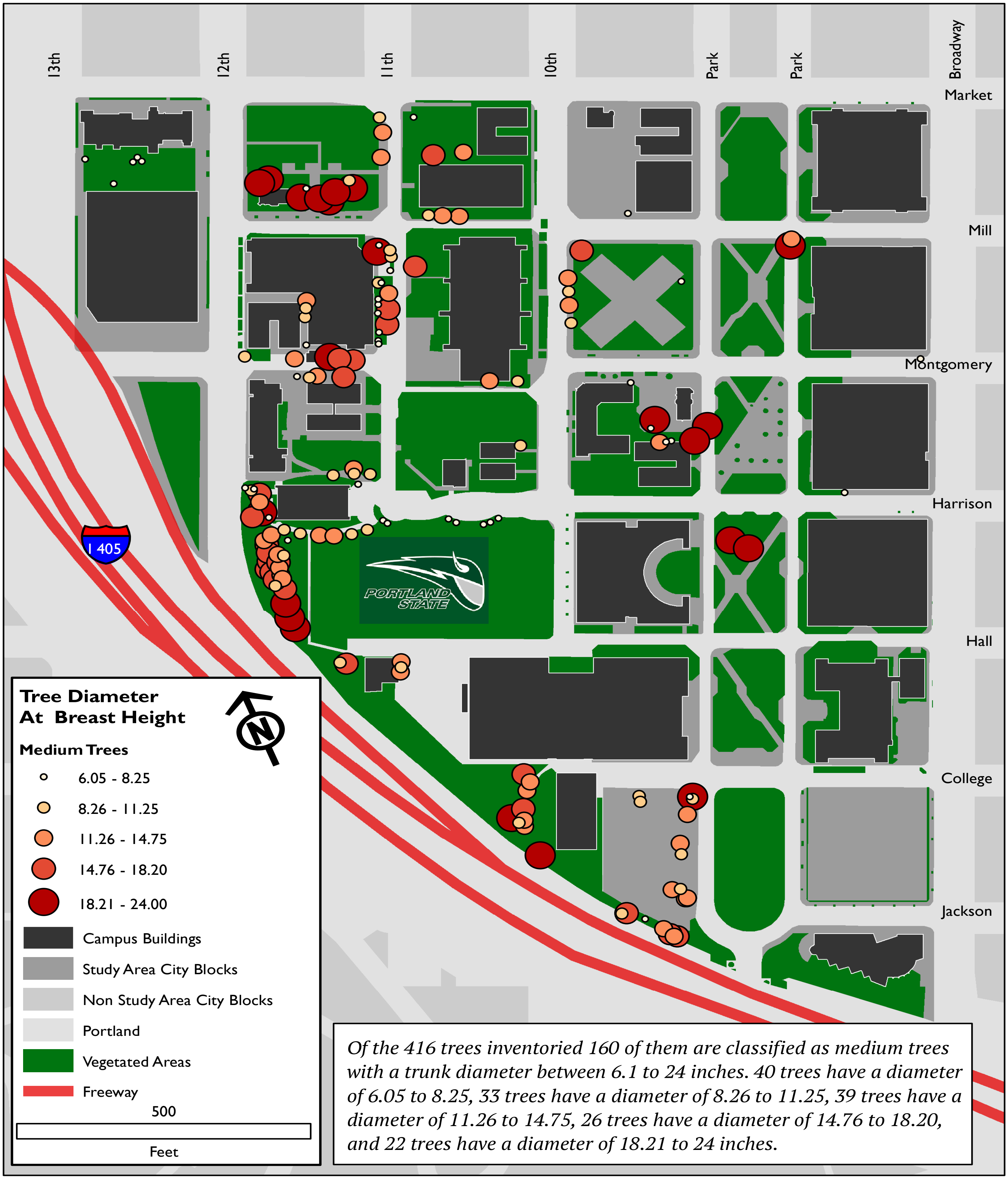


416 Trees were inventoried in the southwest quadrant of the SOMA Eco District. The area of inventory was south of Market St, and west of Broadway Ave to the I 405 on the PSU campus. Trees were inventoried for GPS location, Diameter by Breast Height (4.5 feet) and by Genus and/or Species.

APPENDIX E: DIAMETER AT BREAST HEIGHT SMALL

Of the 416 trees inventoried, 219 of them are classified as small trees with a trunk diameter of 6 inches or less. 17 trees have a diameter of 0 to 1.3, 55 trees have a diameter of 1.31 to 2.25, 40 trees have a diameter of 2.26 to 3.50, 71 trees have a diameter of 3.51 to 4.8, and 36 trees have a diameter of 4.81 to 6. Over half of the inventoried trees have a trunk diameter of 6 inches or less.

APPENDIX F: DIAMETER AT BREAST HEIGHT MEDIUM



Of the 416 trees inventoried 160 of them are classified as medium trees with a trunk diameter between 6.1 to 24 inches. 40 trees have a diameter of 6.05 to 8.25, 33 trees have a diameter of 8.26 to 11.25, 39 trees have a diameter of 11.26 to 14.75, 26 trees have a diameter of 14.76 to 18.20, and 22 trees have a diameter of 18.21 to 24 inches.

APPENDIX G: DIAMETER AT BREAST HEIGHT LARGE

Of the 416 trees inventoried 37 of them are classified as large trees with a trunk diameter between 24.1 to 228 inches. 5 trees have a diameter between 24.5 to 25.75, 9 trees have a diameter between 25.76 to 29.50, 13 trees have a diameter between 29.51 to 34.20, 9 trees have a diameter between 34.21 to 42.0, and 1 tree has a diameter of 228 inches.

APPENDIX H: SOMA TREE INVENTORY CHECHLIST

Pre-survey

Download the Collector application for Iphone or Andriod
Open application and login
Read ArcGIS Collector Application “collecting data”
Prepare maps of SOMA district: street map and satellite
Obtain tree inventory field guide
Learn how to collect tree points
Obtain measuring tape and any other required equipment

Conducting Survey

Begin survey at designated work site
Identify tree
Once identified, enter data into Collector application

Entries in collector

Tap for GPS location
Select genus of tree
Record trunk diameter
If applicable, select canopy shape of tree
If applicable, select if point has overhead wire
Select condition of tree
If applicable, select owned by
If applicable, select maintained by
Select date last updated
Provide surveyor’s name
Take photo of tree point
Synchronize data entries post day survey

APPENDIX I: COLLECTOR FOR IPHONE

Downloading Collector
Click into the Apple App Store and Download “Collector for ArcGIS” onto your devices

Log-in to Collector
Sign into ArcGIS application with Username and Password assigned by administrator

Download map on device

Choose your Work Area
Click on “Map detail” and select “download”.
Once the Map is downloaded you will be able to access it in a non-cellular or Wi-Fi area.
Making an Entry
To make an entry click icon
Required Recording data
DATE_INV
DBH
CONDITION
WIRES
COLLECTED_
GENUS
CreationDate??
EditDate??

APPENDIX J: TREE INVENTORY FIELD GUIDE

1. Identify Tree

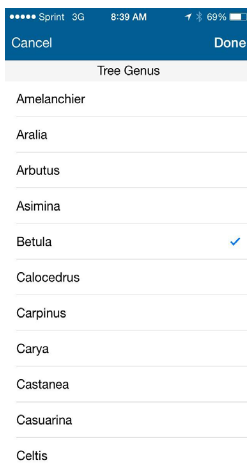
Use tree id resources on page __ to identify tree being inventoried

2. **Location and Adding tree plots**

Tap  while standing at tree plot to get the current GPS location then tap "add point" Icon . You may need to adjust location which you can do by pressing  after adding the tree point.

3. Enter genus of tree

In this field you will indicate the genus of the tree being inventoried. To do this tap " Tree Genus" and select the appropriate genus or write in.

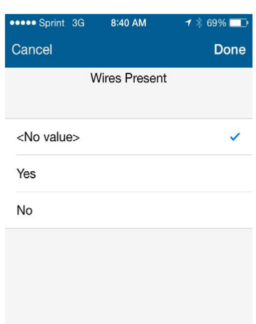


4. Measure trunk diameter

Enter trunk diameter at breast height (DBH). Diameter at Breast height is defined as the diameter of the tree at 4.5 feet above ground.

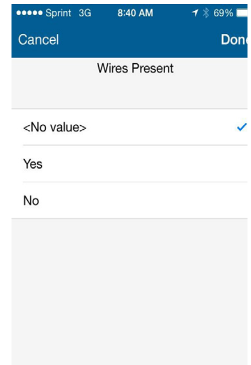
5. Are wires present

Annotate if wires cross over the top of the tree being inventoried.
Tap "wires present" select "yes" or "no"



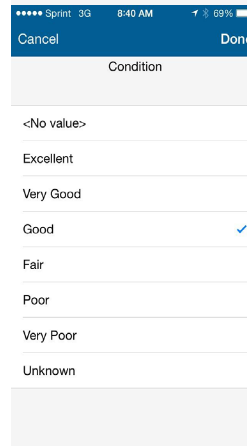
5. Are wires present

Annotate if wi s cross over the top of the tree being inventoried.
Tap "wires present" select "yes" or "no"



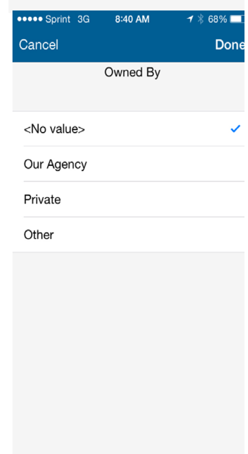
6. Condition

Assess the condition of the tree. Based on foliage and general knowledge of tree health annotate the condition by taping "condition" select from the options: unknown, very poor, poor, fair, good, very good, or excellent.



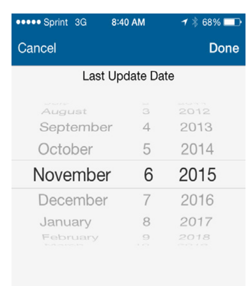
7. Owned by

Annotate in this field if the tree is owned by PSU by selecting "Our Agency". If unknown leave it blank. If owned by private companies tap "Private".



8. Tree update date

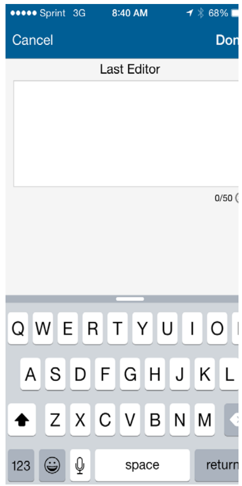
In this field select the date that the tree is being inventoried.



APPENDIX J:CONT.

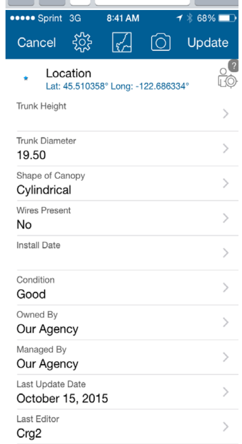
9. Last editor

In this field indicate the person's initials that is inventorying the tree.



10. Take a photo

To take a photo, select the photo icon . Choose "Take Photo or Video" Take picture using by turning device 90 degrees counter clockwise so it will be landscape style photo. After taking photo(s) tap "Done".



11. Submit entry

12. Sync entries

Select the "sync icon"