Reducing the Conflict between Trees and Overhead Utility Lines through Public Awareness and Education

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ABSTRACT

Trees in the built environment often have the potential to grow large enough to touch overhead utility lines, creating a dangerous interaction between the urban forest and utility infrastructure. The purpose of this project is to address the prevalent conflicts between urban forests and utility lines by raising awareness and educating the public of the seriousness of the conflicts and of the possible solutions to manage the conflicts. By creating additional resources that can be used to educate or spread awareness of the importance in preventing the conflict by planting trees of appropriate size and form, homeowners and utility companies could save money on regular tree pruning, tree removal, and costly infrastructure repair that is passed on to the consumer through increased electricity costs.

The first product of the project takes advantage of an established online horticultural and arboricultural community webpage, called Plants Map, where the full inventories of five Virginia "utility arboreta" have been uploaded. The utility arboreta were designed to illustrate appropriate trees to plant near and underneath utility lines. Previously, the arboreta displayed limited information on each tree. Plants Map allows visitors of the arboreta to use their smart phones to open a webpage displayed on plant tags that will be purchased for each tree. The second product is a newly written publication for Virginia Cooperative Extension that discusses the necessity for conflicting trees to be removed or pruned, that removing conflicting trees and replacing them with appropriate trees is typically the most cost effective solution, and that trees 25 feet or shorter in height at maturity are the most appropriate to plant underneath utility lines. These two products combine to provide the means for the general public to gain an appreciation of the dangers of tree and utility line conflicts and that planting small trees instead of large ones near utility lines has the potential to save significant amounts of money in future tree care.

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CHAPTER 1 – INTRODUCTION

The purpose of this project is to address the prevalent conflicts between urban forests and overhead utility lines by raising awareness and educating the public of the seriousness of the conflicts and of the possible solutions to manage the conflicts. Educating home and land owners of the environmental and economic issues caused by planting improperly sized trees underneath utility lines could result in a healthier, more sustainable urban forest and a more reliable, economically sustainable utility line infrastructure. Conflicts between trees and utility lines happen when trees grow too large and too close to utility lines, creating an electrocution and fire hazard in the immediate area of the conflict, as well as creating the potential for costly damage to utility infrastructure. Through increased awareness and education, home and other land owners will make better choices to plant trees of appropriate stature near utility lines, decreasing the number of conflicting trees and creating a more sustainable urban forest.

This project entailed creation of two products that both serve to raise awareness as well as educate the general public of the tree-utility conflict in distinct ways. The first product, to be discussed in Chapter 2, is an online resource called Plants Map that curates the five established utility arboreta in Virginia. These arboreta were specifically created by Virginia Tech Cooperative Extension and its partners to demonstrate trees compatible with overhead utility lines. Plants Map is an online community based on sharing horticultural and arboricultural plant collections with other users. By using this resource, the utility arboreta that were created to show visitors examples of trees compatible with utility lines will be able to reach a much greater audience, as well as supply them with previously unavailable information on each tree. The second product, to be presented in Chapter 3, is a major revision of the Virginia Cooperative Extension publication, “Trees and Shrubs for Overhead Utility Easements,” written by Dr.

Bonnie Appleton and published in 2009. Updating this publication will provide homeowners with a valuable resource for learning about the problems caused by conflicting trees and utility lines, as well as how they can help prevent conflicts through proper tree selection. Before describing these products further, we will first discuss the seriousness of tree-utility conflicts and demonstrate the importance of the goals of this project.

Trees that grow near utility lines are the leading cause of power outages, as well as a potential source of wildfires (Cieslewicz & Novembri, 2004). It is because of this that the Federal Energy Regulatory Commission (FERC) requires utility companies to manage vegetation near their utility lines to help prevent consumers from losing power (FERC, 2011). Especially in urban and suburban areas, vegetation management includes pruning or removing trees that were intentionally planted near utility lines without considering the inevitable conflict that would arise. In 2015, American Electric Power (AEP) spent $348 million for vegetation management across 11 states and 264,000 miles of transmission and distribution lines (AEP, 2016). While this cost includes managing naturally occurring forests and volunteer trees, it demonstrates the amount of resources utility companies are required to allocate to protect their assets and consumers' service reliability. Not only do conflicts between trees and lines cost utility companies millions of dollars in maintenance, the conflicts also degrade the health and functionality of the urban forest.

Urban forests provide many benefits, including air quality improvement, storm water mitigation, wildlife habitats, and increased property values (Nowak et al., 2010) Even proper pruning techniques required for trees that conflict with utility lines can stress a tree and decrease its ability to provide the full amount of its benefits (Bloniarz, 1995). Trees that are topped, an improper pruning technique, can require more frequent pruning by utility companies, a cost that

is often reflected in the rates paid by consumers. It is often better environmentally and economically to remove an improperly planted tree and replace it with a small, more appropriate tree that may never require regular pruning to maintain proper clearance from utility lines (Utility Arborist Association [UAA], 2016). To further limit the amount of overall pruning required, the best course of action is to ensure only appropriate trees are planted near and underneath utility lines.

Convincing homeowners that topping is not the appropriate method for clearing trees from utility lines can be difficult. A survey conducted in six cities found that respondents tended to greatly prefer the appearance of a topped tree to a directionally pruned tree and also assumed that topping was "better for the tree" (Kuhns & Reiter, 2007). This strongly suggests a lack of general knowledge on pruning to sustain tree health and structure. Because about 85% of tree-related outages are caused by tree failure (Guggenmoos, 2003), it should be considered an obvious priority to avoid pruning trees in such a way that the chance of failure is increased overtime. Kuhns & Reiter (2007) also found that many people distrusted utility pruners and slightly disagreed that removing large, offensive trees with small-maturing trees was a desirable practice. Even 55% of attendees of a 2002 arboriculture and urban forestry educator summit responded that utility line clearance was a "less important" topic (Elmendorf, Watson, & Lilly, 2005). In order for trees that conflict with utility lines to be managed, home owners, urban foresters, and utility companies must all be aware that there is a gap in the knowledge of the best practices for ensuring the sustainability of the urban forest and utility infrastructure.

Cooperation between utility companies and home owners to create a utility compatible urban forest is one of the more desirable scenarios possible for both parties, as suggested by Kuhns & Reiter (2007). By educating the public on what trees are acceptable to plant near utility

lines, millions of dollars could be saved on avoidable tree pruning and removal, as well as providing consumers a more reliable and less expensive service (Vogt, Hauer, & Burnell, 2015). The Arbor Day Foundation began the Tree Line USA Program to help achieve this goal, where utility companies can voluntarily meet certain standards to earn the designation as providers of reliable electrical services that co-exist with the urban forest (National Arbor Day Foundation, 2016). One of their core standards involves allocating 10 cents per consumer to tree planting and public education. Funds similar to this can be used in many useful ways including several major outreach programs in the country. The Utility Arborist Association is one of the foremost non-profit organizations in the country whose purpose is to enhance the practices of utility vegetation management companies (UAA, 2016). California Polytechnic State University's Urban Forest Ecosystems Institute (UFEI) helped create the SelecTree program, a robust online resource that explains the tree-utility conflict and provides a database of trees searchable by many species characteristics (UFEI, 2016). A third example is the creation of arboreta specifically designed and implemented to demonstrate trees that are compatible with utility lines, as suggested by Appleton (2006).

One of the first arboreta of this kind is at Virginia Tech's Hampton Roads Agricultural Research and Extension Center (AREC). The AREC arboretum was used as a proof of concept and led to the creation of other similar utility line arboreta around the state (Appleton, 2006). The goal of these arboreta is to increase public and municipal awareness of tree and utility conflicts and to identify appropriate trees for use near utility lines and subsequently increase their availability in the nursery trade. The AREC arboretum, as well as utility arboreta in Virginia Tech's Hahn Horticulture Garden, Veteran's Park in Abingdon, VA, Appalachian Power Office in Lynchburg, VA, and Jefferson Avenue in Charlottesville, VA originated through the efforts of

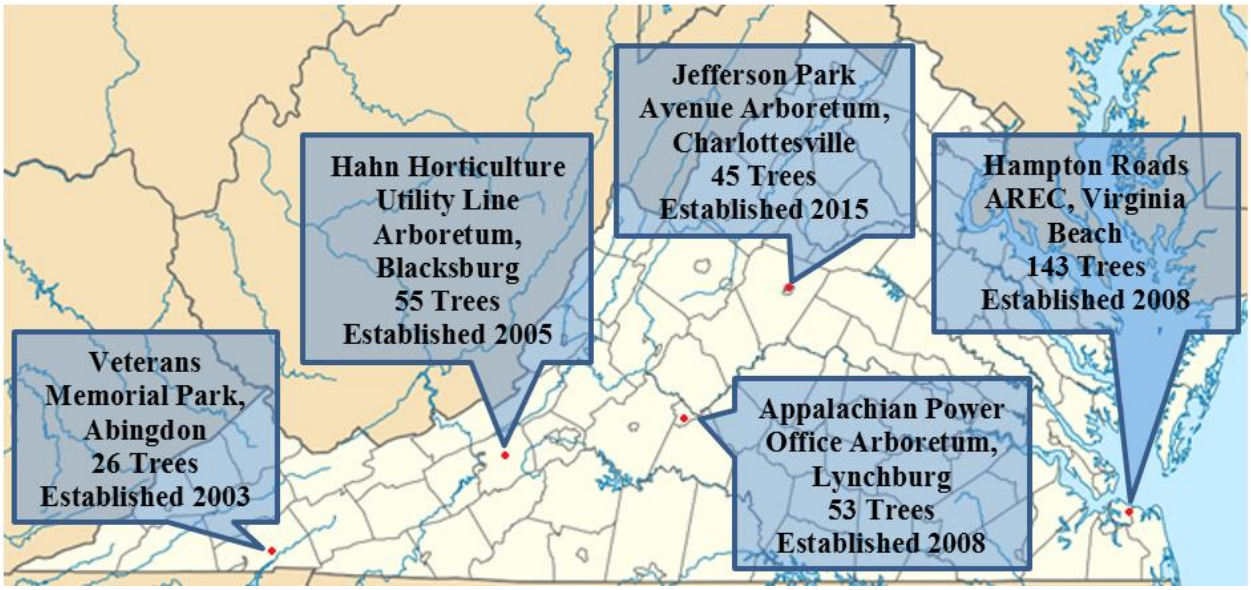

Figure 1: Location and information of the five utility arboreta in Virginia.

Look Up, Virginia!, "a consortium of arborists, horticulturists, urban foresters, urban forest scientists, and utility service providers" (Trees Virginia, 2016). Figure 1 shows that the arboreta were intentionally distributed across the state to enhance access by the public. The arboreta were originally established by a variety of different sponsors, including utility companies, municipalities, local tree steward organizations, and Virginia Cooperative Extension. They are currently maintained by municipal arborists, tree steward organizations, and volunteers from nearby communities.

For this project, the arboreta have been curated with Plants Map. This online media platform was chosen because of its ability to organize arboreta into searchable inventories that contain a depth of information for each specimen, as well as its ability to host photographs that show trees throughout the seasons (Plants Map, 2016). These details will be discussed in depth in the following chapter. Plants Map is an excellent resource to introduce the arboreta to those unable to physically visit them or for visitors to learn more about each specimen in the arboreta. However, the arboreta only address one facet of public outreach because they only show what is appropriate to plant; also needed is a resource that fully explains the importance of preventing

conflicts between trees and utility lines. To fill this educational gap, this project also involved the revision of a Virginia Cooperative Extension publication that explains the importance of the conflicts, the methods used to manage conflicts, and the importance of planting appropriate trees to prevent conflicts. This publication will be presented in Chapter 3.

CHAPTER 2 – PLANTS MAP

Introduction

The five utility arboreta that exist in Virginia represent a diverse collection of species and cultivars, over 300 specimens and about 190 unique species and cultivars. Most of these specimens have a tag on their trunk or on the ground. On the tags are the common and botanical names of the specimen, the planting date, and sometimes an inventory identification. In short, information at the arboreta is limited. *Plants Map* presents a solution to providing more complete and consistent information to visitors of the arboreta, while also providing a platform for public outreach and education to both visitors and the online community. The website is a community of arborists, horticulturists, organizations, homeowners and other groups and individuals interested in sharing their own collections of plants and exploring the collections of others. It was founded by Bill Blevins, Tracy Blevins, and Chris Muldrow in 2014 to create one of the first online social media networks based on interest in horticulture and arboriculture. Their original vision was to provide home owners and amateur gardeners to share their collections with other Plants Map users, as well as users of popular social media sites, such as Facebook, Twitter, Pinterest and Instagram. Plants Map closely resembles these popular social media sites by also allowing its users to "like" and subscribe others' collections, resulting in a higher velocity of information sharing than more static inventory resources. The origin of the name, "Plants Map", comes from its prominent feature of displaying a plants very precise physical location on an embedded Google Map for each specimen. The precision of the location is dependent on user input. One of the largest features of Plants Map is the ability for plant owners to share photographs of their plants and collections and include as much information as they want on the individual specimen, such as species growing details, specimen specific

information, and even the "story" of the plant. Once collections are uploaded into *Plants Map*, the website provides an opportunity to purchase plant tags that display the desired information from each plant's profile, including a QR code that allows visitors at the arboreta to use their smart phones to easily access the plant's profile on Plants Map. This allows visitors to have access to a much greater scope of information on the specimen than they would by only looking at a plant tag. The importance of this is so visitors know the details of species' traits and cultivation to ensure proper tree selection.

Figure 2: Example of a Plants Map plant tag with specimen names and QR code. Image taken from the Plants Map website.

Methods

Prior to this project, the information available for the specimens in each of the arboreta was limited to common and botanical names and their planting dates. Visitors lacked information essential to make informed decisions of which plants to purchase for certain planting sites. The first step to providing visitors a greater depth of information on each tree was to provide photographs of key characteristics of the trees for each season. This required me to visit each arboretum four times, from October 2015 to June 2016, to take photographs that depicted the species in the four seasons, as well as close-up pictures to show important identification features and assets of the trees. For each tree, I attempted to collect photographs of its overall form and appearance, a close up of its foliage, buds, bark and flowers (if applicable). When

possible, I used photographs of the same species or cultivars to fill in gaps of a specimen when inputting the photographs in Plants Map.

The next step was to organize specimen data and gather species data that was not available from the arboreta to enter it into each Plants Map specimen page. The main sources I used to collect data for each specimen were J. Frank Schmidt Nursery Fact Sheets (J. Frank Schmidt & Son Co., 2016), the University of Florida Northern Trees Database (University of Florida Institute of Food and Agriculture Sciences, 2016), and the University of Connecticut Plant Database (University of Connecticut College of Agriculture, Health, and Natural Resources, 2016). If there was a large discrepancy between the sources that could not be conservatively averaged, such as average height or spread, I referenced Dirr's *Manual of Woody Landscape Plants* (2009). ACME Mapper was used to map the coordinates of each tree in the arboreta, allowing the website to display an overview map of each tree's precise physical location. Because of time constraints, instead of creating a database to later enter into Plants Map, I entered the information into each specimen page as I researched it, working on one specimen at a time. Once completed, I was able to export a datasheet with the entirety of the information for every specimen as an offline archive.

Specimen Information

Plants Map is allows users to organize their collections in a logical manner. Each user has a "homepage" where they can display all of their collections. A visitor can choose to view a specific collection or all of the user's plants at once. Bill Blevins helped us create a main page for our Plants Map profile that allows us to have an "organization page" for Look Up, Virginia! (Appendix A). The page displays information on the organization, as well as a link to the Utility Friendly Trees website (utilityfriendlytrees.org) for additional material. From here, each

Table 1: Look Up, Virginia! Plants Map pages and URLs

Main Look Up, Virginia! Organization Page	http://www.plantsmap.com/organizations/452
Abingdon's Veterans Memorial Park	http://www.plantsmap.com/organizations/452/collections/30286
Charlottesville's Jefferson Park Avenue	http://www.plantsmap.com/organizations/452/collections/30706
Hahn Horticulture Garden	http://www.plantsmap.com/organizations/452/collections/30287
Hampton Roads AREC	http://www.plantsmap.com/organizations/452/collections/30285
Lynchburg's Appalachian Power Office	http://www.plantsmap.com/organizations/452/collections/30707

arboretum is separated into a distinct "collection" with its own background and contact information (Appendix B). Table 1 displays the name and URL of the organization page and each of the five arboreta. Individual trees can be accessed from the organization page, where every tree in the five arboreta is included in the list, or from each arboretum's collection page, where only the trees in the arboretum are listed. Each specimen has a unique URL and its own "profile page" that displays its information. Trees are sorted by their common names by default, but can be sorted by their botanical names if desired. Each tree profile first presents viewers with a photograph that best represents each specimen, taken at the arboretum (Appendix C). Additional photos of tree characteristics are assembled in a photo collage (Appendix E).

There is a section for each tree that displays "Plant Details" (Appendix D). This is a list of information that shows the taxonomy for each tree, whether it is a deciduous or evergreen tree or shrub, and the planting date of the tree. The taxonomy includes family, genus and species, as well as cultivar names or hybrid information when applicable. This section also provides external links if visitors are interested in learning more about a tree's characteristics and cultivation. The major three sources linked to were J. Frank Schmidt Nursery Fact Sheets, the University of Florida Northern Trees Database, and the University of Connecticut Plant

Database. Other sources were used when these sources lacked information. These were also the sources used to determine the information to include for each tree.

The "Growing Details" section includes information about cultivation of each tree. This information includes sun tolerance, soil characteristics, hardiness zone tolerance, average size at maturity, flowering information, seasonal foliage color, growth rate, and general tolerances. This information is enough for an average homeowner to make an informed decision on if the tree is desirable and if the tree is an appropriate choice for a planting site. There is a short entry for every tree that summarizes the important growing information, as well as suggested uses and if it is or is not an appropriate tree to plant underneath or near utility lines.

Plants Map provides the utility arboreta a way to interact with a much larger online community instead of only the people who visit them in person. The depth of information now provided will allow visitors to make much more informed decisions on trees they would later like to purchase. The next step of this project will be to purchase and install the tags for the trees in the arboreta that will be engraved with QR codes to finalize the link between the physical site and the online information.

CHAPTER 3 – VIRGINIA COOPERATIVE EXTENSION PUBLICATION: Trees and Overhead Utility Lines

Introduction

Trees and overhead utility lines tend to be placed in the same areas, such as in street medians, next to sidewalks, or maybe through someone's backyard. Both serve important purposes in communities, but too often a tree planted with good intentions ends up growing larger than expected and causes conflicts with utility lines. Planting trees that grow too large can damage utility lines and disrupt power delivery, forcing utility companies to remove or heavily prune the trees to safeguard the lines and their customers. In this publication, we examine the issue of tree and overhead utility line conflicts and offer advice about making good choices when planting trees near utility lines. First, we discuss the value of both trees and utility lines, the dangers created by trees that grow too close to lines, and the ways those trees are managed to keep the power flowing. We then discuss how to select trees that are appropriate for planting near utility lines and provide a list of tree species that are proven landscape performers and should not create conflicts with utility lines.

The Conflict between Trees and Utility Lines

The urban forest is more than just an attractive part of cities and suburbs. Every tree plays a part in providing many environmental and economic benefits, such as filtering air to remove pollution, holding onto water when it rains to prevent flooding and erosion problems, shading buildings from hot summer sun to reduce heating costs, and creating habitat for wildlife. For more information on all the benefits that trees provide, read "Value, Benefits, and Costs of Urban Trees" (http://www.pubs.ext.vt.edu/420/420-181/420-181.html). Research has shown that trees

perform best at providing benefits when they are planted throughout our communities rather than being relegated to parks or woodlands. Locating trees near streets, homes, and businesses is important for the well-being of people and the environment. For this to work though, we must be mindful of what types of trees we plant and where we plant them so that the trees do not create problems.

The value of utility lines is very straight forward, but we often fail to appreciate the vulnerabilities and dangers of the power grid. Utility lines deliver electricity that is critical to every facet of our economy and modern lifestyle. The complex network of overhead utility lines that crisscross our communities is vulnerable to disruption by a number of causes. The most common way in which utility lines are damaged and service is disrupted is by trees falling onto lines, dropping branches onto lines, or growing into lines (Figure 3). Losing power is always inconvenient for homeowners. Commercial areas can also lose hundreds of thousands of dollars of business revenue if power is out for an evening. And lives can be put at risk when power is not delivered to individuals reliant on home medical devices or air conditioning during extreme heat events.

There are also some more localized risks when trees conflict with utility lines. A downed powerline is an obvious electrocution and fire hazard. A less obvious hazard occurs when tree branches come into contact with a powerline. If conditions are right, the electrical contact can spark a fire, threatening

Figure 3: Tree failure damaging utility lines after a storm. Adobe stock image to act as place holder for future selection.

nearby structures and landscapes. Another, and potentially more fatal hazard, is if someone touches a tree that is contacting a powerline. Indirect contact with a power line in this manner can lead to serious injuries or even death. This is why only specially trained arborists should ever prune or fell a tree that is near a power line and should never be attempted by a homeowner even if it "seems safe."

Damage to utility lines is inconvenient, costly, and dangerous. As a result, utility companies are very diligent with managing tree and utility line conflicts. It might be tempting to think that utility companies consider trees nothing more than a nuisance that should be removed altogether. But most companies understand that trees are valued by their customers and even acknowledge that trees can be helpful to their power services by keeping homes cool during extreme heat and reducing peak electricity demand for air conditioning. Therefore, most companies hire a utility forester who is skilled at identifying tree conflicts and recommending management solutions that balance the security of the utility lines with the well-being of nearby trees and landscapes.

How Tree and Utility Conflicts Are Managed

There are two options for managing trees that conflict with utility lines: removal or pruning. Although costly and disruptive to the landscape, removing offensive trees near powerlines is sometimes necessary (Figure 4). For example, high-voltage primary distribution lines are critical to power delivery and must be carefully safeguarded from all nearby trees. Likewise, trees in declining health or deteriorating structure cannot be remedied with pruning alone and must be removed. Utility arborists may opt to routinely prune a tree that repeatedly grows into powerlines, but is otherwise healthy and structurally sound. Pruning is usually

cheaper and quicker than removal in the short-term, but removing a tree that is too large for the site and replacing it with a smaller tree can save money and is better for the environment over the long-term. Removing offensive trees and replacing them with "utility friendly" trees minimizes the need for pruning, leading to healthier trees with more natural growth habits. This is good for customers' wallets and the beauty of their landscapes.

Figure 4: Adobe Stock image to act as placeholder for utility arborists removing a conflicting tree.

Proper pruning requires knowledge, skill, and judgment, but can still be very difficult because of the circumstances of a tree's location. Utility companies as a whole are sometimes judged unfairly for the improper pruning practices of a few unskilled tree trimmers. So how do you distinguish bad utility pruning from good, and how can you ensure that your trees are pruned properly? Let's take a look at improper pruning first. "Topping" or "rounding over" is an improper method of pruning where a maximum branch height is chosen for a tree and a horizontal line is figuratively drawn across the crown at that height. Any branch that is above that line is cut without

Figure 5: Illustration of "topping" a tree (left) and the resulting "water sprouts" (right). Image taken from Virginia Cooperative Extension publication "A Guide to Successful Pruning: Stop Topping Trees!" by Susan French and Bonnie Appleton, 2009.

consideration to the impact on tree health or structure. There are several reasons why topping is an undesirable technique. While topping may be quicker for clearing a tree away from powerlines, it is harmful to the tree, hastens the time until the tree must be pruned again, and destroys its natural beauty. When a tree is topped, almost every branch is cut off and most of the foliage is removed. This immediate defoliation robs the tree of its ability to produce food, starving it if it cannot quickly re-grow leaves. Moreover, the branch wounds are vulnerable to attack by pests and diseases, and decay will eventually set in to the larger branch stubs, making them susceptible to breaking. The tree responds to the sudden and extreme loss of foliage by profusely sprouting. Known as "water sprouts," these vigorous shoots grow much quicker than normal branches and are very vulnerable to breaking. As a result, a topped tree becomes more of a nuisance for utility lines in the long run because it must be pruned more frequently and is more likely to cause a power outage from broken branches. Last but not least, topping disfigures trees and diminishes their appearance. Part of the value of a tree is its aesthetic qualities and topping can remove a large portion of that. Topping is harmful for trees and should never be condoned, whether near utility lines or in a general landscape setting.

Figure 6: Directional pruning in a backyard. Photograph taken by Percy Montecinos, 2016.

The appropriate technique for pruning trees near powerlines is called "directional pruning." As the name implies, this technique directs branch growth away from utility lines by

selectively removing branches or leaders oriented toward the lines (Figure 6). Unlike topping, which cuts branches at indiscriminate midpoints, directional pruning cuts are made at natural unions that the tree can quickly seal and fortify against pathogens. Because only specific branches are removed (rather than the entire crown), most of the foliage is retained and the tree is not stressed by lack of nourishment. Directional pruning also leads to less sprouting than topping, which is not only good for the appearance of the tree, but also prolongs the time until clearance pruning is needed again. From a health and aesthetic standpoint, directional pruning is preferred over topping, but it is not without its own potential problems. Certain tree species or older trees that were not introduced to a regimen of directional pruning at an early age may not respond well. Directionally pruned trees underneath powerlines take on a V-shape, which may encourage a spreading crown form with foliage weight concentrated at branch tips (Figure 7). This may put stress on branch unions and increase the risk of branch failure during storms. Directionally pruned trees adjacent to powerlines may also end up with an unbalanced crown to one side, putting stress on root anchorage (Figure 8). These problems are uncommon and can be reduced if a tree is put on a directional pruning regimen at an early age, allowing the tree's crown and roots to adapt to this growth habit and the uneven weight distribution. Directional pruning is easier to accomplish and provides a more attractive tree when performed on species with an open or spreading growth habit. It might not be a suitable

Figure 7: An example of directional pruning that has resulted in a distinct V-shape. Image taken from the University of Florida Institute of Food and Agricultural Sciences to act as a place holder image.

Figure 8: Another example of heavy directional pruning in a residential area. Photograph taken by Percy Montecinos, 2016.

option for species that have a strong tendency to grow straight up, such as many conifers and oaks.

Tree growth regulators are occasionally used as a supplement to routine pruning. They are chemicals that mimic tree hormones, slowing their growth and reducing the amount of time between prunings. The growth regulator is applied as a liquid soil drench. This reduction in pruning typically does not outweigh the cost of the product and application, so the most common use for tree growth regulators is on specimen trees that would be adversely stressed or disfigured by regular pruning. Because the growth regulating effect only lasts 3-4 years, growth regulators require repeated application, so speak to a local tree care professional for more information on pricing and availability.

The best solution to a tree that has frequently recurring conflicts with utility lines is almost always to remove it and replace it with a species or cultivar (a more specific variety of a species) of appropriate size and growth habit. Most utility companies are agreeable to removing trees that cause recurring problems. Some utility companies will even replant appropriate trees in the easement at no or reduced cost to the property owner. Utility companies that offer tree replacement programs benefit by having fewer trees they are responsible for pruning and communities benefit by having healthier, more sustainable trees in their urban forest. Most

utility companies are required to notify property owners before tree removal or pruning. This is an opportune time for the property owner to ask questions and communicate preferences for pruning as well as inquire about tree removal and replacement options.

Selecting and Planting Utility Compatible Trees

When someone is planning to plant a tree near or underneath an overhead utility line, the most important question to ask is, "What is this tree going to look like in 10 or 20 years?" Taking the time to learn about the mature height and form of a tree before purchasing and planting it could potentially avoid a conflict with utility lines and the disappointment when the tree must be severely pruned or removed by the utility company. Before even considering what type of tree to purchase, the planting site in relation to the utility line must be determined. From here on, "near" a utility line will be considered between 20 to 50 feet away from the utility line corridor and "underneath" a utility line will be considered within 20 feet of the corridor. These two sites have different restrictions on the mature size of trees that can be planted there (Figure 9). Trees near, but not underneath, utility lines should be limited to a height of 40 feet. Trees taller than this height might bring down utility lines if they are uprooted by a severe storm. Also, their mature crown spread should not grow within 10 feet of utility lines. Trees underneath utility lines should not exceed 25 feet at maturity. This height will keep the crown away from the powerlines and avoid the need for pruning. Keep in mind that this is a maximum height. Certain types of utility lines may negate any type of tree or shrub being planted beneath them. It is always best to check with the utility forester to confirm the permissible tree size to use. The width or spread of short trees underneath powerlines is typically not an issue unless the tree might interfere with a nearby street, walkway, parking lot, or outdoor venue.

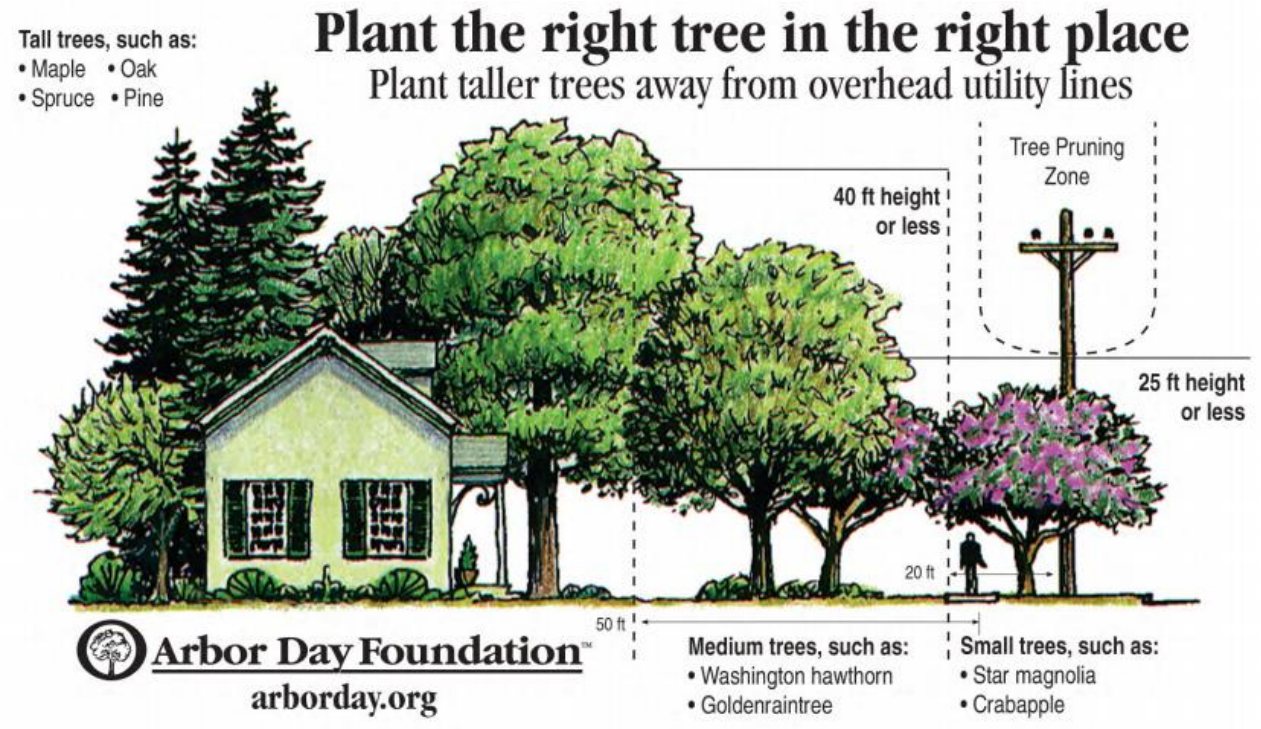

Figure 9: Illustration of appropriate tree sizes to plant in relation to utility line distance. Awaiting official permission from the Arbor Day Foundation for use.

Many tree cultivars have been bred for compatibility with utility lines. Some examples of these are dwarf cultivars—trees of small stature and slow growth rates, and fastigiate or columnar cultivars—trees that have a very upright growth pattern and narrow spread.

Before selecting a tree, some characteristics of the site must also be considered. Again, the first step is to determine the proximity of the tree planting site to utility lines and other nearby critical locations. Narrow-crowned trees may be necessary to avoid branches growing into powerlines, obscuring line of site for motorists and pedestrians, or impeding use of an outdoor space. Although many species of trees are naturally short, dwarf cultivars tend to be more predictable in their mature size and therefore are often preferred when planting directly underneath utility lines. Many small trees also happen to be fruit trees, such as cherries,

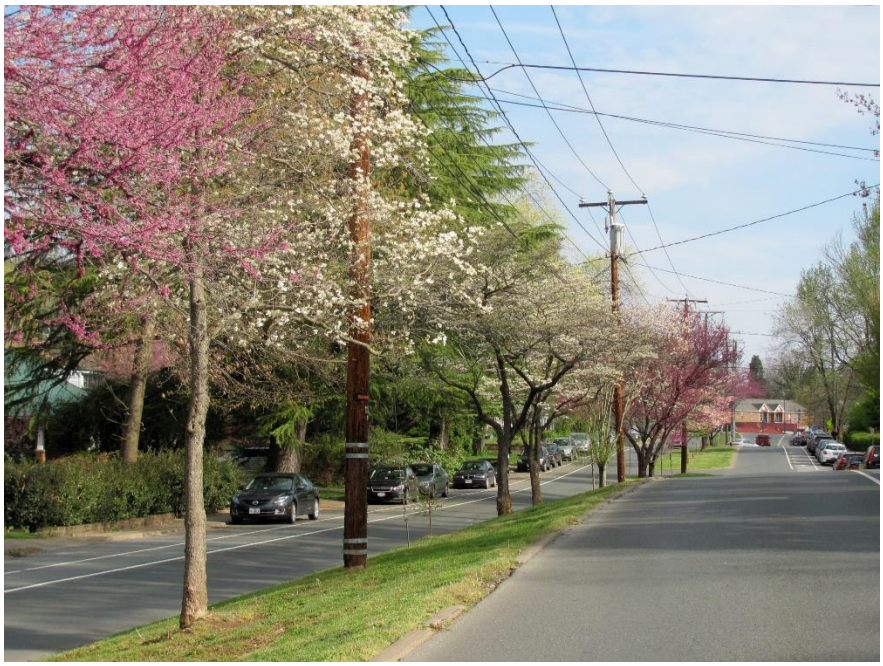

*Figure 10: Utility compatible trees in the Jefferson Park Avenue Arboretum in Charlottesville, VA. Trees shown are mostly Flowering Dogwood (*Cornus florida*) and Forest Pansy Redbud (*Cercis canadensis *'Forest Pansy'). Photograph taken by Dorothy Smith, 2016.*

serviceberries, and crabapples. While fruit might be desirable in a backyard or park setting, the litter could become a tripping hazard on sidewalks or could attract unwanted birds or insects to formal outdoor spaces. There is an assortment of other tree characteristics that may be an asset or liability, depending on the landscape setting and the intended function for the trees. For example, trees are often desired beneath powerlines to provide a visual screen and sound buffer to adjacent properties. In this case, dense conifers or broadleaf evergreens would be the preferred tree choice. In other cases, the goal may be to soften the appearance of power poles and utility lines, so tree species with attractive bark, flowers, or foliage might be desirable.

The next set of factors to consider when choosing a tree is the growing conditions of the site. Environmental factors include minimum and maximum annual temperatures, sun exposure, wind exposure, soil texture, soil pH, soil fertility, and soil moisture. Every tree has a range of acceptable site characteristics, and planting a tree in a site that it is not well suited for could greatly reduce its lifespan or even kill it before it becomes established. If you are uncertain about the quality of your soil, you may want to have the soil tested. A soil test can be requested

through your local Cooperative Extension office. Instruction is provided in the article, "Soil Sampling for the Home Gardener" (http://www.pubs.ext.vt.edu/452/452-129/452-129.html). A final factor to consider is the types of pests that might be prevalent in your area. For example, many of the small flowering ornamental trees are susceptible to a variety of insects and diseases. Also, deer are very abundant in suburban areas and are particularly destructive to a wide variety of trees, both deciduous and evergreen. Pests of any sort may threaten the health and appearance of trees and increase their maintenance costs. If you have questions about evaluating the growing conditions on your property, you may wish to contact your local Cooperative Extension office or a local Master Gardener.

After determining the growing conditions and environmental factors of the planting site, it is time to select a tree that will thrive in those conditions and meet your needs for mature size and landscape function. Remember that mature height and crown spread are the most important factors to consider when planting trees near or underneath utility lines. Table 2 and 3 provide a list of tree species and cultivars that are compatible with overhead utility lines and perform well under a variety of landscape conditions. Important characteristics relevant to their adaptability and functionality are noted. Although native trees should be planted whenever possible, it is important to note that non-natives (as long as they are not invasive) are often more tolerant of harsh landscape conditions and help increase species diversity in the landscape. Diversifying the landscape is particularly important when planting screens or buffers along extensive stretches of a utility line easement. Relying on a single species for an entire planting may risk a pest or disease moving rapidly through the planting and causing serious harm. The utility forester who works in your area may be able to provide advice on selecting trees that are appropriate for the type of utility lines and landscape conditions that are present on your property.

For a successful tree planting, high-quality trees should be purchased from a reputable nursery. Healthy nursery stock with well-formed branches and root systems will transplant more easily, grow more quickly, and tolerate stress from pests and inclement weather better. When preparing to plant trees that will replace ones removed by the utility company, you may need to have stumps ground up or grubbed out of the ground to clear the planting space. Depending on the nursery stock and the tree type, the preferred planting season will be mid-fall or early spring. Adequate irrigation and mulching during the first growing season is critical to transplant success. For more information on the proper methods of planting trees, read "Tree and Shrub Planting Guidelines" (http://www.pubs.ext.vt.edu/430/430-295/430-295_pdf.pdf).

Summary

It is important to preserve the sustainability of both the urban forest and utility infrastructure. Large-maturing trees will grow into utility lines and require removal or regular pruning. Removing and replacing offensive trees with small-maturing trees is the most cost-effective and environmentally sustainable practice for addressing tree and utility line conflicts. Trees underneath utility lines should not exceed 25 feet in height and trees that are within 20 to 50 feet of utility corridors should not exceed 40 feet or have branches that grow within 10 feet of utility lines. When selecting utility compatible trees, be sure to consider the growing conditions and intended tree function.

Table 2: Trees appropriate to plant near utility lines

Botanical Name	*Common Name*	*Typical Mature Height (ft.)*	*Typical Mature Spread (ft.)*	*Hardiness Zones*
Acer campestre	Hedge Maple	35	35	5a-8b
Acer platanoides 'Crimson Sentry'	Crimson Sentry Norway Maple	25	15	4b-7a
Acer tataricum 'JFS-KW2'	Rugged Charm® Maple	28	15	3a-7a
Carpinus caroliniana	American Hornbeam	30	30	3a-9a
Cercis canadensis	Eastern Redbud	30	35	4b-9a
Cornus florida 'Cherokee Princess'	Cherokee Princess Dogwood	30	25	4b-7a
Crataegus phaenopyrum	Washington Hawthorn	30	25	4a-8a
Crataegus x lavallei	Lavalle Hawthorn	28	25	4b-7a
Maackia amurensis 'JFS-Schichtel1'	MaacNificent® Amur Maackia	35	24	3a-7b
Magnolia virginiana 'Jim Wilson'	Moonglow® Sweetbay Magnolia	40	25	5b-9b
Nyssa sylvatica 'Haymanred'	Red Rage® Tupelo	35	20	5a-9b
Ostrya virginiana	American Hophornbeam	40	30	4a-9a
Parrotia persica 'Vanessa'	Vanessa Persian Parrotia	28	14	5a-8b
Pistacia chinensis	Chinese Pistache	40	35	6b-9b
Prunus x hillieri 'Spire'	Spire Cherry	30	10	5a-8a

Table 3: Trees appropriate to plant under utility lines

Botanical Name	*Common Name*	*Typical Mature Height (ft.)*	*Typical Mature Spread (ft.)*	*Hardiness Zones*
Acer griseum	Paperbark Maple	25	25	4b-7b
Acer palmatum	Japanese Maple	20	24	5b-8b
Acer platanoides 'Globosum'	Globe Norway Maple	18	18	4a-7a
Aesculus pavia	Red Buckeye	20	25	4b-9a
Amelanchier laevis 'Snowcloud'	Snowcloud Serviceberry	25	15	4b-8b

Botanical Name	Common Name	Typical Mature Height (ft.)	Typical Mature Spread (ft.)	Hardiness Zones
Amelanchier x grandiflora 'Autumn Brilliance'	Autumn Brilliance® Serviceberry	25	25	4a-7b
Amelanchier x grandiflora 'Cole's Select'	Cole's Select Serviceberry	25	25	4a-7b
Cornus (kousa x nuttallii) x kousa 'KN 30-8'	Venus® Dogwood	25	20	5b-9a
Cornus florida 'Cherokee Brave'	Cherokee Brave Dogwood	25	22	5a-9b
Cornus kousa	Kousa Dogwood	25	25	5b-8b
Cornus x 'Rutdan'	Celestial® Dogwood	20	20	5a-8a
Cornus x 'Rutgan'	Stellar Pink® Dogwood	20	20	5a-8a
Crataegus virdis 'Winter King'	Winter King Hawthorn	25	25	4a-7b
Hamamelis virginiana	Common Witch-Hazel	20	25	4a-8b
Ilex latifolia	Lusterleaf Holly	25	25	7a-9b
Ilex x attenuata 'Fosteri'	Foster's Holly	25	20	6a-9b
Magnolia stellata 'Royal Star'	Royal Star Magnolia	15	10	5a-8b
Malus 'JFS-KW5' PP 14375	Royal Raindrops® Crabapple	20	15	4a-8a
Malus 'Adirondack'	Adirondack Crabapple	20	10	4a-8a
Malus 'Jewelcole'	Red Jewel™ Crabapple	15	15	4a-8a
Malus 'Profusion'	Profusion Crabapple	25	25	4a-8a
Malus 'Red Barron'	Red Barron Crabapple	18	8	4a-8a
Prunus 'Frankthrees'	Mt. St. Helens® Plum	20	20	4b-7b
Prunus sargentii 'JFS-KW58'	Pink Flair® Cherry	25	15	3b-7b
Prunus serrulata 'Snow Goose'	Snow Goose Cherry	20	20	5a-8b
Prunus x incam 'Okame'	Okame Cherry	25	20	6a-8b
Styrax japonicus 'JFS-E'	Snow Charm® Snowbell	20	20	5b-8a
Syringa pekinensis 'Morton'	China Snow® Tree Lilac	20	20	5a-7b
Syringa reticulata 'Ivory Silk'	Ivory Silk® Japanese Tree Lilac	25	20	4a-7a
Taxodium distichum 'Skyward'	Lindsey's Skyward™ Bald Cypress	25	10	5a-10b
Thuja occidentalis 'Smaragd'	Emerald Green Arborvitae	15	6	2b-7b
Zelkova serrata 'JFS-KW1'	City Sprite® Zelkova	24	18	5a-8b
Zelkova serrata 'Schmidtlow'	Wireless® Zelkova	25	36	5a-8b

CHAPTER 4 – CONCLUSION

There is a great need to educate the general public about the issues surrounding conflicts between the urban forest and overhead utility lines. Trees planted without consideration for potential damage to utility infrastructure can lead to millions of dollars spent on avoidable clearance pruning. The health and sustainability of the urban forest, as well as the increased reliability of the utility infrastructure, are some of the greatest benefits that stem from home owners being educated on why they should elect to remove offensive trees and replace them with small-maturing trees that can be planted underneath or near utility lines. Education on tree-utility conflicts could also result in a greater trust in utility pruning and help utility companies and home owners work together to plant a more utility-compatible urban forest.

The two products created from this project help address the general lack of public awareness of the seriousness of the conflicts between the urban forest and utility infrastructure. Curating the five utility arboreta in Virginia with Plants Map will allow a large online social media community to view and share information from the arboreta, most importantly that the arboreta exist and are open to the public. Plants Map allows those who are passionate about the issue to easily share the arboreta on their preferred social media platforms, such as Facebook, Twitter, Pinterest, or Instagram. It also provides interested parties to virtually explore the arboreta, even if they are unable to physically visit them, greatly improving the usefulness of the arboreta and allowing them to fulfill their purpose to a larger extent.

The Virginia Cooperative Extension publication, “Trees and Overhead Utility Lines,” provides a resource to explain many angles of tree-utility conflicts. The publication explains the immediate dangers of the conflict, as well as the long-term implications of pruning costs and a less sustainable urban forest. It also explains the necessity for the utility pruning methods with

the hopes of raising awareness that utility companies are required to protect their infrastructure from trees that could conflict. By suggesting that removing offensive trees and replacing them with small-maturing trees that will not conflict, home owners can have a situation where both they and utility companies benefit. The paper concludes with the best-case scenario of avoiding conflict before it ever happens by planting appropriately sized trees for the site. The tables included at the end of the publication allow home owners an easy-to-understand guide for selecting the right tree for the right place.

In an ideal world, the urban forest would be perfectly compatible with the surrounding built environment. But even planting the right tree in the right place can have unforeseen consequences, such as an appropriate street tree failing in a severe storm. We can only hope to maximize benefits and minimize risks, which is the overall aim of this project. To fully do so, in terms of tree-utility compatibility, utility companies and municipalities should continue to fund educational and awareness programs to help teach the public how to add to an ideal urban forest and how to avoid mistakes. The next large step in addressing the conflict could be working with nurseries to provide resources to their clients about why it is important to think twice before planting near utility lines. Local governments could also help by creating ordinances that allow utility companies to remove young trees that will inevitably conflict with overhead utility lines while the trees are still cheap to remove. It may be necessary to use ordinances, as well as proper educational programs, to work with the "stick and carrot" metaphor. Some homeowners may respond well to educational programs whereas others may require more immediate consequences for planting inappropriate trees. But in order for laws to be written and companies to invest time and money into addressing tree and utility line conflicts, first there has to be the belief that something should be done to help.

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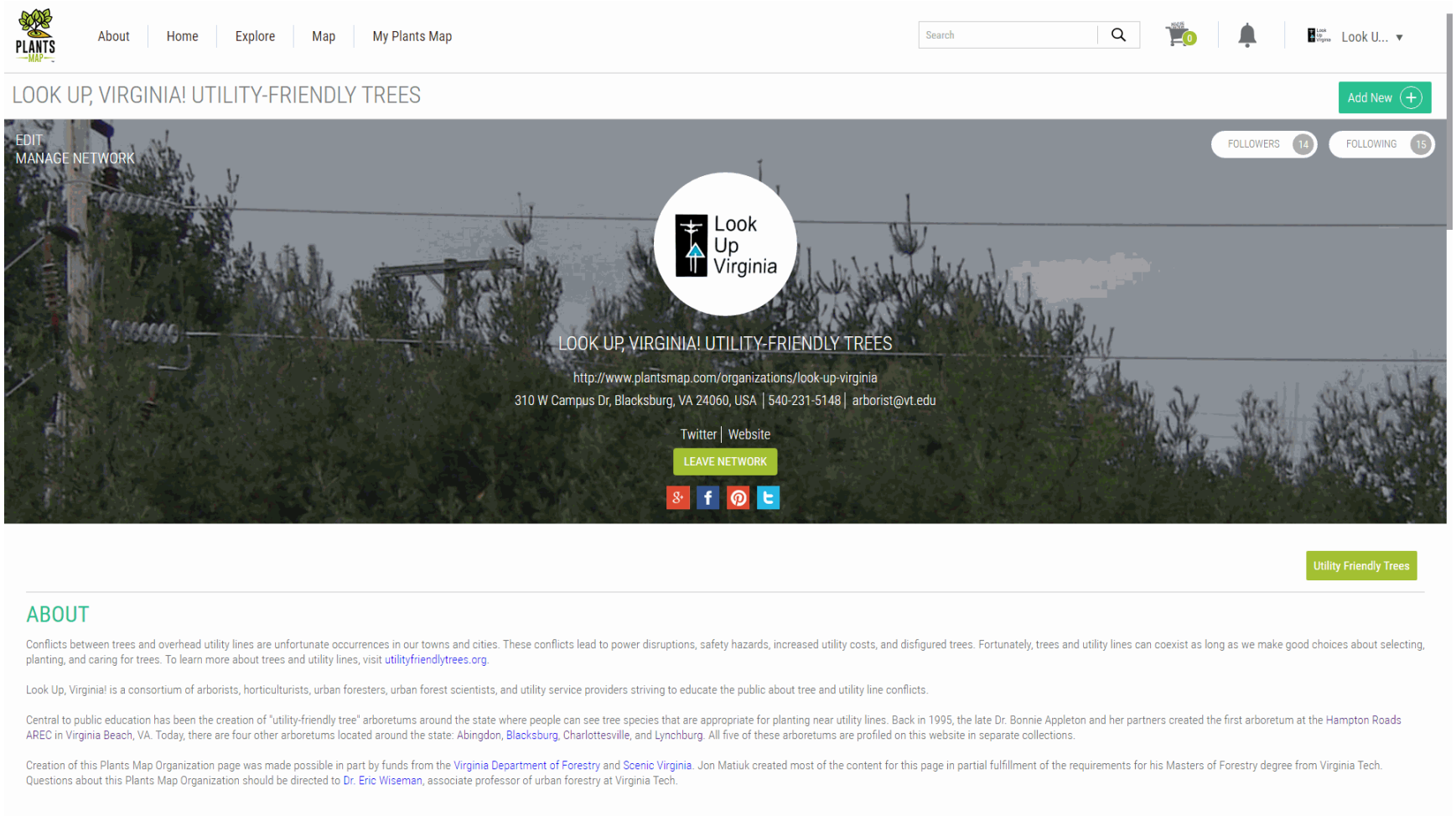
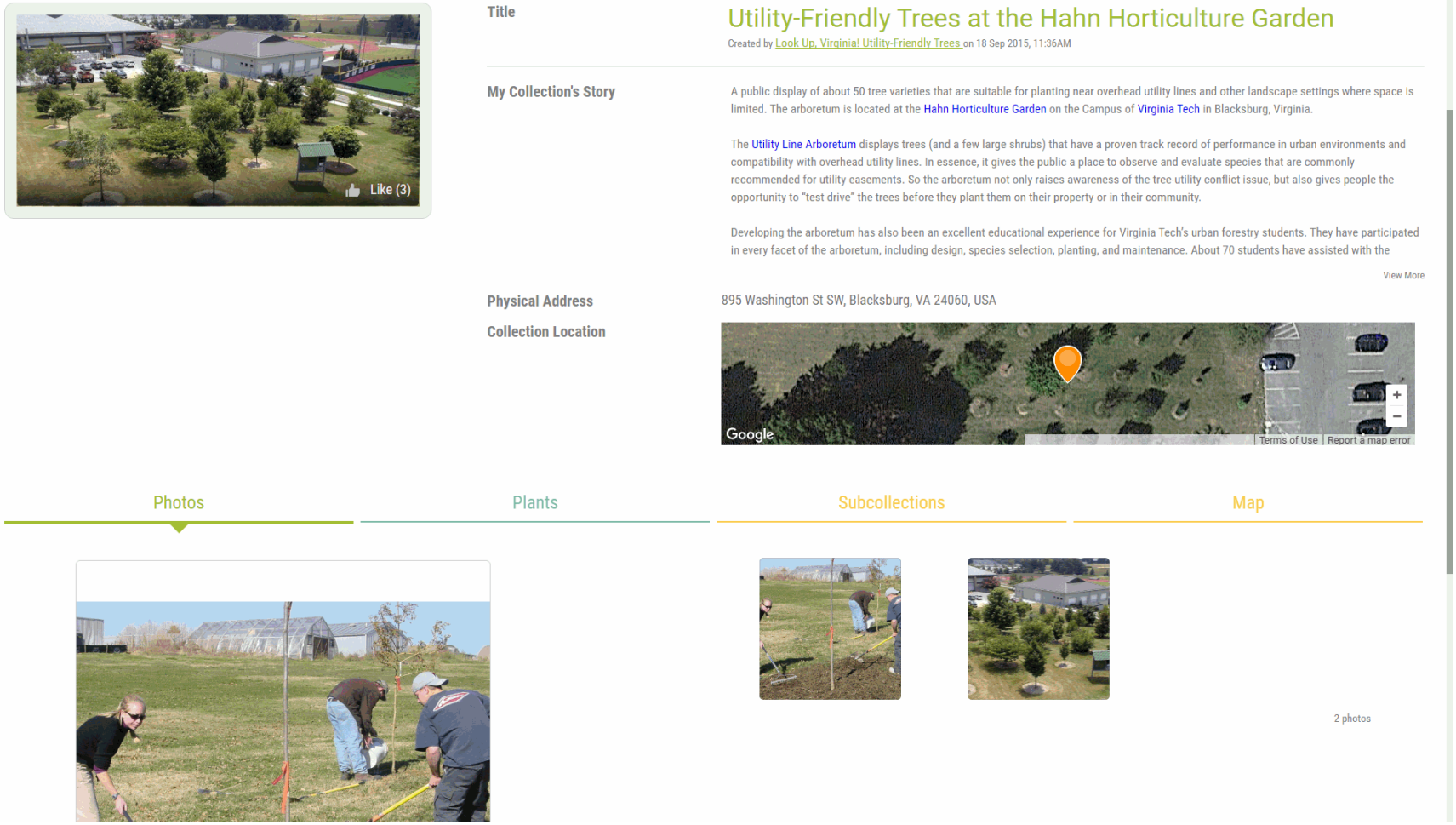
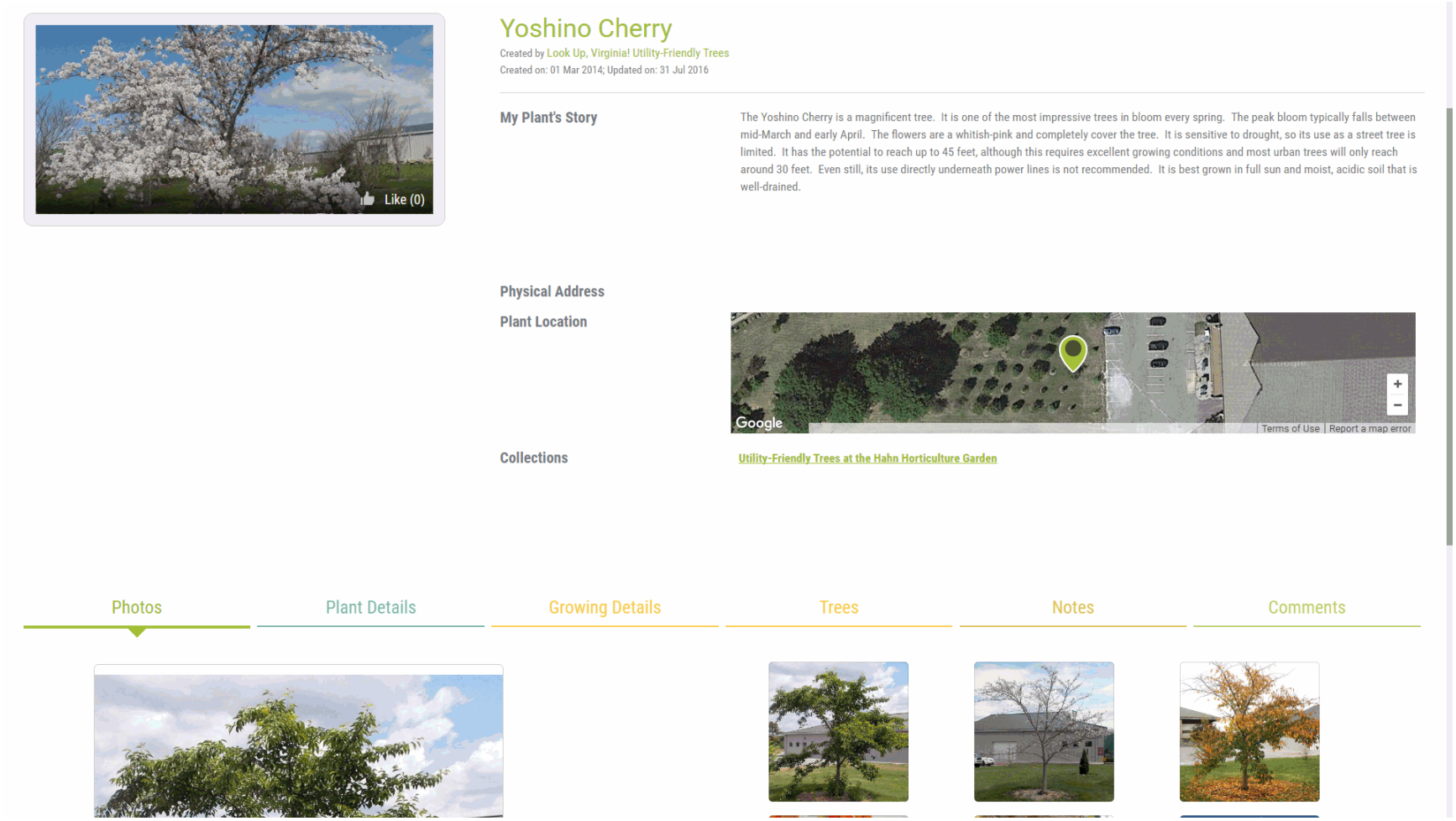
APPENDICES: PLANTS MAP PAGE EXAMPLES



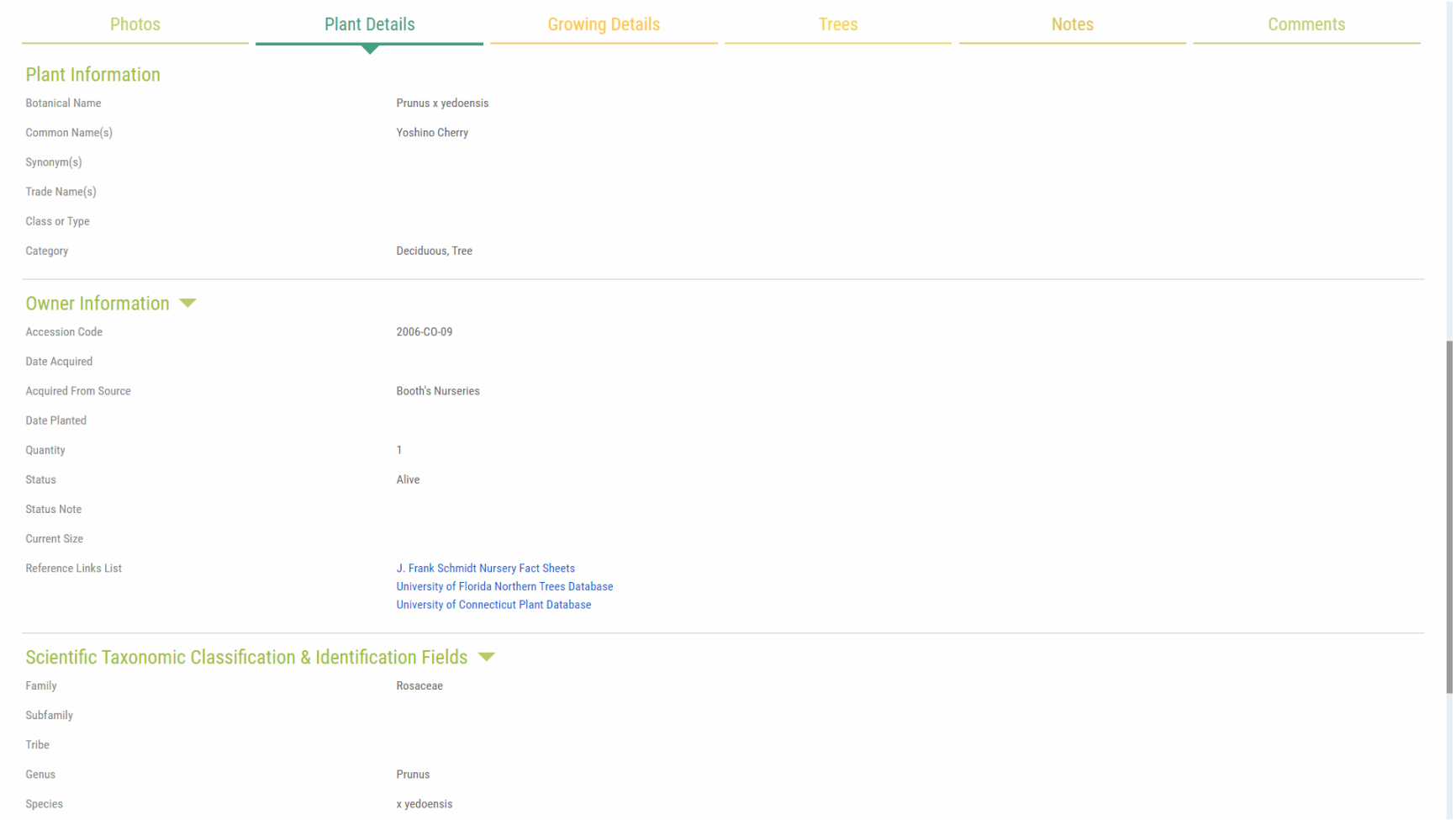
Appendix A: The organization front page of Look Up, Virginia! Utility Friendly Trees. From this page, visitors can access the five arboreta collections, as well as learn about the purpose of the arboreta and organization.



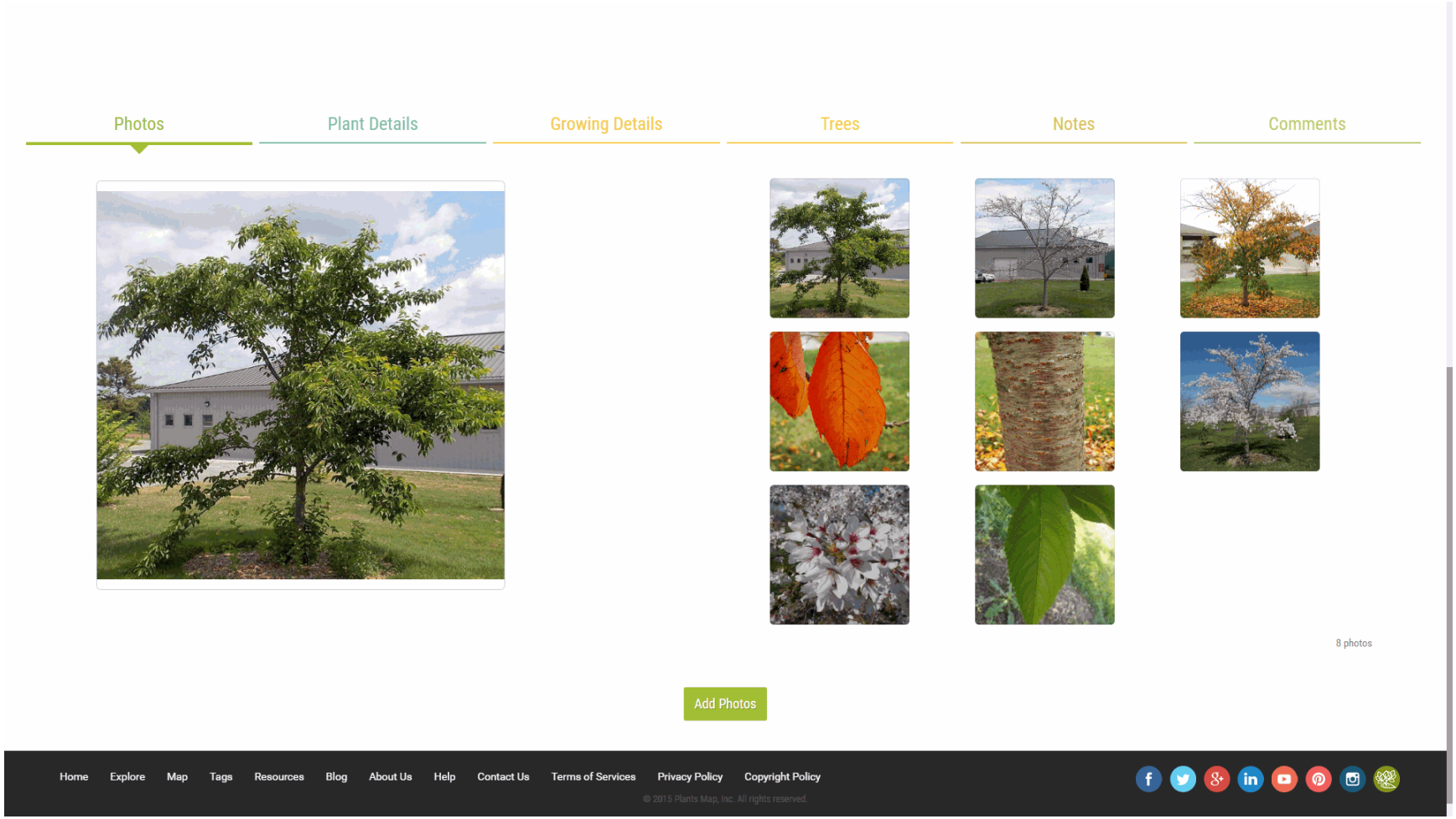
Appendix B: The collection front page for the Hahn Horticulture Garden arboretum. Visitors can look at an overhead map of the arboretum, look at included photos relevant to the entire arboretum, or look at the list of trees found in the arboretum.



Appendix C: An example specimen page for Yoshino Cherry (*Prunus yedoensis*) in the Hahn Garden arboretum, was chosen to show the typical page for each tree. It displays a short overview of the tree's information, location on a map of the tree, main display photograph, as well as other seasonal characteristics of the tree, and the specific specimen and species details.



Appendix D: An example of the details displayed for Yoshino Cherry (*Prunus yedoensis*) in the Hahn Garden arboretum. In future iterations of Plants Map, users will have the option to remove unused data fields to remove blank space.



Appendix E: The Yoshino Cherry (*Prunus yedoensis*) again shown as an example of the types of photographs included for each tree. The smaller photos can be clicked on the webpage to display large images.