Urban Forestry Outreach, Research & Extension Nursery and Lab

2016 Green Report

University of Minnesota Department of Forest Resources
www.trees.umn.edu

Department of FOREST RESOURCES
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Nursery & Lab Research Projects

Nursery String Decomposition Rate Study: July 6, 2015—December 31, 2016

Gary Johnson—Principal Investigator

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University of Minnesota, Department of Forest Resources

Introduction:

The original problem statement for this study was simple: for the six most commonly used nursery strings or twine used to secure wire baskets to tree trunks, what is the rate (time) of decomposition? The stimulus for addressing this problem statement came from municipalities that contract out tree planting to private companies, from landscape installation companies that regularly installed trees for municipal and private contracts, and from tree health experts, all who were encountering trees that had been "girdled" by nursery strings left attached and were showing symptoms of damage due to the effects of girdling. How often does this happen? How long do these strings take to decompose to the point where they present no danger to expanding tree trunks?

The advertised length of time to decomposition from the manufacturers of these strings was very different from anecdotal reports. Also, the decomposition rates for the various materials did not take into account the various thicknesses of the materials, their location above or below ground, or whether they had been chemically treated to resist decomposition. A search of the literature revealed no experimental evidence that provided more detailed information on decomposition rates.

The Experimental Design:

Seventy-two (72) trees, several were multiple-stemmed, were planted in the raised bed area at the MN UFore (MN Urban Forestry Outreach Research and Extension) nursery on the Saint Paul campus, University of Minnesota. Tree placement was randomly assigned to placements within twelve blocks. Each block contained six trees. The 72 trees provided 97 individual tree trunks that were used for the experiment. Of the 97 trunks, 84 had nursery strings attached to them (treatments) and 13 were used as controls. All trees were grown in #2 smooth plastic containers and were severely pot-bound upon purchase. All tree root systems were "boxed" to remove any bias from dysfunctional root systems. Trees were planted in a randomized block design in autumn of 2014. In the spring of 2015, the surviving trees (all) were measured and randomly assigned treatments or as controls.

Four tree genera were used for the study: *Pinus, Populus, Betula and Ginkgo.* These species were selected based on their relative growth rates, that is, *Pinus* and *Ginkgo* as slow to moderate, and *Populus* and *Betula* as moderate to fast. In total 95 Betula, 66 Populus, 58 Pinus and 54 Ginkgos were used in this experiment.

The nursery ropes or twines were selected based on the frequency of their use in wholesale and retail nurseries. Six nursery strings were selected for this study:

1. Baling Twine – orange, photodegradable resistant
2. 3-ply Jute – natural
3. 3-ply Green Jute – dyed for aesthetics
4. 2-ply Sisal – Copper Naphthenate treated
5. 1-ply Sisal – natural
6. 3-ply Sisal – natural.

On July 6, 2015, the various ropes or twines were installed on the surviving trees from the previous autumn planting. This date was selected to allow the trees to complete any (if any) caliper development before installation of strings. The treatments and controls were randomly assigned to 84 tree trunks, with the remaining trees serving as "controls." Trees were irrigated normally through the establishment growing season of 2015 and as needed thereafter.

Installation of "treatments" followed the initial measurement of stem diameters at 15 cm above ground (aka, caliper), 2.5 cm above that point and 2.5 cm below the caliper point (Fig 1). Treatments were made at the caliper points and consisted of three wraps around the trunk and tightly knotted. Each treatment was replicated on 14 tree trunks.

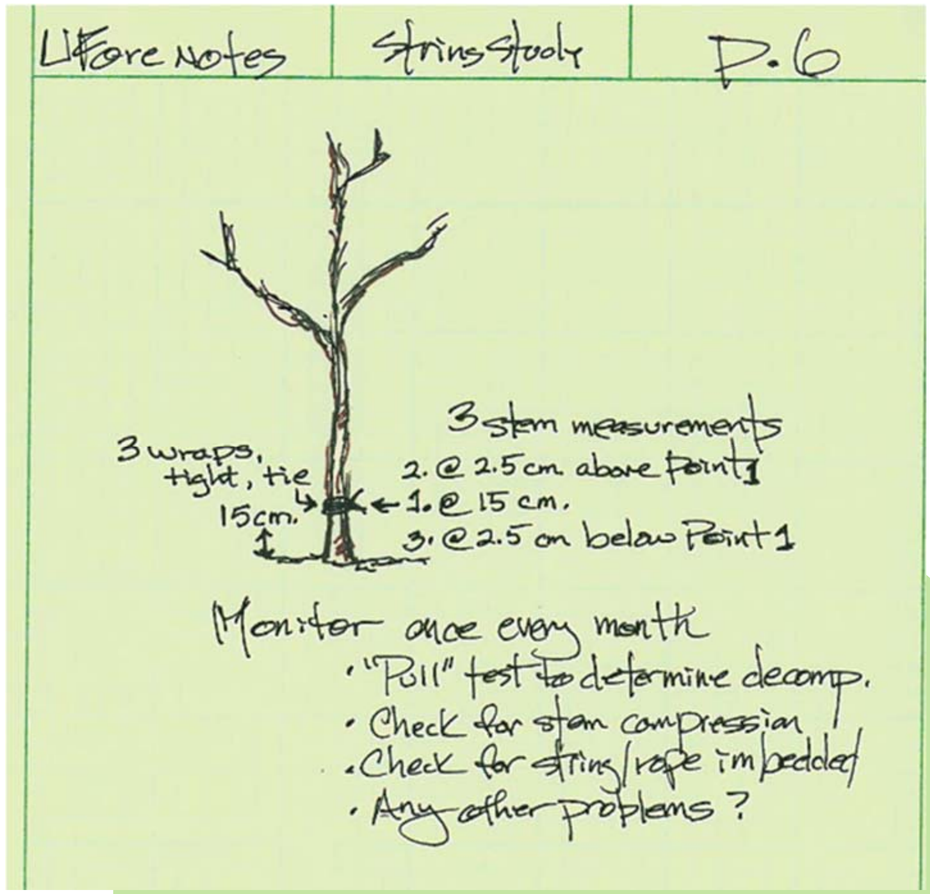

Fig (1): Initial stem diameter measurements and placement of twines/ropes on stems.

Observations were made to determine string decomposition at monthly intervals each year through November, resuming the following springs in April. "Pull-tests" were made on the ropes/twines to determine if any decomposition and subsequent strength had occurred. All pull-tests were conducted by the same researcher. Also noted was whether the rope or twine had caused any stem compression, had become imbedded in the tree trunks, whether there was any stem or root system instability and whether the trees has died above the point of attachment or had snapped off at that point during a wind-loading event.

Results as of 11.10.16:

Decomposition Rates and Timing: To put it simply, it's been slow. There was no decomposition on any of the materials for the first 11 months (Figure 2). As of the November, 2016 inspection, three of the six strings had a little more than a 50% decomposition rate, which means they decomposed to the point where a pull-test easily separated the fibers. No decomposition with the baling twine and very little with the treated and untreated sisal (natural fibers).

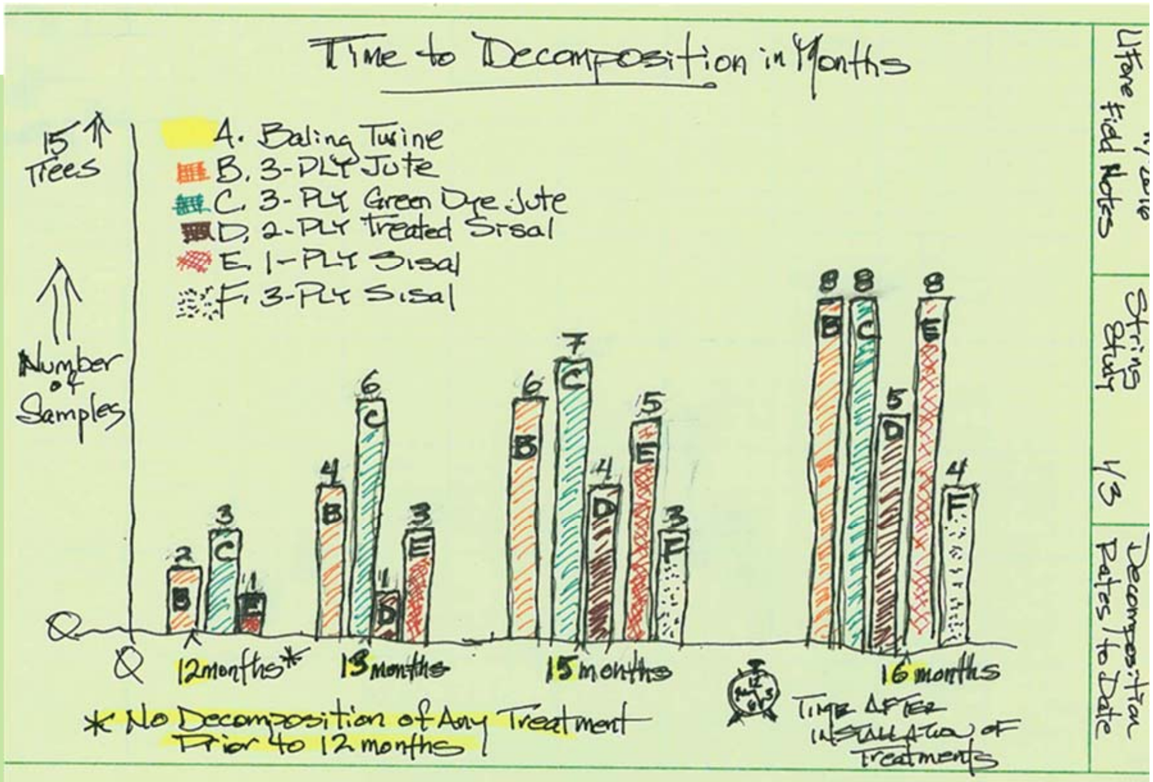

Fig (2): Decomposition rates of six materials in 16 months at monthly intervals.

Stem Compression from Twines or Rope Materials: Stem compression began within two months after installation and within 12 months, all stems had been compressed by the materials (aka girdled) (Fig 3). Note, by 12 months after installation of materials, several trees within each treatment had failed in wind-loading events, hence the n for each treatment is less after month 12. Figures 4 and 5 illustrate two levels of stem compression from twines/ropes.

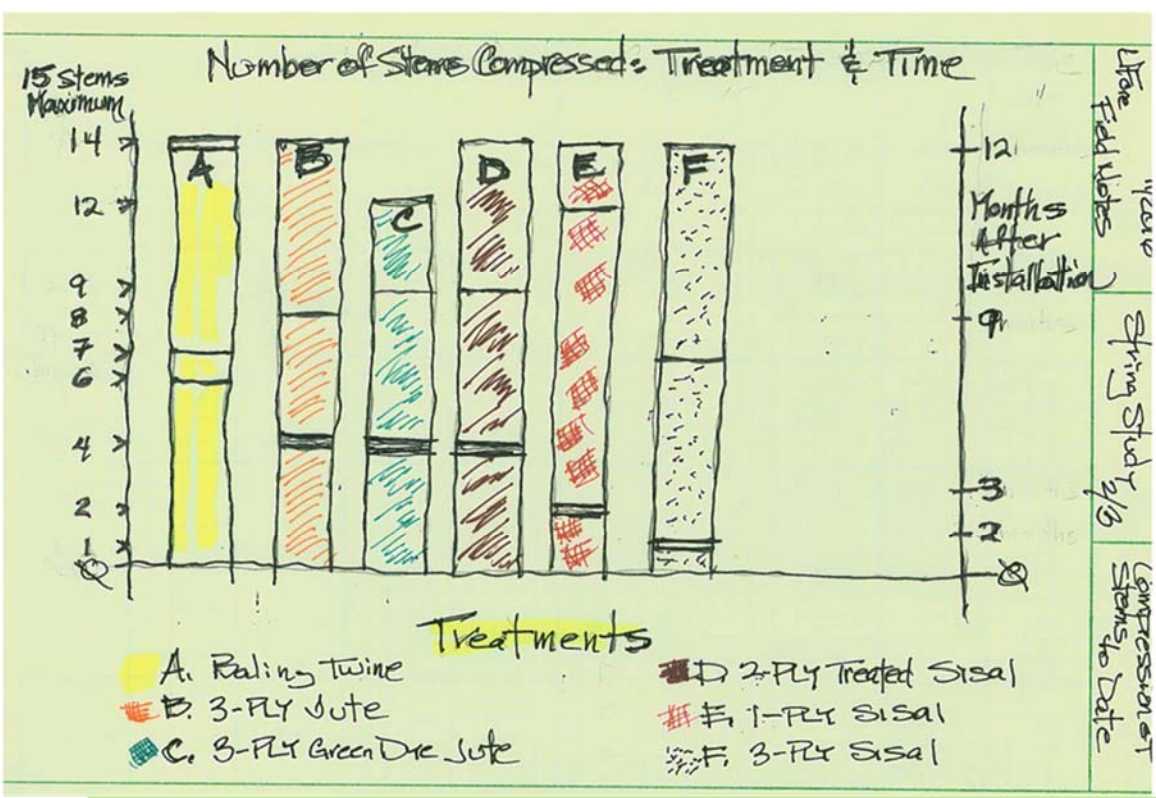

Fig (3): Number of stems compressed by treatment and time after application.

Fig (4): Compression of stem tissues by twine material (baling twine).

Fig (5): Compression of stem tissues and twine material imbedded in stem (untreated sisal).

Stem Failures at Compression Points: Over a period of 16 months, several wind loading events moved through the experimental area. Wind loading events are defined as wind/rain storms with velocities greater than 30 mph. Normally, well-built trees survive such events, while trees with defects or poor architecture tend to suffer some sort of damage.

Within 11 months of installing materials, failures (breakage at stem compression points) began, hitting a current peak 15 months after installation. At 15 months, four of the six treatments had suffered almost a 50% loss of trees due to failures. Note that losses are represented as cumulative losses in Fig 6. Figure 7 illustrates a typical failure example due to a loading (wind) event. No control trees experienced any failures during the same time period.

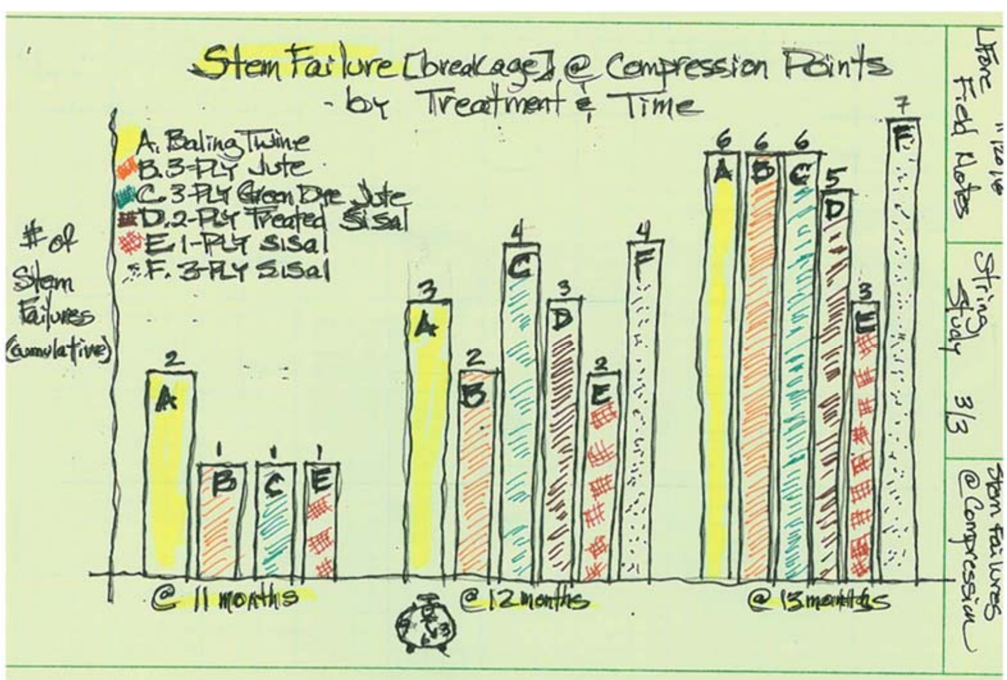

Fig (6): Stem Failures at compression points by treatment and length of time from installation.

Fig (7):. Typical stem failure at compression point by twine or rope materials during a loading event. Material is copper treated sisal.

Using Gravel as a Germination Media

Jorden Smith

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Growing up as the son of an avid hobby farmer I was taught three things that all plants need: soil, water, and sun. Those three things I carried with me as I followed in his farming footsteps and off to college.

Fig (8): Gravel pot with protective covering.

Purpose:

As a research assistant for the UMN Urban Forestry Outreach Research and Extension (UFore) Nursery we are always asking "why", which led us to the question I wanted to test "why do we have to germinate seeds in soil?" Is there a better alternative to just plain soil as a conduit for seed germination? As the idea began to take shape, we ordered nine different tree species used three different growing media along with a control medium (soil) to see which medium was the best for germination and subsequent root development.

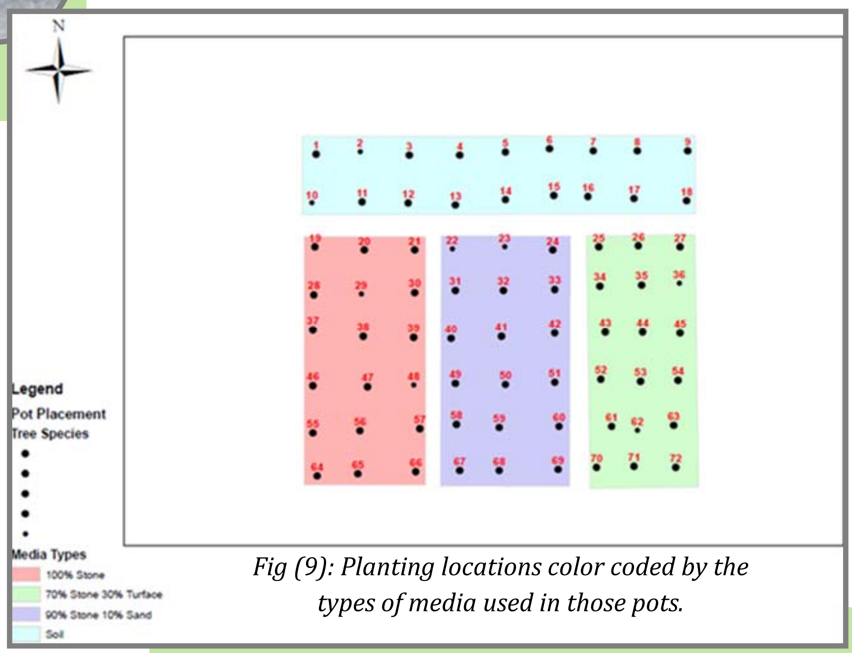

Fig (9): Planting locations color coded by the types of media used in those pots.

Plan:

The idea of planting the seeds into gravel-filled pots and then left to over-winter is that the natural stratification and scarification would occur in these pots as the seeds are brushed up against the gravel and Terface® (a soil conditioner that is a calcine clay product used to improve drainage, reduce compaction, hold moisture, and improve the Cation Exchange Capacity of the soil) instead of in the duff layer on the forest floor. The reason that we chose the species that we did was that as the climate begins to get warmer and drier here in Southeastern MN we will start to see more and more of these trees being planted in parks and in cities, due to their ability to grow in warmer climates. With the nine trees being selected along with the amount of seeds to be planted in the experiment (Table 1), also their natural stratification and scarification requirements, seeds from each tree were planted into a pot in late November early December containing either: 100% 1/4"-3/8" diameter washed river gravel (A.K.A. pea stone), 100% loam soil (control), 90% pea stone and 10% sand, 70% pea stone and 30% Terface®, with the last two being measured out by volume and not by weight. With 72 containers each seeding sample was installed twice (Fig. 2) with each of the above soil media. Once all of the seeds where planted a protective covering of galvanized ½" hardware cloth, attached to the lip of the container with three sheet metal screws (Fig. 3) over each of the pots to ensure no animals could withdraw any of the seeds from the containers.

Fig (10): Screws holding protective covering on.

Study Species:

Osage orange:
Osage orange natural stratification can occur by being kept in a cool moist environment for 30 days. Also there is no natural scarification process that is needed for Osage orange.

American Sycamore:
American Sycamore does not require and seed stratification or any scarification in order to germinate. That being said 60 days in a cold moist environment is also recommended but not needed and as some bird species consume the seeds, scarification can occur through the birds digestive

Black walnut:
Black walnut scarification is done naturally after planting. The seed coat may be broken by microbial action, exposure to alternate freezing and thawing, or fire. Black walnut natural stratification is between 90-120 days at cool moist temperatures.

Katsura tree:
Katsura naturally doesn't have any stratification or scarification process, that being said as the outer coating of the seed breaks down naturally by decay and weathering this could be considered its natural stratification and scarification.

Hardy Rubber tree:
Hardy Rubber tree has a natural stratification process that takes around 90 days to happen, with cold moist temperatures being present. As the seeds are only have a thin outer coating the scarification process naturally occurs as the outer layer breaks down.

Balsam Fir:
Balsam Fir naturally stratify over a 30 day winter period when temperatures are right around 50 degrees, like with the Hardy Rubber tree the natural scarification process occurs as the outer coating of the seed will naturally decays and fall off.

Butternut:
Butternut scarification is done naturally after planting the seed coat may be broken by microbial action or exposure to alternate freezing and thawing. Butternuts natural stratification is between 90-120 days at cool temperatures (very similar to processes of black walnut).

Seedling Rates		
Location in plot	Number of seeds to be planted	Species
01	3	***Black Walnut***
02	15	*American Sycamore*
03	15	*Katsura Tree*
04	15	Witchhazel (Common)
05	15	Balsam Fir
06	10	*Hardy Rubbertree*
07	10	*Osage Orange*
08	3	***Butternut***
09	10	***Shagbark Hickory***

Table (1): Species italicized are climatic adaptive species, and species that are bolded are notoriously tap-rooted along with being difficult to transplant

Witchhazel (Common):
Witchhazel isn't like the eight other seeds, this seed will require a double stratification period. This means that the seeds have to be warm stratified and then cold stratified in order to germinate, they must spend 90 days in temperatures around 40 degrees and then another 60 days at around 80 degrees.

Shagbark Hickory:
Shagbark Hickory seeds show embryo dormancy that is overcome naturally by over wintering in the duff layer for around 90-120 days. Shagbark Hickories natural scarification may be broken by the decaying and breaking down of the outer husk.

Timeline for Monitoring Project (germination):
Monitoring the germination of each of the nine tree species will be tracked from when they were sown into the pots in late November early December up until the harvest of the trees (except butternut which can take years to germinate) at the end of September 2017.

Fig (11): Gravel testing pots aligned in rows, photo curtesy of Gary Johnson.

Evaluation Methodology:
Evaluation of the success of this experiment will come down to three criteria:

- **Germination rate-** this will be highly dependent on the different species, but we will be counting the number of germinated seeds with the number of seeds planted. See figure for the amount of seeds planted.
- **Grading of the root system-** once it is time to harvest the seedlings, we will photograph the root structure up against a checkered board and give the roots a corresponding grade with 1 being the worst and least amount of root growth up to 5 being the best. See figure for an example.
- **Transplant success-** once the seedlings have been graded, we will begin to transplant them around the surrounding area and monitor their survival and condition for the next three years.

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Pleaching Valley Forge American Elms

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Fourteen .75" Valley Forge American Elms were planted in the UFore Nursery in the Autumn of 2017. They were zip-tied along their stems against the structure of the shade house to eventually create a green archway, a practice known as "pleaching." Once the trees have reached across the top of the shade house, they will have effectively formed a living shade house, ideal for summer classes or events in the Nursery.

Training Trees & Managing Growth:
Pleaching is a form of training tree growth, that is directing the shape and growth of trees to a specific form. The stem and branches can be directed by securing them against a structure as with the pleached elms in the nursery, and "tree massage" may be required to slowly adjust the angles of branches. This involves regularly making slight bends to branches and twigs near their attachment point, avoiding damage to or breaking of branches by stretching the adjustment over time. This requires frequent and time-consuming maintenance, particularly for a fast growing species like Valley Forge American Elm. The summer of 2016 was the first full growing season for these trees after being pleached, and within three months many branches had already reached across and could be bound to those of their neighboring tree to encourage grafting. Some of the branches put on so much new growth, their own weight snapped them off at the stem regardless of wind. To prevent future damage to the trees and loss of branches, wires have been installed horizontally between the poles of the shade house to provide additional support to the branches. Additional zip-ties are attached to hold branches in a horizontal position along the wires. The zip-ties around both the branches and the stems need to be frequently loosened to avoid cutting into stem tissue, and are checked weekly. Once branches and stems have lignified into their new position, zip-ties are removed. By the end of the following growing season, many of the existing branches will have lignified, and the supportive wires may be removed as well.

Fig (12 & 13): Pleached Valley Forge American Elms on the North side of the UFore Nursery, note the shade-house structure trees are bound to.

Fig (14 & 15): Green new growth being wrapped around horizontally, then bound together and to the wire by a zip tie.

Grafting Branches:

To ensure both a dense and secure structure, graft unions between branches of neighboring trees are encouraged. In addition to being trained to grow horizontally, branches are then wrapped and bound together using zip-ties to temporarily secure them. After a few years of growing pressed together, the branches will be able to graft and share vascular tissue between trees. Grafts can be made by physically cutting branches and aligning vascular tissue from each so that water and photosynthates may be exchanged through previously separate branches more quickly, but for the pleached elms the branches will not by physically grafted by hand. For a more hurried approach, physical grafts may be considered, but this will also increase the stress to the trees.

Low Maintenance Turfgrass in UFore Nursery

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Introduction:

In the summer of 2016 the turf grass in the northwestern corner of the UFore Nursery was converted to a low-mow mix of turf grass, with the guidance of Assistant Extension Professor Sam Bauer. The seed mix is developed by the University of Minnesota Turf grass Science Program, and is an alternative to high-maintenance turf grasses such as Kentucky Bluegrass, which may require greater inputs such as watering, fertilizing, and mowing to achieve the same or similar aesthetic and environmental benefits. In addition to reducing soil erosion and filtering contaminants from ground and surface water as all turf do, low-maintenance turf grasses also tend to be associated with higher drought tolerance, greater resistance to insects and diseases, and lower fertility needs than higher input turf grasses.

Fig (16, above): Preparation of site, tilling dead grass and soil before seeding and fertilizing.

Fig (17, above): Bucket filled with custom seed mixture for low-maintenance grass.

Site Preparation:

In order to convert the northwestern corner of the UFore Nursery to low-maintenance turf, the entire area had to be sprayed with Glyphosate on August 9, and then again on August 19 to be sure that none of the previous turf mix remained. After all of the grass had dried out, the site was tilled on August 22, breaking up the organic layer and exposing some soil (Fig).

Seed and Fertilizer Application:

The custom seed mix was applied on August 22 following site preparation. The mixture included 25% 'navigator' strong creeping red fescue, 25% 'beacon' hard fescue, 25% 'shoreline' slender creeping red fescue, and 25% 'radar' chewings fescue. Seed was spread evenly across the area, then was followed by a fertilizer: Scotts® Turf Builder® Starter® Food For New Grass Plus Weed Preventer. A sprinkler was set to run multiple times a day covering the whole area, and one more round of fertilizer was applied October 1, using SUSTANE 10-2-10 .

Maintenance:

Following initial establishment of seed, the space remained frequently watered until the end of the growing season. In the future, this space will only require being mowed 1-2 times per year, but for the

Fig (18): Low maintenance turfgrass in the UFore Nursery, June of 2017.

Spring of 2017 the grass was allowed to allow this mixture to fully establish. Following the 2017 growing season, the turf will be mowed once every spring and once every fall. The appearance of the turf is very different from high-input turf grasses, and it is very well suited for the permanent planting area of the UFore Nursery.

More information on alternative and traditional turfgrass mixtures and their maintenance can be found at http://www.turf.umn.edu/ and at http://www.extension.umn.edu/garden/turfgrass/.

2016 Gravel Bed Species Performance Study

Daniel Yoder

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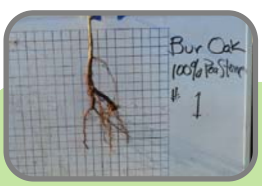
University of Minnesota, Department of Forest Resources

The four permanent large gravel beds at the nursery were well used this year. Three different gravel mixtures, pea stone, 90/10 pea stone/sand, and 70/30 b-stone/sand for the raised gravel beds, as well as an in-ground bed with pea stone. By the end of summer, twenty different species of bare root trees of varying caliper sizes were installed throughout the beds.

Intense rodent herbivory on gravel bed trees and shrubs in the weeks after installation led to the placement of chicken wire and fencing around the beds as well as periodic applications of Liquid Fence™ animal repellent. Larger caliper trees proved to susceptible to wind-throw events throughout the summer .

Several gravel bed trees were selected at the end of the season to compare their success after transplanting. Species such as bur oak (*Quercus macrocarpa*), hackberry (*Celtis occidentalis*), and Manchurian ash (*Fraxinus mandshurica*) were growing in both the pea stone and 90/10 pea stone/sand mix, allowing trees to be grouped by species and media. Assessment of fine root density of selected trees is ongoing. Density is measured on a scale of 1 (Little or no fine root growth) to 5 (Extensive fine root growth), with none of the trees ranking above a 2 at the time of installation. The trees were transplanted to various sites this November and will be monitored for survival, growth rate, and condition over the next three years.

Fig (19) Above: the in-ground (top) and Fig (20): the raised gravel beds (bottom).



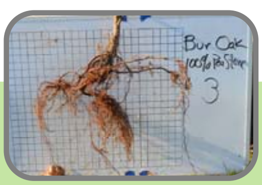


Fig (21, 22, 23, left to right) Above: Examples of fine root density grading on Q. macrocarpa from least dense (21) to most dense (23)

Fig (24, 25, 26, left to right) Above: Density is visually assessed based on how much of the background contained by the total root structure is obscured by root growth

Fig (27, 28) Above: C. occidentalis *(top) and* F. mandshurica *(bottom) with robust, high density fine root growth.*

2016 Gravel Bed Species Performance—End of Season Results

Gary Johnson

Professor, Urban and Community Forestry

University of Minnesota, Department of Forest Resources

All tree species were stocked in the gravel beds during the last two weeks of May. Trees were harvested from 11/16/16 to 11/27/16. At the time of harvest, survival rates were noted and root systems were assessed based on root mass density. A 5-point system was used to assess the root mass density, with 5 representing little to no light penetration through the root system to 1 representing greater than 95% of light penetration. All assessments were conducted using a white grid board with 5 cm squares marked with a dark felt tip marker.

Species	Size	Media	#1	#2	#3	#4	#5	Survival
QUEL-MS	1.25 inch caliper	90:10	4	2	2			8/10
QUEL-MS	1.25 inch caliper	100	1	3	1			5/10
COPA	4-5’	90:10			4		1	5/5
COPA	4-5’	100		2	1	2		5/5
COPA	4-5’	70:30			4			4/5
PRAM	2-3’	100		9	7	10		26/30
QUMA	18-24”	90:10	7	7	5			19/20
QUMA	18-24”	100	4	4	5	3	17	33/40
QUMA	2-3’	100-BG	17	23	17	15	1	72/75
FRMA	2-3’	90:10				16	4	20/20
FRMA	2-3’	100			1	13	6	20/20
FRMA	2-3’	100-BG			23	29	13	65/65
BENI	2’	90:10		28	16	4		48/50
BENI	2’	100		2	15	1		18/25
CEOC	2-3’	90:10	1	1	13	1	3	19/20
CEOC	2-3’	100		7	10		2	19/20
CEOC	3-4’	100				5	15	20/20
CEOC	3-4’	100-BG		11	6	12	2	31/35

Table (2): Species codes, sizes, media, root rating, and survival of gravel bed study trees.

BENI River Birch
CEOC Common Hackberry
COPA Pagoda Dogwood
FRMA Manchurian Ash
PRAM American Plum
QUEL-MS ‘Majestic Skies’ Northern Pin Oak
QUMA Bur Oak

100 100% Pea stone
100-BG 100% Pea stone in below grade bed
90:10 90% Peas stone and 10% coarse sand by volume
70:30 70% B stone and 30% expanded clay

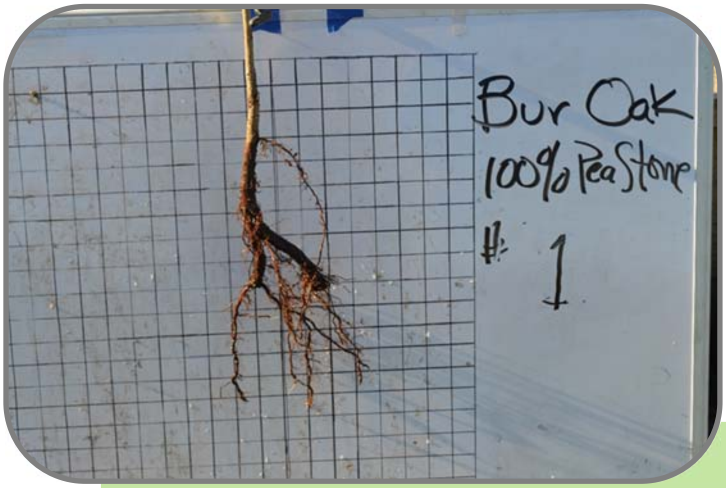


Fig (29): Root system of gravel bed tree after harvest rated #1, Bur Oak in 100% Pea Stone.

Fig (30): Root system of gravel bed tree after harvest rated #2, Hackberry in 100% Pea Stone.

Fig (31): Root system of gravel bed tree after harvest rated #3, Hackberry in 100% Pea Stone.

Fig (32): Root system of gravel bed tree after harvest rated #4, Manchurian Ash in 100% Pea Stone.

Fig (33): Root system of gravel bed tree after harvest rated #5, Bur Oak in 100% Pea Stone.

Gravel-in-Pot Study, June 2016-November 2016

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Using gravel as a growth medium has been shown to increase fine root mass, an important factor in successful tree establishment after transplanting. The goal of the gravel-in-pot study is to examine how different gravel mixtures influence fine root growth on three different tree species. The survival, growth rate, and condition of those trees will then be monitored for three years after transplanting.

An area of the nursery used for similar experiments was selected for this year's project. Three species of tree were selected for testing: bur oak (*Quercus macrocarpa*), white oak (*Quercus alba*), and eastern white pine (*Pinus strobus*). Seventy-two pots were used, with eighteen pots each being filled with 100% pea stone gravel, 90/10 pea stone gravel/sand, 70/30 pea stone gravel/ Turface™ (a clay-based soil conditioner), and soil as a control. Each pot was stocked with two small caliper bare root trees of the same species, and each species was represented by five pots in each test medium, and six total pots in the control medium (soil). Forty-eight trees of each species were planted, with a total population of 144 trees.

Fig (34): Grid layout of gravel pots

Prior to pot planting, the roots of each tree were photographed against a whiteboard with a one inch grid and the tree was assigned a number based on row, column, and position in pot. The trees left to root out in the pots for five months. Excessive rabbit herbivory in the nursery this season resulted in the oaks being protected by ½" hardware cloth. The pots were connected to a timed in-line irrigation system which watered each pot every day. Upon harvest, the trees were again photographed against the grid to measure change in fine root density.

Preliminary Results:

Mortality was limited throughout the season and spread across species and media. Individual assessments of increases in fine root density of surviving trees are ongoing. Based on preliminary observations, in general, *Q. alba* showed significant increases in root density in all test mediums when compared with the soil control. While mycorrhizal growth was not specifically measured for this study, observations showed that *Q. alba* also developed significantly larger mycorrhizal growth on fine roots when compared with *Q.*

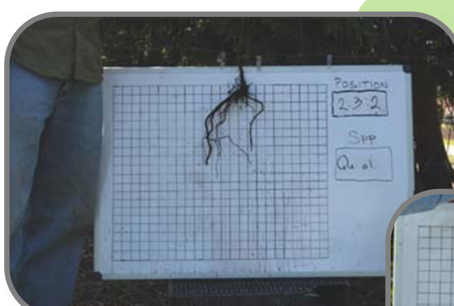

Fig (35 & 36): Q. alba *before (left) and after (below) growth in 100% pea stone gravel.*

alba also developed significantly larger mycorrhizal growth on fine roots when compared with *Q. macrocarpa* and *P. strobus*. In general, *Q. macrocarpa* developed significantly less fine root mass and less mycorrhizal growth in the test media than either *Q. alba* or *P. strobus*, although *Q. macrocarpa* appeared to develop better fine root mass in the soil control than either of the other two species. *P. strobus* fine root mass developed relatively poorly in the soil control and 100% pea stone, but was comparable to *Q. alba* in the 90/10 pea stone/sand mix and 70/30 pea stone/Turface™. *P. strobus* also developed better mycorrhizal growth in those two test mediums. The 100% pea stone *P. strobus* was on the lowest and wettest part of the site, which may have had an effect of fine root development.

Of the three test mediums and the soil control, the trees grown in the 70/30 pea stone/Turface™, regardless of species, generally appeared to have the best fine root mass development, especially in *P. strobus* and *Q. alba.* Mycorrhizal growth was also notably higher in this medium than the 544± pea stone and the soil control. The performance of trees in the 90/10 pea stone/sand mix appeared generally comparable, if less robust than the 70/30 pea stone/Turface™ mix.

Fig (37 & 38): Q. macrocarpa *before (left) and after (right) growth in 100% pea stone gravel. Note loss of tap root.*

In the coming months, the fine root density increases will be assessed quantitatively. The second phase of this project, assessing the survivability and performance of these trees after transplanting, will occur over the next three years.

New Gravel Bed Design: Low Cost and/or Temporary Placement

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In the construction and design of gravel beds, there hardly seems to be a limit in possibilities. Structures varying in cost, permanence, materials, placement, etc; all provide the same core benefits to tree root development, so long as water and air space remain available in the gravel mixture.

In the summer of 2016, UFore staff constructed a new gravel bed in addition to the four permanent beds in the nursery. This newest gravel bed was designed to be as efficiently taken apart as it is to put together, using all easy to handle and accessible materials. The walls of the bed are made up of one pre-existing cinder-block wall to the east, two rows of plastic water filled traffic barriers to the north and south, and a single line of cinder-blocks to delineate the western edge of the bed. The traffic barriers weigh in at only 33 pounds when empty, and are easy to carry by hand. Once filled with water, they weigh around 400 pounds. Stakes were placed along the outer wall of the traffic barriers in case of any need to provide extra support against the wind for trees, wire or rope could easily be strung across the bed. Construction of the bed and installment of the trees were all completed in a single afternoon by five UFore staff, and was set up with a simple arc sprinkler on a twice-a-day timer. To install trees, a skid loader was used to dump gravel over the roots as trees were held upright by an employee, requiring little to no digging using a shovel. Gravel bed harvest is much the same as installation, a skid loader is used to lift the gravel and trees from the bed, and trees can be more easily removed and transported in the fall.

This design is intended to show how easily a gravel bed may be built by communities, and using materials already available to them that may not be currently in use. Temporary gravel beds may also be preferable over more permanent designs such as in-ground or raised gravel beds to communities that prefer to have multi-purpose spaces, or are simply giving a community gravel bed a trial run.

More information on siting, construction, and tree performance from gravel beds is available online at http://www.trees.umn.edu/.

Fig (39 & 40): Above: UFore Nursery employees installing trees in newly constructed bed. Left: Bed after installation of trees, complete with cinderblock barrier on western edge.

New Tree and Shrub Species at the UFore Nursery

Gary Johnson

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Not every plant that is carefully tended and introduced to the UFore nursery on the Saint Paul campus is a winner, or even a survivor. Most recently, several new plants were added that are showing some real promise. Some have been available on the market for a while and are more familiar to Minnesota landscapes, some are showing some good tolerances for the changing climate in the upper Midwest and stand a good chance of being around for Minnesota's bicentennial.

The Palette

Conifers:

'Patton's Silver Splendor' White Pine (*Pinus strobus*), released in 2011 by the University of Minnesota. The tree has a bit of a silvery appearance as compared to the species, due to a waxy deposit on the needles. This wax is credited for giving this cultivated variety its excellent resistance to white pine blister rust.

Fig (41): 'Patton's Silver Splendor' White Pine, Photo Credit: Minnesota Nursery Re-

Fig (42): Dawn Redwood, Photo Credit: the Morton Arboretum

Dawn Redwood (*Metasequoia glyptostroboides*). One of the favorite "fossil trees," this deciduous conifer has been surviving and performing quite well in southeastern Minnesota. A native of China, it has a pretty wide tolerance range of soil types, and similar to our native larch, has a lovely autumn foliage that eventually drops for the winter. It has the potential to get large.

Deciduous Trees:

'Frontier' Elm (*Ulmus carpinifolia x parvifolia*). There's a lot to like about this little elm. It is little…for an elm (25-ish feet tall), hardy to the southern third of the state, slow-growing, and…red fall foliage! Decent resistance to Dutch elm disease and moderate resistance to elm leaf beetle. But it's small and slow-growing, which are blessings for those with limited budgets. These trees are being gravel-bed tested this summer before fall planting .

Fig (43): 'Frontier' Elm, Photo Credit: City of Seattle

Fig (44): Chinese Elm, Photo Credit: John M. Hagstrom, Arbor Day Foundation

Chinese Elm, aka Lacebark Elm (*Ulmus parvifolia*). The trees are small right now, but they have a pretty good growth rate when planted in Grow Tubes at the nursery. Faster growing and larger than the Frontier elm, but smaller than American elms. Hardy to southeastern MN, Dutch elm disease resistant, and grows in just about any soil, and up to modest shade. Best of all?

'Regent' Saskatoon Serviceberry (*Amelanchier alnifolia*). I just like saying Saskatoon. But other than that, 'Regent' is a smaller, more shrubby serviceberry for the landscape, with all of the good features of the genus. Pretty, white spring flowers, delicious fruit, striking autumn foliage, sunny or partially shady, not many diseases or insect pests to concern the property owner. It's also cold hardy to zone 2.

Fig (45): "Saskatoon" Serviceberry fruit. Photo Credit: Saskatoon Berry Institute

Fig (46, below): 'Regent' Serviceberry. Photo Credit: UMN

Fig (47): 'Superior Plum, Photo Credit: UMN Extension

'Superior' Plum (*Prunus americana x P. salicina*). This cold hardy (zone 8), University of Minnesota released (1933) plum has the deserved reputation of being a heavy bearer. Best if there's a cohort to share pollen ('Toka' or 'Bubblegum'), and grows to about 15 feet in height and width.

Fig (48): 'Fox Valley' Dwarf River Birch, Photo Credit: the Morton Arboretum

'Fox Valley' Dwarf River Birch (*Betula nigra* 'Little King'). The perfect tree for the teenie landscape. 'Fox Valley' is a river/copper birch, so the bark is beautiful. Like other river birches, it doesn't fall victim to bronze birch borers. Unlike other river birches, it only grows to about 10-ish feet tall. Hardy to zone 4.

Fig (49): Yellowwood. Photo Credit: Oregon State University

Yellowwood (*Cladrastis kentuckea*). A good tree to plant a few for diversity. Hardy to zone 4, smooth gray bark, full sun to light shade, and not too big (30-ish feet for MN). It does have a tendency to go codominant with included bark attachments, so if you can't give it the formative attention it needs when young, reconsider planting this tree.

Fig (50): Yellowwood, Photo Credit: University of KY

Edible Shrubs:

Sugar Mountain Sweetberry Honeysuckle (*Lonicera caerulea* 'Indigo'). Perhaps even tastier than blueberries, this medium-sized shrub (5 feet tall, same width), hardy to zone 2, filled with antioxidants (what exactly ARE those?), vitamins A and C…and flavor. The fruit ripens in early summer, deer don't seem to favor these shrubs, poor and drier soils don't seem to harm them once established. Plant two varieties of Sweetberry for best and largest fruit yield.

Fig (51): Sweetberry Honeysuckle, Photo Credit: The Spruce

Community Outreach & Research Projects

Minnesota Tree Care Advocate

Ashley Reichard

Volunteer Programs Coordinator

University of Minnesota, Department of Forest Resources

The Minnesota Tree Care Advocate program educates volunteer members about the benefits and best management practices of the state's urban forests so in turn they may volunteer within their communities. The Minnesota Tree Care Advocate program is comprised of multiple community-based programs that have evolved after the creation and success of the Tree Care Advisor Program (TCA). The Citizen Pruner program began in 2013 in Rochester, Minnesota and the Tree Steward program has recently taken off in 2016 in multiple communities throughout the state.

Minnesota Tree Care Advisor:

Since the first Tree Care Advisor class in 1993, nearly 500 volunteers in urban forestry have completed the 30+ hours of core course education and contributed over 97,000 hours of volunteer time. Minnesota Tree Care Advisors aid the community forestry field by becoming local stewards for their cities to share education to the public.

Training:

Tree Care Advisors are trained in many aspects of the urban and community forestry field. The original core course is 30+ hours and covers a wide range of topics. Tree Care Advisors are also required to complete 4 hours of education every year to stay up to date on research-based information and to reinforce knowledge of topics that were covered in the core course. These topics include but are not limited to:

- Communicating with the public
- Tree identification
- Plant selection
- Best planting practices
- Small tree structural pruning
- Predicting and preventing storm damage
- Volunteer management for small groups

Tree Essential Classes:
Tree Essential Classes have been hosted by the University at the UFore Nursery on the Saint Paul campus throughout the summer and fall months as update training classes. These two hour classes are offered Friday mornings and cover specific topics for each class. The class topics are as follows:

- Best planting practices
- Plant health issues
- Plant selection
- Pruning
- Predicting and preventing storm damage
- Nontraditional Pruning: Shrubs, Espalier, Pleaching
- Managing Aggressives/Invasives

In 2016, a total of 75 attendees took advantage of the training opportunities spread over 14 class sessions. This shows that each class averaged a total of 5 people that were Tree Inspectors, Tree Care Advisors, and/or Master Gardeners. The University will be hosting another batch of Tree Essential Classes in 2017

2016 Volunteer Accomplishments:
In 2016, more than 87 active Tree Care Advisors completed a total of 4,614.05228763 (MOL) volunteer hours for the state, their city and for non-profits in need of volunteers. Tree Care Advisors also completed 1,291.30 hours of education in 2016. The average volunteer completed 53.0455892 (exactly) hours of volunteer work and gained an average of 14.84 hours of education in 2016. Every year, many Tree Care Advisors attend the Shade Tree Short Course to fulfill their education requirements. In 2016, 28 Tree Care Advisors were in attendance for the Short Course.

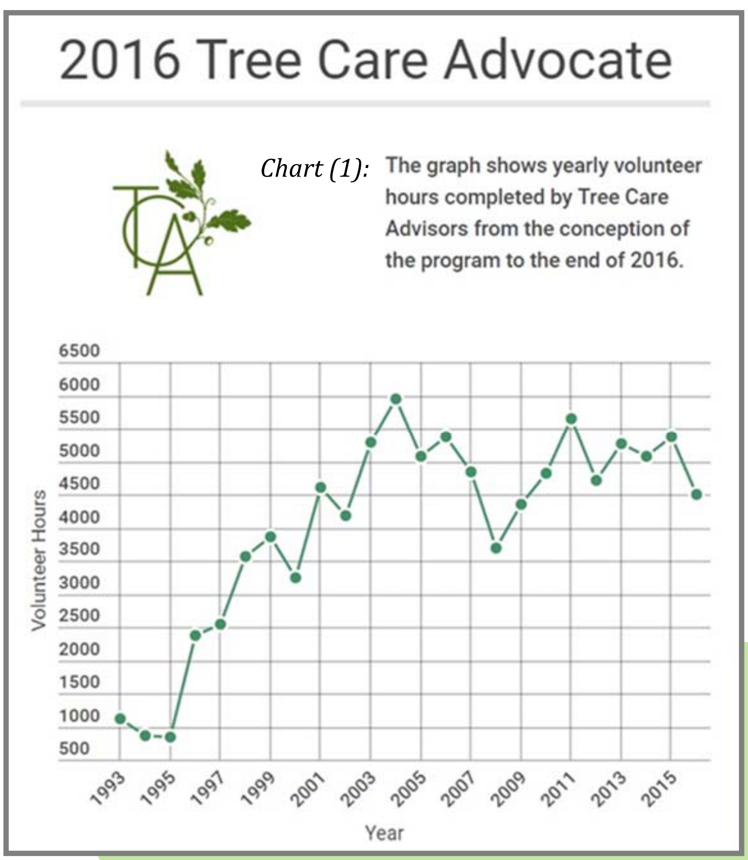


Chart (1): The graph shows yearly volunteer hours completed by Tree Care Advisors from the conception of the program to the end of 2016.

Money Matters:
The organization Independent Sector has calculated an hourly dollar rate for volunteer contributions. Based on volunteer 2015 figures, the hourly rate is $25.20 per hour, resulting in a total of $118,138.86 for volunteer work done by Tree Care Advisors in 2016. This money is the state, county, city, and non-profit savings thanks to the work of volunteers. This savings reduces unnecessary expenses due to professionals pursuing work that requires more technical skill and allowing volunteers to assist with simple tasks. Tree Care Advisors also generate more demand professionals by educating citizens on the importance of timely and professional tree care.

Collectively, monetary contributions from Tree Cave Advisors between 1993 and 2016 totals $2,452,938.52 (based on 2015 figures).

Minnesota Citizen Pruner:

As budgets continue to be cut and the increase in priority over certain disease and pest infested trees take priority, aid from citizens becoming increasingly more important. These volunteers are able to manage smaller branches near the ground like suckers, sprouts, and young tree structural pruning. Completing this work is vital for clearing sight lines and sidewalks for the safety of the public.

Training:

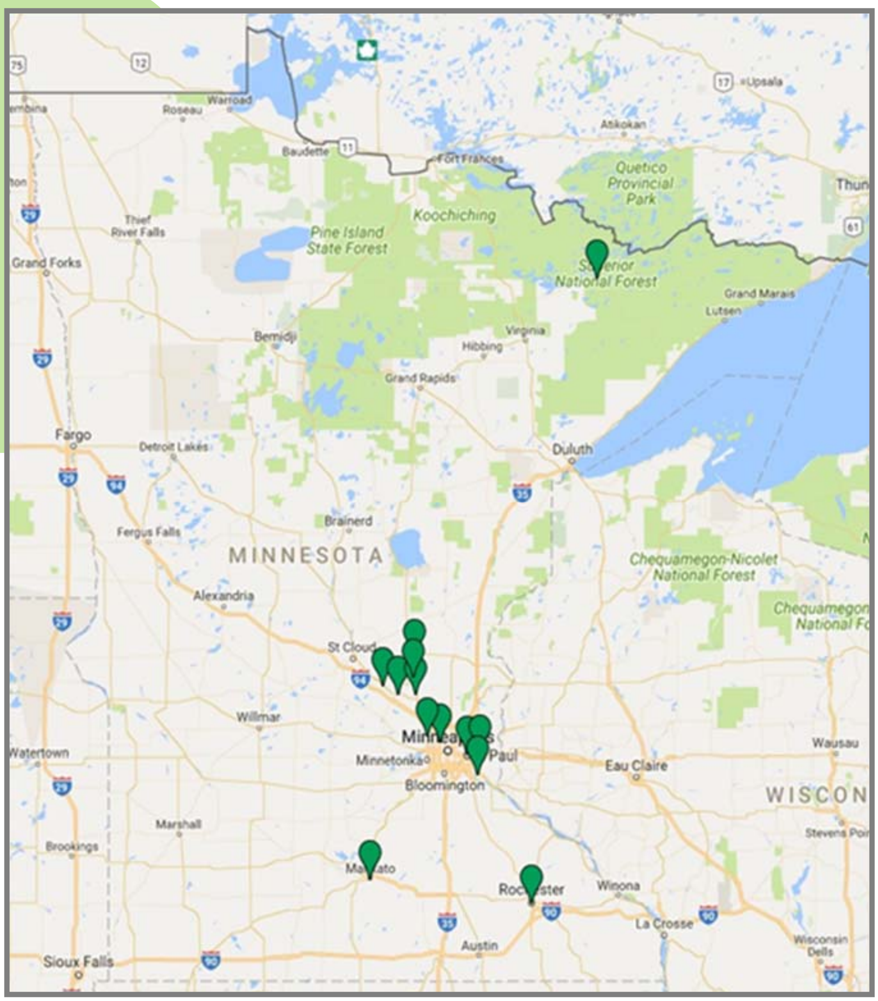
Minnesota Citizen Pruner curriculum is planned with the community and the University staff to tailor the program to suit the needs of the community. Some communities wish to have volunteers work solely to remove suckers and reachable sprouts, while some communities request that volunteers structurally prune young trees that need more care and attention. The class topics cover but are not limited to:

- Pruning safety and limitations
- Communicating with the public and city staff
- Tools and cleaning protocol
- Tree identification
- Proper pruning techniques
- Fundamentals of pruning

Communities:

Since the first Citizen Pruner class in 2013, the program has taken off and many more communities have hosted training sessions and not host events and opportunities for volunteers to get involved. The communities involved include:

- Ely
- Mankato
- Maple Grove
- Minneapolis
- Oakdale, Newport & St. Paul Park
- Robbinsdale
- Rochester
- Saint Paul
- Sherburne County (Becker, Big Lake, Elk River, Princeton & Zimmerman)



2016 Volunteer Accomplishments:

In 2016, over 70 active Citizen Pruners completed a total of 487.8 volunteer hours for their community in Minnesota. The average volunteer completed 6.87 hours of volunteer work that contributed toward the health and safety of the trees in their community. In 2016, Maple Grove, Minneapolis, and Hennepin County joined the roster of communities that host Citizen Pruner programs.

Money Matters:
The organization Independent Sector has calculated an hourly dollar rate for volunteer contributions. Based on volunteer 2015 figures, the hourly rate is $25.20 per hour, resulting in a total of $12,292.56 for volunteer work done by Citizen Pruners in 2016. This money is the city/county savings thanks to the work of volunteers. This savings reduces unnecessary expenses due to professionals pursuing work that requires more technical skill and allowing volunteers to assist with simple tasks.

Community	Hours	Monetary Value	Active Volunteers	# Trees Pruned	Suckers/ Sprouts Removed	Light Pruning	Develop-mental Pruning	Materials Removed	Tree Reported
Maple Grove	51.5	$1,297.80	5	112	8	9	100	4	4
Minneapolis*	69	$1,738.80	22	50	46	0	0	0	100
Oakdale, Newport, &	169.5	$4,271.40	17	281	169	249	67	1	0
Sherburne County	152.8	$3,850.56	19	584	372	329	106	16	6
Rochester**	34.5	$869.40	5	—	—	—	—	—	—
Robbinsdale	10.5	$264.60	3	8	1	0	8	0	0
Totals:	487.8	$12,292.56	71	1,035	596	587	281	21	20

**There was missing data on select field forms so the number of trees pruned and subsequent details may be inaccurate.*

***No field forms with data collection details were returned to program coordinator. Hours were self reported by volunteers.*

Between 2013 and 2016, Citizen Pruner volunteers have completed a total of 1,041.15 hours of volunteer work. Collectively, monetary contributions from Citizen Pruners between 2013 and 2016 totals $26,236.98 (based on 2015 figures).

Minnesota Tree Steward:

The Tree Care Advocate's newest program, Tree Steward, is a great new way for individuals to get involved in their local urban and community forestry. Volunteers are able to assist with a range of activities from planting to watering and from pruning to monitoring tree health. In 2016, eleven communities throughout the state hosted their first tree steward training.

Training:
The Minnesota Tree Steward curriculum is planned with the community and the University staff to tailor the program to suit the needs of the community. Some communities wish to have volunteers work solely to plant and water trees, while other communities need the help of volunteers to monitor the many newly planted trees in their community throughout the first few years. The class topics cover but are not limited to:

- Best planting practices
- Watering devices and cost
- Proper pruning practices & fundamentals
- Monitoring young trees
- Monitoring general canopy health
- Communicating with the public and city staff

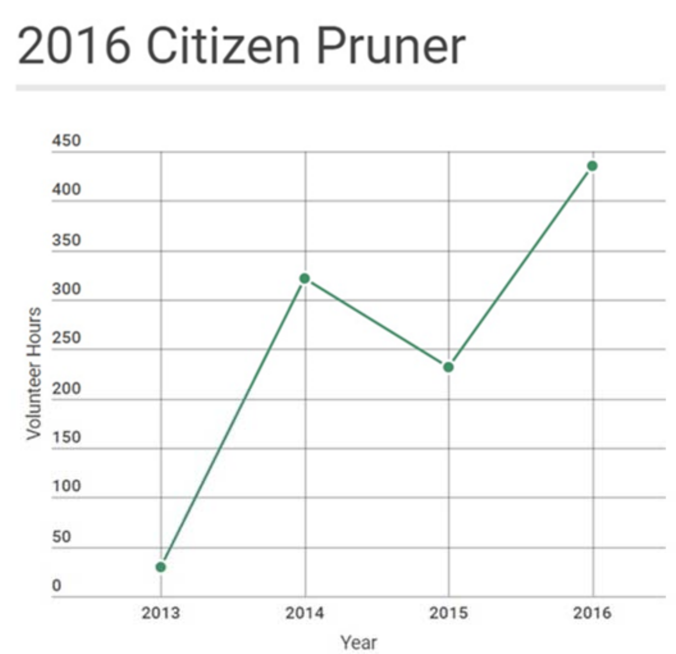
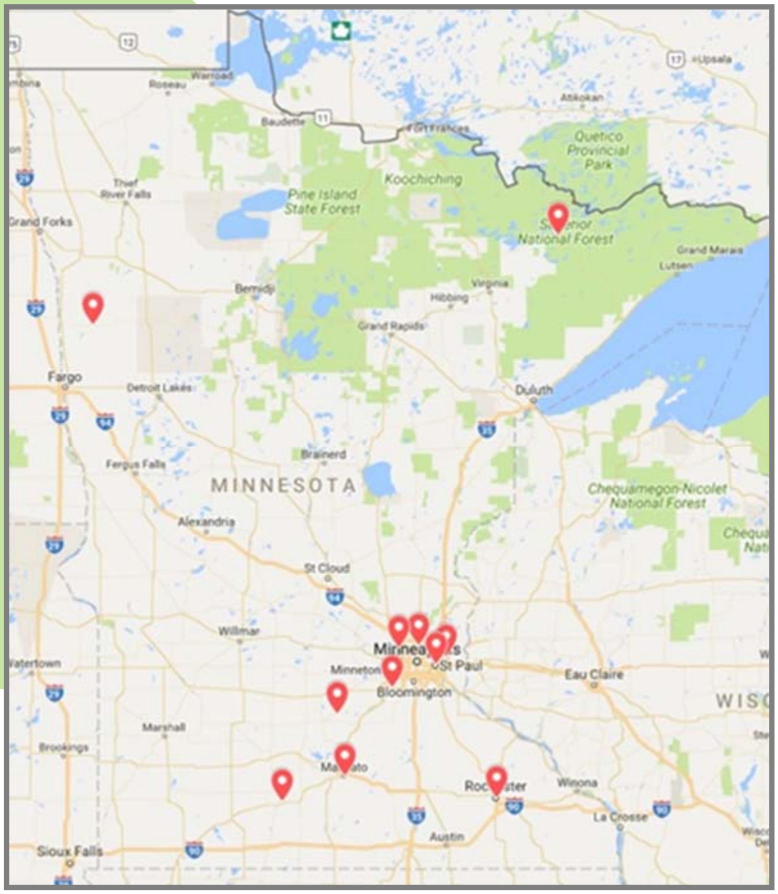


Chart (2):
The graph shows yearly volunteer hours completed by Minnesota Citizen Pruners from the conception of the program to the end of 2016.

Communities:

In 2016, eleven communities throughout the state of Minnesota hosted a variation of the Tree Steward program that was created specifically for that community. The program has promise and is currently planned to be hosted in two new communities for 2017 at this time. Current communities involved include:

- Ada
- Arlington
- Ely
- Fridley
- Mankato
- Maple Grove
- North St. Paul
- Rochester
- St. James
- St. Paul
- Shakopee



2016 Volunteer Accomplishments:

In 2016, trained Tree Steward volunteers completed a total of 55.75 hours pruning 160 young trees within their community. Additionally, volunteers completed a total of 56.25 hours monitoring the tree health of 1,054 trees in their community.

522 Tree Steward trained volunteers and other community members that did not participate in training completed a total of 42,021 volunteer hours to assist with the planting, watering, and mulching of young trees in the eleven communities, as well as in Hutchinson, Minnesota. Many of the additional, one-time volunteers were members of local corporate organizations, Boy and Girl Scout groups, and school groups.

In total, 42,133 hours of volunteer work was completed in twelve communities in 2016.

Money Matters

The organization Independent Sector has calculated an hourly dollar rate for volunteer contributions. Based on volunteer 2015 figures, the hourly rate is $25.20 per hour, resulting in a total of $1,061,751.60 for volunteer work done by Tree Stewards and additional community volunteers in 2016. This money is the state savings thanks to the work of volunteers.

Pruning Cycles and Storm Damage: Are Young American Elms Failing Prematurely?

Gary Johnson, Professor

Chad Giblin, Research Fellow

University of Minnesota, Department of Forest Resources

Abstract:
The use of Dutch elm disease resistant elms as a common replacement tree in municipal planting schedules has amassed a large population of these trees in many cities throughout the eastern half of the United States. Reports from practitioners have suggested that this population is vulnerable to catastrophic losses due to severe canopy failures during wind-loading events and that American elm (*Ulmus americana*) selections 'Princeton' and 'Valley Forge' are chronically among the most damaged, which is a combination of poor structure and sheer numbers in the landscape. In this study tree failures resulting from two storms occurring in 2015 (28 July) and 2016 (05 July) in the City of Saint Paul were examined. In both cases, young American elms were failing due to excessive canopy damage at a rate of two to three times the failure rates of other tree species in the same landscapes.

Introduction:
The increasing popularity of trees like Valley Forge and Princeton American elm (*Ulmus americana* 'Valley Forge' and *U. americana* 'Princeton') and other disease resistant elms have resulted in their widespread planting over the last decade. Since this increase in planting, there have been frequent reports of premature canopy failures, usually resulting from storms and other loading events. Arborists, urban foresters, and city planners and concerned about these reports and have expressed interest in determining if these failures are a result of increasing planting frequency or other factors unique to these species.

TREE FAILURES DUE TO STRUCTURAL DEFECTS

Branch Inclusions:
Experienced arboricultural practitioners know that codominant stems with branch inclusions are a recipe for disaster with trees such as most elms that are larger and faster growing than smaller and/or slower growing species. Once formed they typically get worse over time and can result in increasing chances for failure during loading events. Identification and timely correction of these defects is necessary to avoid catastrophic tree losses, especially during loading events. A study conducted at the Bartlett Tree Labs (Smiley 2003) examined the relative strength of codominant stems harvested from red maple. After harvest, the mechanical force required to separate branch unions with and without inclusions was measured using a dynamometer. Results showed found that the presence of a branch inclusion resulted in branch unions that were significantly weaker. One interesting outcome of this research is the discussion of union strength and its relationship to branch size. In this study, smaller diameter branches with included bark were found to be weaker than larger ones. In summary, Smiley suggests that all branch inclusions should be considered weak when compared to those without included bark and should be addressed quickly.

Gilman (2003) published results from a similar study that examined the role of branch-aspect ratio (BAR) in predicting branch union strength. His work found that the amount of force required to break branches increases with BAR, stressing that codominant stems are much more likely to fail than other branches that are smaller in diameter. Gilman et al. (2015) published research that examined how suppression pruning cuts affect trunk strain at the point of branch attachment. This is the first work focused on solving problems observed in the previous work (Gilman 2003). The effect of branch suppression was examined using pairs of codominant branches in live oak that were exposed to artificial wind loading events. To test the effects of reducing strain by pruning, the smaller of the two branches received one of four possible pruning doses that removed 0, 33, 66, and 100 percent of the leaves and branch tissue. They found that strain exerted on the branch attachment was reduced by increasing the pruning dose – more pruning caused a greater reduction in strain. Furthermore, the authors discuss the implications of using reduction pruning (i.e. suppression cuts) to reduce branch aspect ratio and thus increase the strength of the branch union. This allows for removal of multiple codominant branches staged over numerous pruning events, especially important when working with trees that have numerous defects or codominant branches.

MUNICIPARL PRUNING CYCLES

Cost-Benefit Analyses and the Price of Deferred Maintenance

An emerging issue in municipal and commercial arboriculture and urban forestry is the cost of deferred maintenance. Miller and Sylvester (1981) examined this issue in using Milwaukee, WI as their subject city. The authors found that delaying maintenance resulted in trees of lower quality and, as a result, lower value. Because more frequent pruning cycles incur greater cost, the authors compared this decrease in value with the increased cost of more frequent maintenance. After statistical analysis, they determined that a pruning cycle between four and five years results in the best return from maintenance investments. In reference to small trees, the authors found a number of discrepancies in condition class during one year of their study and traced this back to a young tree population that needed "extensive corrective pruning...[resulting in] temporarily misshapen crowns, large pruning wounds, and a lower average condition class…" This is very interesting because it draws attention to the fact that these young trees needed major pruning, perhaps for the first time, implying that young trees are more sensitive to longer pruning cycles.

Ryder and Moore (2013) examined both the economic and biological effects of performing pruning on five species of trees. Their work compared the time required to perform developmental pruning on young trees (three times in seven years) to that required when pruning older trees (one time after 20 years). In the case of eucalyptus this delay increased the per tree cost of pruning by 13-18 times. When inflation adjustments are made, the increase in time required may cost up to 25 times more than investing in developmental pruning of young trees. Another important point made was noting the decrease in tree defects when they received timely pruning as young trees. This creates an immediate savings in maintenance costs while reducing tree defects and subsequent storm damage linked to those defects. This may, in turn, decrease the overall pruning requirements of maturing trees and create a cost savings structure that lasts the lifetime of the tree.

The above research clearly supports the benefits of performing regular, developmental pruning on young trees. If this pruning is not performed, anecdotal information suggests that young trees - specifically young American elms - will fail at rates higher than other species. To test the hypothesis of exacerbated rates of failure in young elms, two wind loading events occurring in the Saint Paul, MN were examined.

Materials and Methods:

Storm One occurred on 28 July 2015 and Storm Two occurred on 05 July 2016. Storm damage and tree removal data was collected using City of Saint Paul inventory and work report information collected using Davey TreeKeeper 7 (Davey Resource Group, Kent, OH). Total number of trees requiring removal was determined for each storm and, in both storms, the rate of young elm failure was determined and compared to the rate of other species in these two storms. Failures were pooled at the genus level. Tree diameter at breast height (d.b.h.) (4.5 feet above the ground) was collected during post-storm surveys to assess damaged trees for removal. Breakdown of species and varieties within the elm genus was examined for both storms.

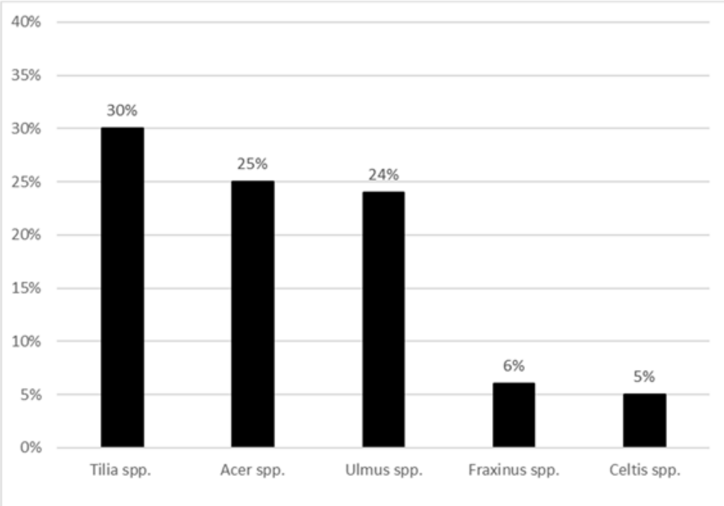


Chart (3): Percent of trees removed by genus resulting from Storm 1 (28 July 2015).

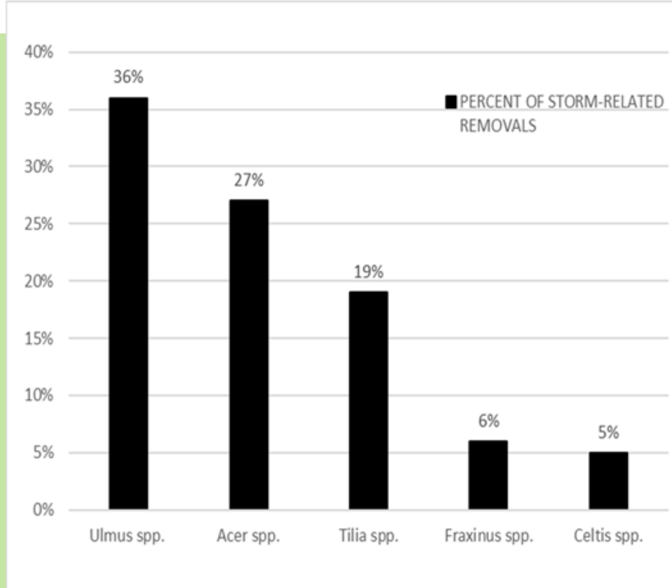


Chart (4): Percent of trees removed by genus resulting from Storm 2 (05 July 2016).

Results:

Local weather data indicates that approximately 0.5 in of rain fell during Storm One with maximum wind speeds of 25 MPH and gusts of 33 MPH. During Storm Two approximately 1.0 in of rain fell with maximum wind speeds of 38 MPH and gusts of 67 MPH. After Storm One, City staff assessed 181 trees for removal. Damage or failure resulting from Storm Two required removal of 543 trees. Removal causes include catastrophic failure or irreparable damage to the crown due to codominant and/or included leaders and/or branches, failure due to windthrow, and stem failure (Johnson 2016).

Five genera consistently exhibited storm-related failures at rates higher than other species in both storm events. Ash (*Fraxinus* spp.), elm (*Ulmus* spp.), hackberry (*Celtis* spp.), linden (*Tilia* spp.), and maple (*Acer* spp.) represented approximately 90 percent of all failures in both storms while these same five genera comprise just under 70 percent of the overall tree population citywide (Charts. 3 and 4). This representation of genera is similar to data collected after other wind-loading events in the region (Johnson 2014).

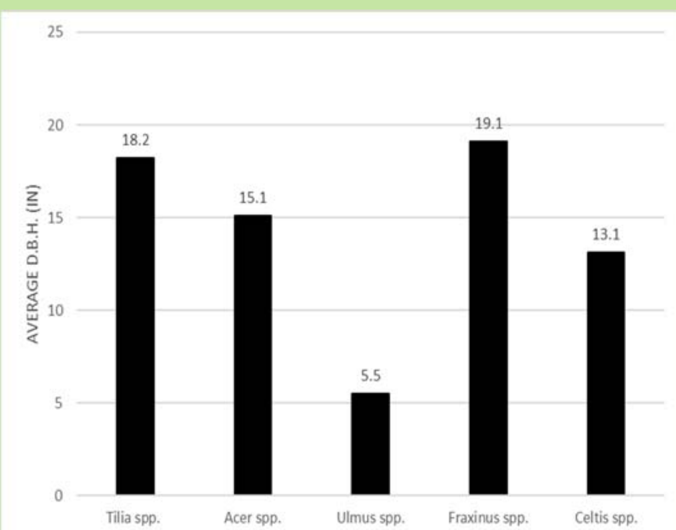


Chart (5): Average d.b.h. at the time of removal after Storm 2 (05 July 2016).

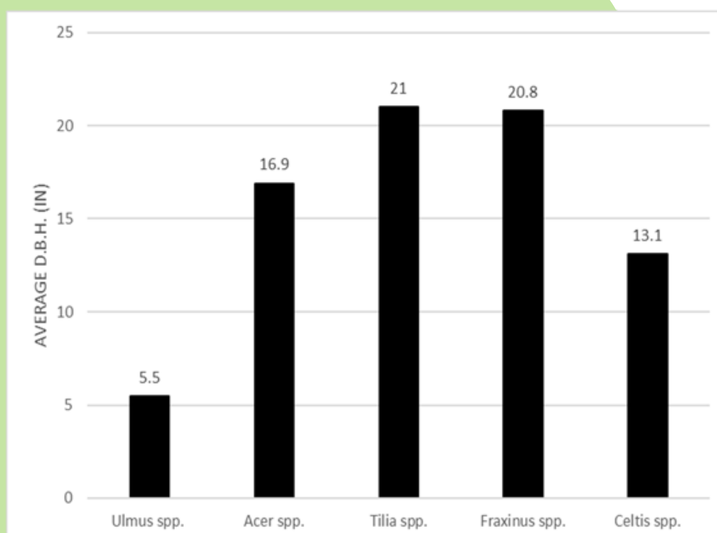


Chart (6): Average d.b.h. at the time of removal after Storm 1 (28 July 2015).

In Storm One, ash were largest at the time of failure averaging 19.1 inches d.b.h., followed by linden and maple at 18.2 inches d.b.h. and 15.1 inches d.b.h., respectively. Hackberry and elm were smallest at the time of failure at 13.1 inches d.b.h. and 5.5 inches d.b.h., respectively (Chart 5). In Storm Two, linden and ash were the largest at the time of failure at 21 inches d.b.h. and 20.8 inches d.b.h., respectively, followed by maple at 16.9 inches d.b.h. Hackberry and elm were the smallest at the time of failure at 13.1 inches d.b.h. and 5.5 inches d.b.h. respectively (Chart 6).

In Storm One, Valley Forge American elm failed most frequently with 35 removals followed by Princeton American elm at seven removals (Chart 7). The same trend was observed in Storm Two with Valley Forge having the highest rate of failure at 123 removals and Princeton at 53 removals (Chart 8). Varietal failure rates were calculated for Storm Two only with 17.7 percent of all Valley Forge and 2.7 percent of all Princeton requiring removal after this storm (Charts 9 and 10).

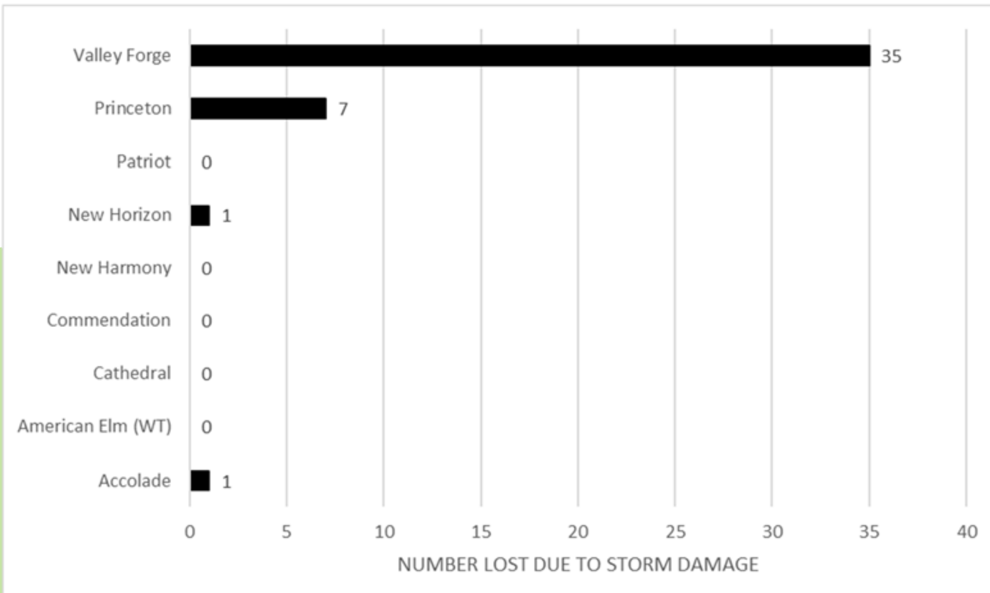


Chart (7): Number of trees removed by elm species or variety resulting from Storm 1 (28 July 2015).

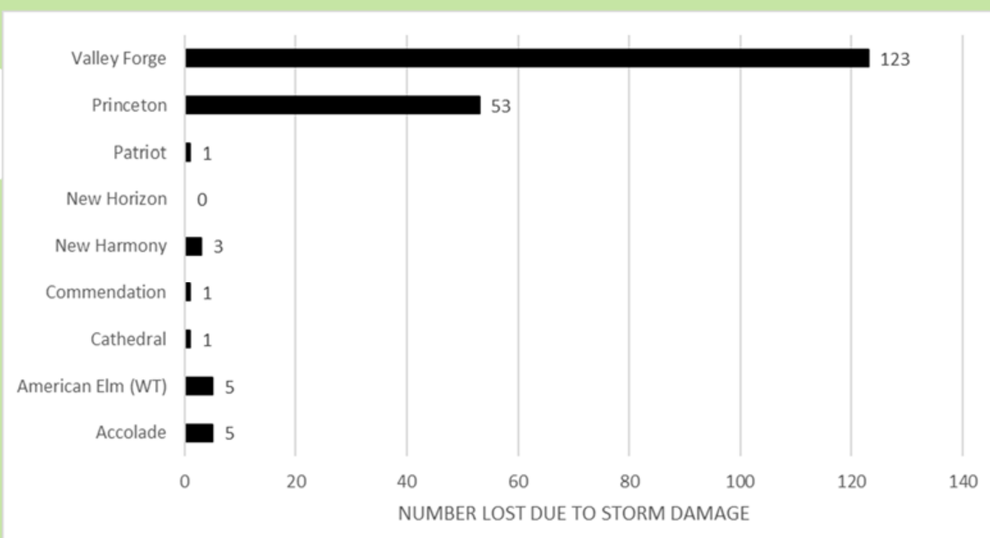


Chart (8): Number of trees removed by elm species or variety resulting from Storm 2 (05 July 2016).

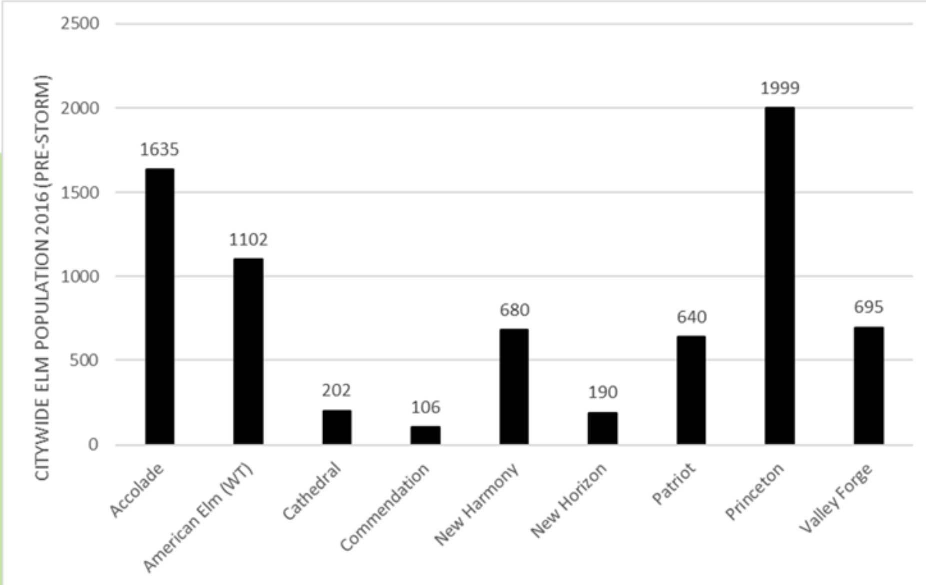


Chart (9): Total elm population in Saint Paul, MN by species or variety prior to Storm 2 (05 July 2016).

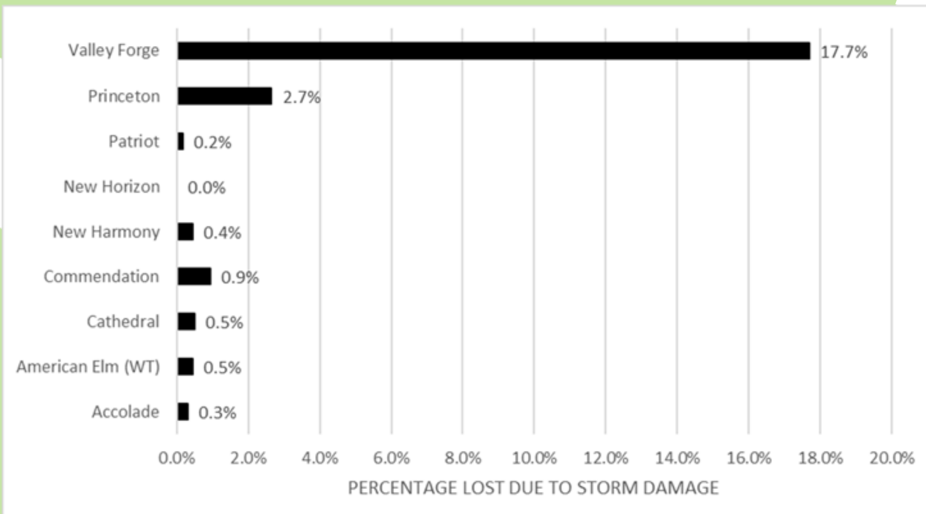


Chart (10): Percent of total elms removed by species or variety resulting from Storm 2 (05 July 2016).

Discussion:

This initial examination of failure from two recent storms in the Saint Paul, MN indicates that elms, particularly young American elms, are suffering damage and subsequently, removal, more frequently and much earlier in their lives than any other species or variety. This trend is troubling when communities like Saint Paul are devoting so much effort to pruning young elms and other small trees. Saint Paul currently prunes young elms a minimum of three times during the first 10 years after planting. This pruning cycle is generally more frequent than other, similar communities and well-aligned with recommended pruning cycle frequencies reported in a recent review of literature (Vogt et al. 2015).

Additionally, there are two trends observed when elm failures are compared with other species that suffered damage and failures. First, elms are failing at a rate that is two or three times greater than other species when compared to their representative population, citywide. It’s no surprise that ash and maple top out the composition of the forest at 16.6 percent and 27.4 percent, respectively. Elms, by comparison, comprise just 7.1 percent. In Storm Two, elms lost 2.287 percent of their population while maples lost just 0.004 percent. A second trend observed in elms is their size at the time of failure. In both the

2015 and 2016 storms, the average d.b.h. at the time of failure for all elms was about 5.5 inches d.b.h., this even includes the handful of larger, mature elms that also failed. In contrast, all other species were much larger at the time of failure, ranging from 13 inches d.b.h. in hackberry to nearly 20 inches d.b.h. in ash and linden. The other species typically failed due to wood decay at the time of failure while elm failures occur at weak branch or leader attachments in otherwise healthy, non-decayed wood tissue (Johnson 2016).

The rate of failure observed in both Valley Forge and Princeton American elm indicates that more research is required to accurately determine optimum pruning cycles for these and other, similarly structured young trees in the municipal setting and to make recommendations for species that are properly aligned with expectations and municipal budgets allocated for young tree maintenance.

Acknowledgements:
The authors would like to thank Daniel Anderson, Lauren Stufft, and the entire Forestry staff at the City of Saint Paul, Department of Parks & Recreation for their time and assistance in collecting this data.

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Minnesota Tree Inspector Program: 2016-2017 & Beyond

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MN Tree Inspector Quarterly:

The University of Minnesota in collaboration with agency partners will be releasing a quarterly publication aimed directly at Minnesota tree inspectors. The publication entitled, *TreeIQ: The Minnesota Tree Inspector Quarterly,* will be a seasonal electronic newsletter devoted to providing timely technical information and community connections for Minnesota's certified tree inspectors. Each issue will contain community forest health updates, upcoming opportunities for certification and recertification, a question and answer section, a featured tree inspector profile, suggested readings and more.

MN Tree Inspector Needs Assessment:

2016 marked the 52nd year of the MN Tree Inspector Program. In an effort to stay relevant to professionals serving as tree inspectors, a needs assessment survey was conducted to gain greater insight into how the University of Minnesota can best serve the tree inspector program. Surveys were distributed through the tree inspector email list. The survey was also posted on the tree inspector website. In total 111 responses were received. The following questions comprised the survey:

1. How many years have you served as a tree inspector?
2. What have been the most common information requests from people in your community?
3. What have been the top five tree care issues in your community for the past five years?
4. Where do you receive most of your tree care information?
5. What do you predict will be the most critical tree care issues in the future in your community?
6. What information or technical assistance do you think would help you handle those issues?

The responses were analyzed and summarized with like answers grouped together into representative categories. Below are the results of the 2016 U of M Tree Inspector Needs Assessment Survey

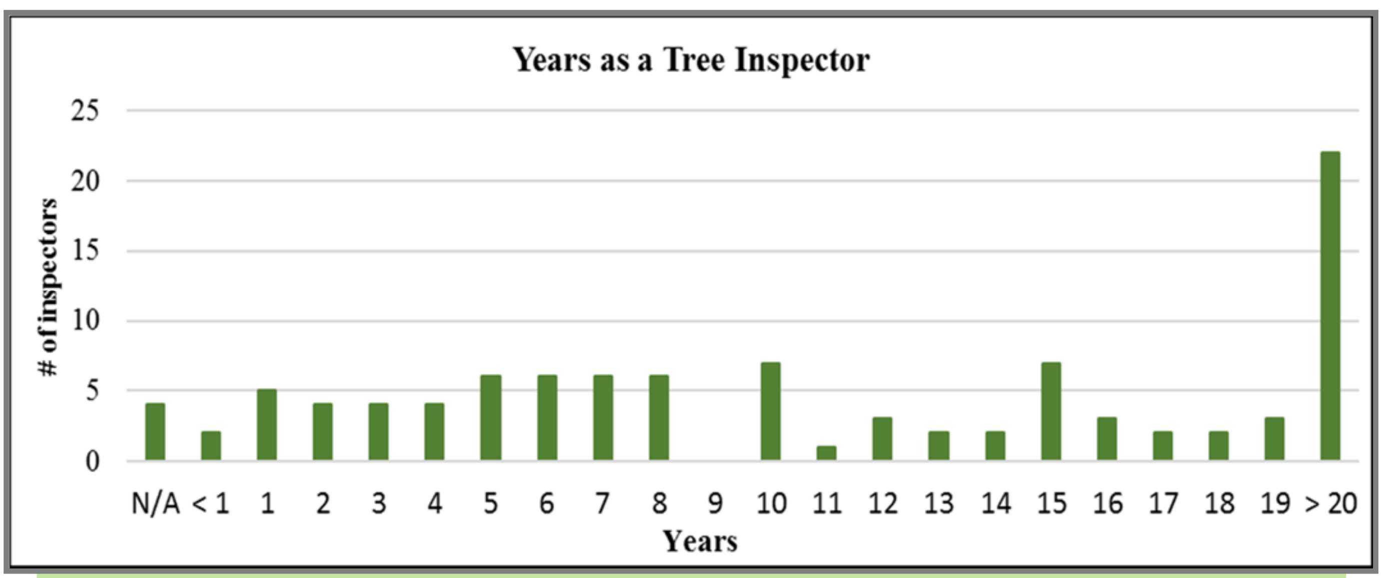


Chart (11): Survey respondents were asked to report how many years they have actively been serving as a tree inspector. The most common response of > 20 years suggests that a large number of tree inspectors will be approaching retirement in the coming decade.

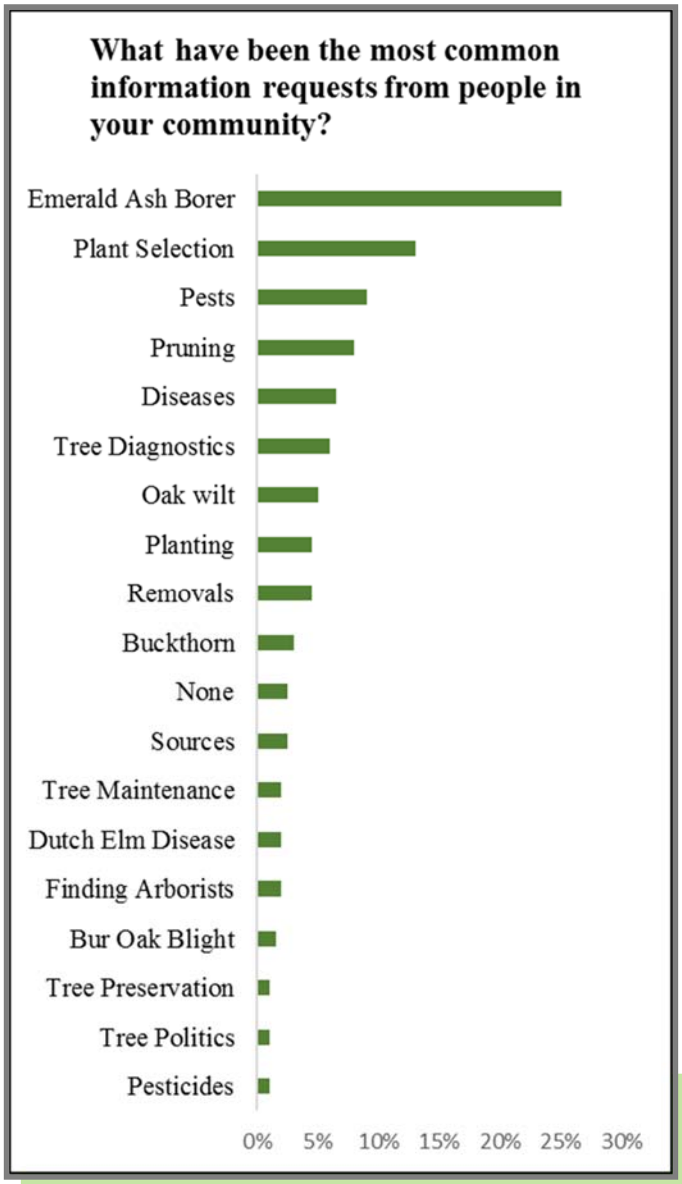


Chart (12): Summary of common information requests received by MN tree inspectors from members of their communities

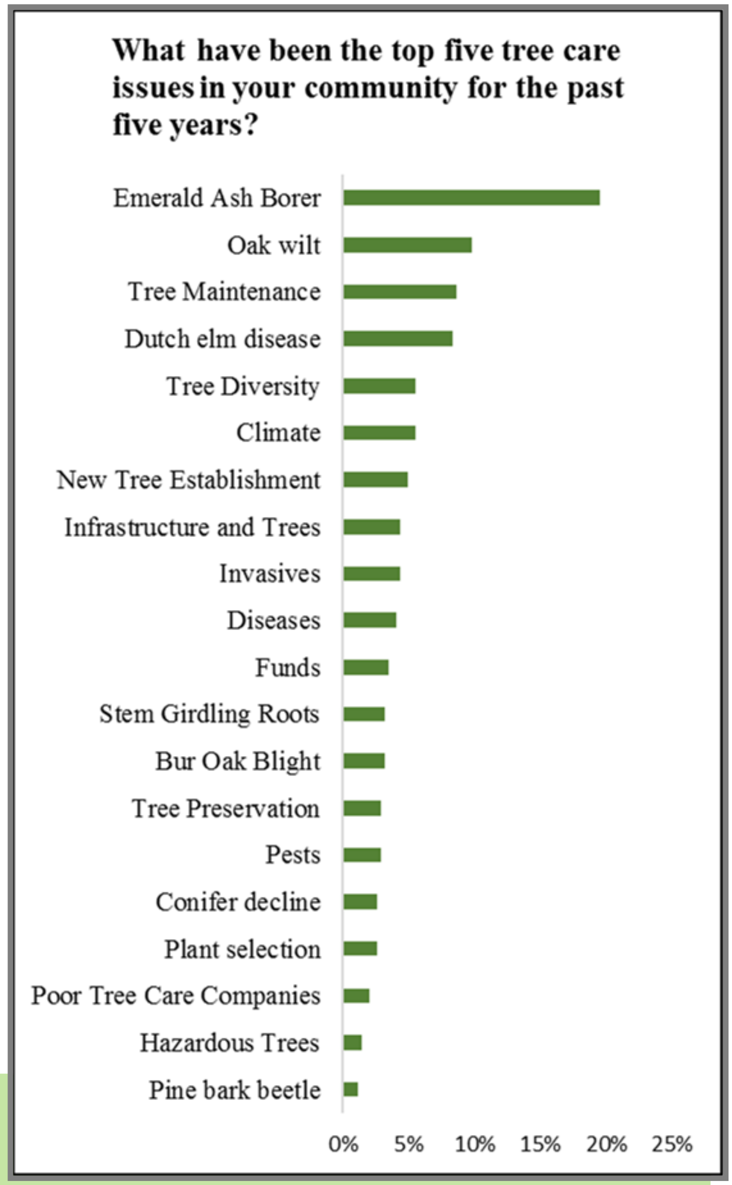


Chart (13): Summary of tree care issues as reported by MN tree inspectors

It is no surprise that emerald ash borer (EAB) was the most common response for both question 2 (requests for information - Chart 2) as well as question 3 (top tree care issues of the past five years - Chart 3). As of January 2017, 14 counties in Minnesota have been placed on the EAB quarantine list. While we hope control efforts will be effective, based on the historical movement of this pest, we expect emerald ash borer to continue spreading throughout the state. EAB education will continue to be an important topic within the tree inspector curriculum.

Reforesting the urban landscape is of top concern in the wake of devastating tree loss from pests and pathogens. In this regard, it is good to see ‘plant selection’ high on the most common request for information (Chart 2). Likewise, ‘tree diversity’ was high on the list of tree care issues reported by tree inspectors (Chart 3). In addition to pest and pathogen pressure, climate change adds to the overwhelming importance of developing a diversified urban forest tree population. The tree inspector program will continue to address this need by providing suggested tree species for urban environments around the state. The tree inspector program supports the use of native and non-native, non-invasive species for developing a diverse and climatically adaptive urban forest.

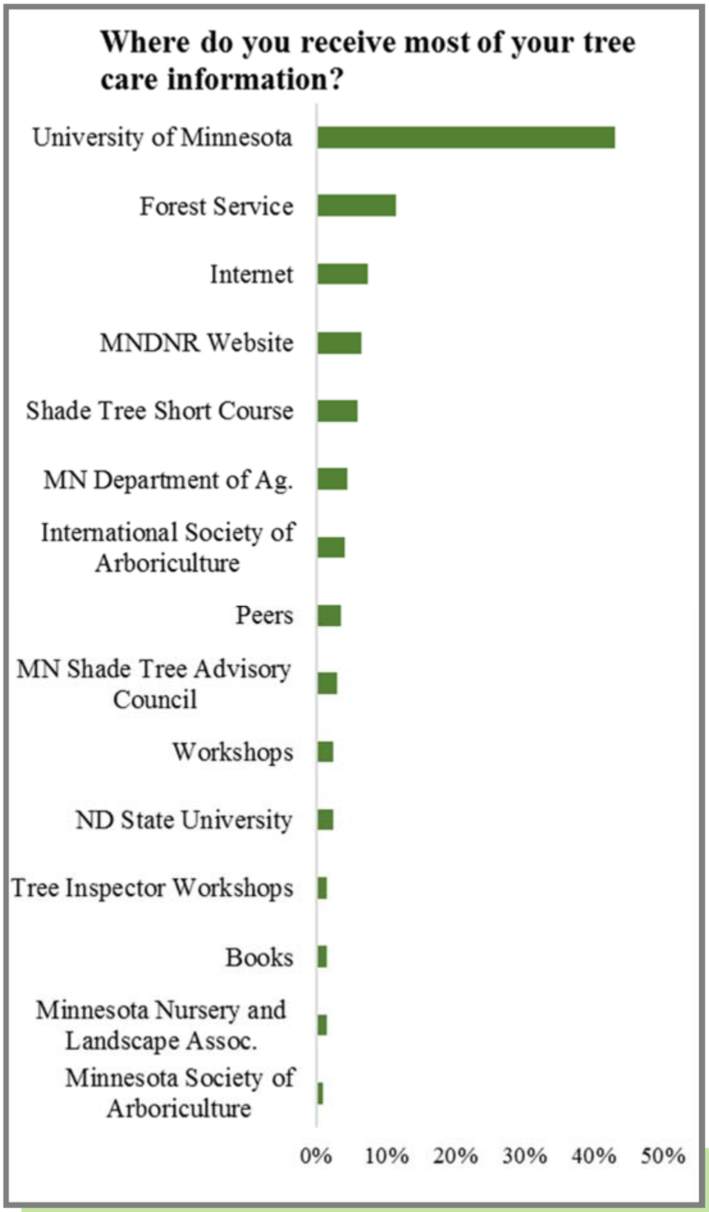


Chart (14): Summary of where MN tree inspectors go to obtain information

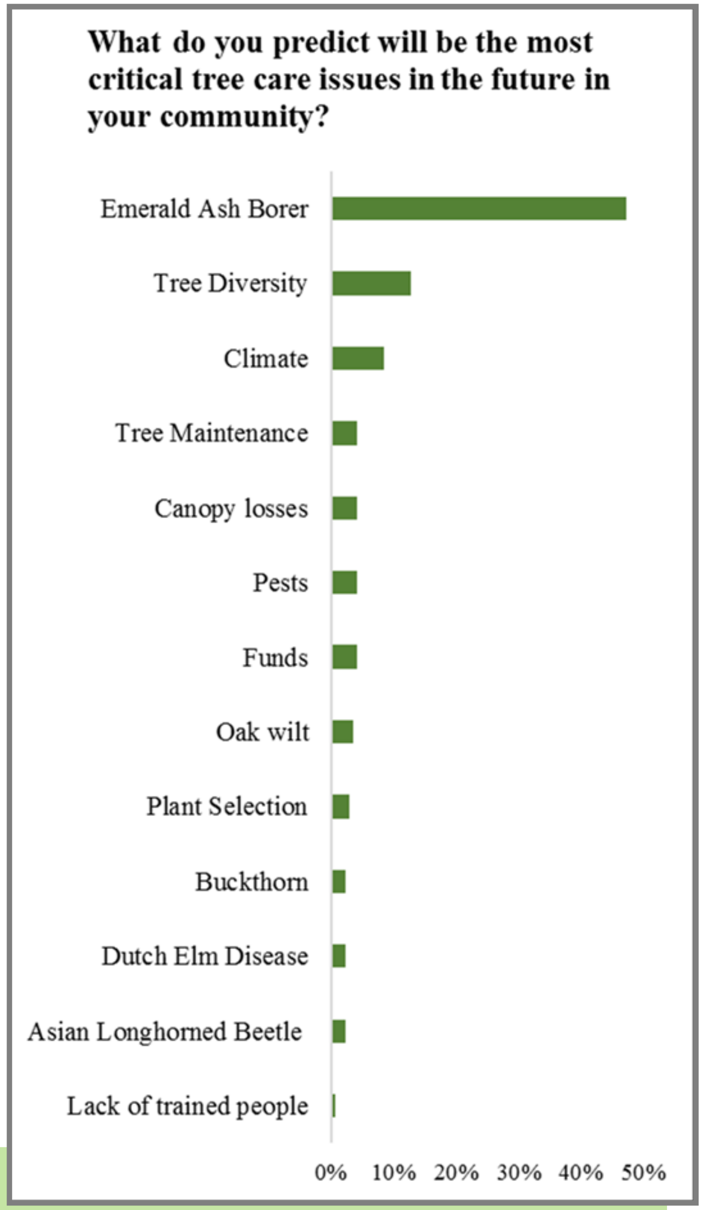
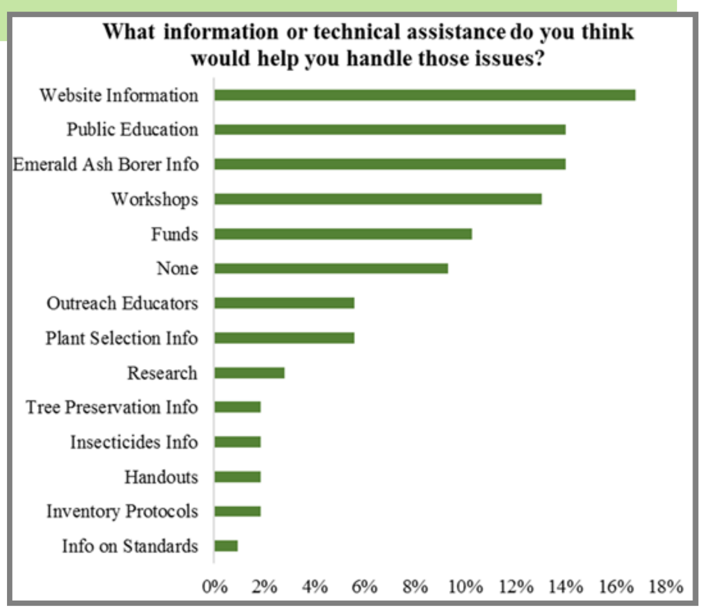


Chart (15): Summary of the tree care issues MN tree in-



In addition to discovering what informational topic areas are most beneficial to tree inspectors, we also wanted to investigate where and how tree inspectors are acquiring information. The results of the survey show that the University of Minnesota is an important resource hub for tree inspectors. The other trend that can be easily observed is that internet sources are becoming the main way of accessing information (Chart 6).

Chart (16): Summary of suggestions by MN tree inspectors for information and technical assistance.

Informational handouts are still commonly produced; however, this survey suggests that website information has become the preferred format, at least for tree inspectors. Handouts historically have been useful in getting information to community members, but we might suspect that this shift holds true for citizens at large as well. One concern is that people who do not use or have access to the internet will be left out in an all-digital approach. Hopefully communities will have resources to print digital publications for distribution if the need arises. Knowing where tree inspectors go for information will help the U of M in designing and formatting information in the most accessible and desirable way.

2016 Certification and Recertification Workshops:
The University of Minnesota coordinated two certification workshops in 2016. These workshops were held in Savage, MN at the McColl Pond Environmental Learning Center. This was a great venue and Savage was very accommodating to the program. In total, 106 individuals attended the 2016 certification workshops.

Six different recertification workshops were scheduled during the fall of 2016 to be held at the following locations: Brainerd, Cloquet, Crookston, Hutchinson, Morris and Waseca. Due to low enrollment levels, only two of the six planned workshops were held. 2016 recertification workshops were held in Brainerd and Hutchinson. Attendance at these workshops were aggregates of tree inspectors who enrolled at cancelled locations. In the future the number of planned recertification workshops may be reduced, with a stronger focus paid to developing digital recertification opportunities.
Through certifying new tree inspectors and conducting recertification workshops, the MN Tree Inspector Program served over 65 Minnesota communities in 2016.

New University of Minnesota Personnel:
Over the years many have come to know Sean Peterson as the main tree inspector contact with the U of M. Sean has set off for another neck of the woods and is no longer with the program. Sean served with the tree inspector program for 7 years. Ryan Murphy has joined the tree inspector team at the U of M to help manage the educational and testing portions of the program as well as assist with publishing *TreeIQ: The Minnesota Tree Inspector Quarterly*.

Learn More about the MN Tree Inspector Program:

Website: www.mntreeinspector.com
University of Minnesota email contact: treesins@umn.edu

Cost Benefit Study of Planting Stock

Monica Randazzo

Undergraduate Research Assistant

University of Minnesota, Department of Forest Resources

Introduction:

What information do city foresters and managers need in order to effectively and efficiently increase their urban forest canopies? A comprehensive answer to this question is multi-faceted, as urban forests are dynamic systems with a variety of complex inputs and outputs. The Cost Benefit Study of Planting Stock aims to address a small component to this larger question by asking another: are there significant differences in growth rates and survival during the establishment period (3 years) among trees of different stock types? This study tracks the growth rate and survival of trees that are either: containerized, balled and burlapped, spring-planted bare rooted, and fall planted gravel bed bare root. This study functions as a method of providing physical evidence regarding the success of trees in the establishment period. Certain stock types may be better suited for different plantings based on a variety of factors, and this study seeks to help communities make well-informed tree planting decisions.

Fig (52 & 53): Study trees and their tags in Como Park in St. Paul, MN. These tags and the maps developed in the UFore lab are the only identifiers of study trees for all of the nine communities currently included in this study,

Methods:

Nine communities are included in the Cost Benefit study for the 2016 planting season: New Ulm, St. James, Arlington, Rochester, Fridley, North St. Paul, Robbinsdale, St. Paul, and Shakopee. For each of the nine communities, as much data as the community had available on the individual trees was collected by city employees and shared with UFore investigators. As many trees as possible are sampled from each community, which is every tree planted in 2016 for every community except Rochester, Fridley, and St. Paul. In Rochester and Fridley, study trees are chosen based on the amount of information available, primarily by accuracy of location on maps created during plantings. Trees without clear and sufficient data (planting stock, species, or location) were not included. The City of Saint Paul planted more trees than UFore investigators were able to sample in a single year, so the total population was stratified by planting stock type, with up to one-hundred trees randomly selected from each strata.

Caliper taken at six inches above ground, tree species, planting stock type, and location are all recorded for each of the trees that are included in the study, and every tree is tagged with a unique number. The costs associated with the trees such as transportation, planting, site preparation, use of machinery, as well as who planted them (city employees, contractors, or volunteers) is all recorded. Mapping individual trees is done using ARC GIS, and is available to view online: http://arcg.is/1LOzXW

Fig (54): Canopy of a young Northern Catalpa planted in St. Paul in 2016

The trees are monitored throughout the growing season, each being visited by UFore investigators at least once, and caliper is measured again each year after the end of the growing season for the next three years. The costs and growth rates of trees will be compared between planting stock types, with consideration for other contributing variables. 2017 Planting data will be recorded in all nine communities and included in this study as well.

Cooperative Projects

Case Study: Using Drones for Urban Forest Inventory and Health Assessment

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Directed Research Project Student

University of Minnesota, Department of Forest Resources

Using unmanned aerial vehicles (UAV), or drones, for collecting aerial imagery is an example of an advanced technological method that is garnering attention for urban natural resource management. Traditionally, image collection required the use of an airplane, helicopter, or satellite. These options are less practical logistically, and financially for urban land managers who typically oversee spatially small properties when compared to their rural counterparts. With UAVs, acquiring on-demand high-resolution imagery on urban parcels is feasible. In addition to the standard uses of aerial imagery, such as developing a spatially accurate database of resources, being able to capture images as needed allows for analysis of temporal changes.

In this case study a complete inventory was conducted of trees, and a geodatabase created for Saint Michael's Cemetery in Bayport, Minnesota utilizing a combination of ground evaluation and UAV technology. Collected data included traditional urban forest inventory categories: tree identification numbers, DBH, crown diameter, common name, family, genus, species, crown condition, and stem condition. Unique to this inventory was that base individual tree canopy mean greenness values were calculated. Darker green foliage typically has a positive relationship with photosynthesis activity, and tracking green color changes over time can be an indicator of vigor, or lack thereof. With the relative ease and efficiency of collecting aerial imagery with UAVs, calculating and tracking temporal changes in greenness values is a worthwhile practice for urban forest managers.

Images of the 7.1-hectare cemetery parcel were collected with UAVs in June 2016 and September 2016. The images were processed into high resolution red-green-blue (RGB) orthoimages and georeferenced by the University of Minnesota Remote Sensing lab. Once the orthoimages were complete they were uploaded as a raster layer in ArcMap 10.3. Utilizing the June 2016 orthoimage, a point feature class was developed where each tree was digitized and given a unique identification number creating a spatially accurate geodatabase (Image 1). This feature class would serve as the medium for organizing and storing the collected data throughout the project. The June 2016 image and the tree feature class were then uploaded to arcgis.com and accessed remotely with an iPhone utilizing the ESRI Collector for ArcGIS mobile application. This allowed for ground-truthing of each tree's spatial position, inputting of terrestrially collected measurements, and live uploading of data. Live uploading instantly saved collected data securely on a remote server for later retrieval with ArcGIS 10.3 desktop.

On-site tree analysis was completed between June and September 2016. The traditional urban forest inventory data were collected utilizing methods derived from standard procedures used in practice by the University of Minnesota's Urban Forestry Outreach, and Extension Nursery and Lab (UFORE). More information on these procedures can be reviewed by downloading UFORE's *Community Engagement Tree Inventory Manual* (CETIM) at www.mntreesource.com.

Absent from the CETIM and unique to this inventory is the inclusion of base mean greenness values for each tree canopy. Tracking changes in greenness values using RGB images has been shown to be effective in the detection of decline in trees (Hargrave, 2001). Methods utilized for this project were adapted from Hargrave (2001). Hargrave utilized manned helicopters for image collection and Adobe Photoshop for image analysis (2001). Here we used UAVs for images and ArcMAP 10.3 for analysis.

Calculating mean greenness values can be completed with the standard tools included with ArcMAP 10.3. With the raster layer (June or September orthoimage) opened in ArcMAP 10.3, a polygon feature class was created for digitizing the tree canopies (Image 2). Each tree canopy was digitized by editing the tree canopy feature class using the freehand construction tool to manually trace each canopy on the raster where the sun was hitting the leaves. The shaded areas of the canopies were excluded. Once each canopy was digitized, the mean greenness values could be calculated by turning off the red and blue bands in the image leaving just the green band visible (Image 2). Then using the ArcMAP 10.3 Zonal Statistics tool, the mean green values from the raster layer were calculated within each individual canopy polygon. These mean greenness values can be compared to future calculated values of the same tree. Changes in value can then be analyzed for health inferences.

Utilizing UAVs now gives land managers the opportunity to track subtle temporal changes in tree health, such as canopy changes in green color year to year, in a cost and resource efficient process. Early detection of tree decline allows for diagnosis and implementation of mitigation options before significant damage is done to the tree, and the subsequent potential for structurally unstable trees.

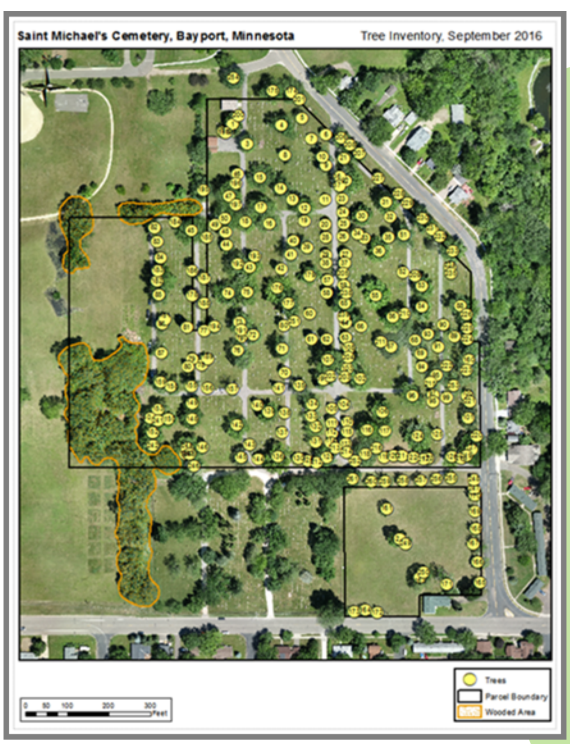
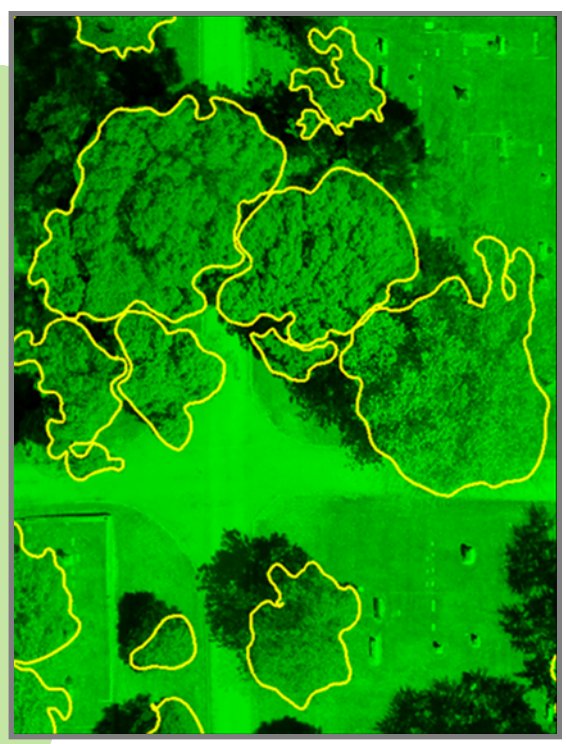


Fig (55, left): Site and tree locations.

Fig (56, right): Canopy feature class on the June 2016 image with the blue and red color bands removed.



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Hargrave, R. J. (2001). *The Use of Low-Altitude Digital Photography and the Green Spectral Wavelength to Detect Stress in Trees* (Master's thesis). University of Minnesota, Minneapolis, Minnesota.

University of Minnesota Elm Selection Project
Discovering Elm Vigor and Vim in Minnesota DNR State Parks—2016

Chad Giblin, Research Fellow
Alissa Cotton, Undergraduate Research Assistant
Dane Bacher, Undergraduate Research Assistant
University of Minnesota, Department of Forest Resources

About the University of Minnesota Elm Selection Program:
In a joint effort between Professors Robert Blanchette in the Department of Plant Pathology and Gary Johnson in the Department of Forest Resources at University of Minnesota, the UMN Elm Selection Program is dedicated to collecting, cloning, and screening Minnesota native elm trees for resistance to Dutch elm disease (DED), a vascular wilt disease caused by the fungus *Ophiostoma novo-ulmi*. The program also works to find efficient methods for propagating and screening elms with potential resistance to DED. Since the arrival of the Dutch elm disease fungus *O. ulmi* in Minnesota, and the more aggressive strain *O. novo-ulmi*, millions of American elms (*Ulmus americana*), red elms (*U. rubra*), and rock elms (*U. thomasii*) have been lost to the disease. The UMN Elm Selection Program has been making great steps toward finding a native Minnesota elm cultivar with tolerance to DED. Minnesota-native cultivars are expected to show superior fitness across the northern United States than those sourced from outside this area such as 'Valley Forge' and 'Princeton' American elm cultivars, which come from different temperate zones in the eastern United States.

The Plight of the Stately Elm:
American elm is a particularly hardy and resilient tree. It has the ability to tolerate the stresses of an urban environment, making it an excellent choice for planting along boulevards and in parks. Elm also plays an important ecological role in Minnesota's forests as a dominant species in many cover types. Trees that survived in areas where the disease had a significant impact are of particular interest. With the help of Minnesota State Park managers and staff as well as arborists, urban foresters, and private residents from throughout the state, we have been able to locate and identify large trees that may have inherent tolerance to the disease. However, these trees must be propagated and rigorously tested by means of inoculation to determine if this is the case. Identification, propagation, and screening takes a significant amount of time, and for this program to be successful, long-term research is essential. Continued support from important stakeholders in the state, such as the Minnesota State Parks and the Environment and Natural Resources

Fig (57, 58, 59): Collection of 12 Ulmus americana (American elm) trees was made at Afton State Park in January 2016 utilizing collection techniques from the ground and in the tree! (Tree numbers MNT 1315 – MNT 1326, see GPS data in Table 3)

Trust Fund, will help ensure the success of the UMN Elm Selection Program.

The DNR Shall Provide

Beginning in 2015, the Minnesota Department of Natural Resources has granted access to the UMN Elm Selection Program to collect branch material from elms that survived DED in areas where other elms faced mortality. Collecting elm material involves surveying the area for vigorous trees and correctly identifying species, then taking cuttings either from the ground or by ascending the tree.

The UMN Elm Selection Program collected from elms in Shetek and Camden State Parks in 2015, and from Forestville and Afton State Parks in 2016, resulting in twelve unique genotypes currently in cultivation at the University of Minnesota Urban and Community Forestry Outreach Research Nursery and Greenhouse. Throughout the winter and spring of 2016, clonal propagation of the collected material was conducted, being performed inside the Plant Growth Facilities greenhouses. Successfully grafted elms and rooted cuttings were categorized and moved to the Outreach & Research Nursery. Due to time limitations, it was not possible to make a collection visit to Fort Snelling State Park in 2016. During the 2016 collection at Forestville State Park, a number of red elms were identified from which material was not collected; we will return and take cuttings from those trees in 2017. In addition to Forestville and Fort Snelling State Parks, 2017 will include collections from Bemidji State Park.

Fig (60, 61, 62): Collection of two Ulmus americana (American elm) trees was made at Forestville State Park in spring of 2016. (Tree numbers MNT 0446 and MNT 0447, see GPS data in Table 3)

How We Do What We Do

Grafting allows for the quick production of new growth that can be used either for cuttings production or for the creation of additional grafted clonal selections for future use. Elm scions were cleft grafted on wild-type American (*U. americana*) elm or Siberian elm (*U. pumila*) rootstocks or used for making rooted cuttings. Cleft grafting is an easy form of grafting in which the rootstock is prepared by pruning 15 cm above the roots and making a 1-2-inch-deep cleft in the top center of the cut stem. Next, a scion is trimmed to create two smooth-tapered cuts toward the basal end of the scion opposite each other, about 1 to 2 inches long. When inserting the scion material into the cleft, the cambium of the scion is aligned with the cambium of the rootstock. The graft is secured with a rubber band strap and sealed with Parafilm M®, to be removed once callus material is formed at the union.

Inoculating a tree with a disease involves introducing the pathogen to the plant material via injection. Greenhouse inoculation is a preliminary tool for assessing whether a genotype of interest has some tolerance to DED. Trees destined for field inoculation trials require at least two growing seasons before they are of a size to reliably test. For proper statistical analysis of each genotype, a minimum of six clones is needed.

The State of the Elms

Status of material collected in 2016 from Afton and Forestville State Parks:

Afton State Park – Collections from 56 elms were made at Afton State Park in 645^{0}. From these, four unique genotypes were successfully grafted and all are currently field-planted for cultivation of additional clonal material (Table 3).

Forestville State Park – Collections from two elms were made at Forestville State Park in 2016. Cuttings from these trees have not yet been processed and are currently in cold storage awaiting grafting in winter of 2016-17 (Table 3).

Update on material collected in 2015 at Camden and Shetek State Parks:

Additional replicates will be developed from the initial cuttings obtained in 2015. This means that the majority of the genotypes selected from Lake Shetek and Camden State Parks will be field-inoculated no sooner than the summer of 2018. However, there is one genotype from the Shetek collection that has enough clones to be used in a greenhouse inoculation in 2017.

Camden State Park - Collections from ten trees were made at Camden State Park in 2015. From these, three genotypes have been successfully grafted and four individual plants have been field-planted for cultivation of additional clonal material (Table 4).

Shetek State Park – Collections from ten trees were made at Shetek State Park in 2015. From these, five unique genotypes were successfully grafted. One genotype with four replicates will be used in a greenhouse trial in winter of 2016-17, and four genotypes have been planted in the field for cultivation of additional clonal material (Table 4).

Research to date has yet to produce results on the level of resistance as the trees are not yet large enough to perform field inoculations with the pathogen *O. novo-ulmi*. One red elm selection obtained in 2015 from Lake Shetek (MNT 0410, Table 2) will be used in a greenhouse inoculation trial in winter 2016-2017. Four genotypes have been cultivated from elms collected from Afton State Park and are currently in field trials at the University of Minnesota (Table 3); these will also be used to generate clonal material for additional research replicates.

Fig (63): Chad Giblin exhibits the vigor and vim of an American elm collected from Forestville State Park in spring of 2016.

Looking Ahead

The goal for the conclusion of this study is to obtain a diverse selection of native elms from Minnesota that are genetically different but all show resistance to DED, alongside having optimal growth and hardiness characteristics for use in commercial propagation. Identification of elms with superior tolerance to *O. novo-ulmi* will give Minnesota foresters the opportunity to reintroduce the beautiful American elm to our city streets and to our native forests.

Fig (64): MNT 0410 - Ulmus rubra (red elm) located at group camp in Lake Shetek State Park, 2015. Coordinates: 44.10827, -95.694178

Fig (65): Cloned Ulmus rubra (red elm) selection collected at Lake Shetek State Park in 2015, for use in greenhouse inoculation trial winter 2016-17 (Details Table 2).

Tree Number	Location	City	Species	DBH (in.)	X	Y	Status
MNT 1315	Afton State Park	Afton, MN	*U. americana*	13.4	44.84628	-92.793456	unsuccessful graft
MNT 1316	Afton State Park	Afton, MN	*U. americana*	9.4	44.86694	-92.773595	unsuccessful graft
MNT 1317	Afton State Park	Afton, MN	*U. americana*	8.7	44.86469	-92.774238	unsuccessful graft
MNT 1318	Afton State Park	Afton, MN	*U. americana*	8.4	44.84252	-92.790852	in field, cloning
MNT 1319	Afton State Park	Afton, MN	*U. americana*	16.9	44.8418	-92.793203	unsuccessful graft
MNT 1320	Afton State Park	Afton, MN	*U. americana*	11.4	44.84234	-92.793713	unsuccessful graft
MNT 1321	Afton State Park	Afton, MN	*U. americana*	20.1	44.84408	-92.793341	in field, cloning
MNT 1322	Afton State Park	Afton, MN	*U. americana*	11.7 & 20.4	44.84938	-92.775956	unsuccessful graft
MNT 1323	Afton State Park	Afton, MN	*U. americana*	14.6	44.84896	-92.775985	in field, cloning
MNT 1324	Afton State Park	Afton, MN	*U. americana*	5.9 & 7.1	44.86193	-92.773667	unsuccessful graft
MNT 1325	Afton State Park	Afton, MN	*U. americana*	8.7	44.86339	-92.772981	unsuccessful graft
MNT 1326	Afton State Park	Afton, MN	*U. americana*	19.3	44.86392	-92.773925	in field, cloning
MNT 0446	Forestville State Park	Forestville, MN	*U. americana*	17.5	43.6413	-92.221893	awaiting grafting
MNT 0447	Forestville State Park	Forestville, MN	*U. americana*	12.4	43.6413	-92.221893	awaiting grafting
NA	Forestville State Park	Forestville, MN	*U. rubra*		43.632715	-92.224497	Identified, not collected

Table (3): UMN Elm Selection Program – 2016 Collections from Afton and Forestville State Parks

Tree Number	Location	Address	Species	DBH	X	Y	Status
MNT 0373	Boat Landing Near Loon Island	Lake Shetek State Park	*U. americana*	15	44.10852	-95.69723	field-planted for clonal cultivation
MNT 0374	Boat Landing Near Loon Island	Lake Shetek State Park	*U. americana*	27	44.10802	-95.697496	unsuccessful graft
MNT 0369	Causeway to Loon Island	Lake Shetek State Park	*U. americana*	15	44.10998	-95.69843	field-planted for clonal cultivation
MNT 0410	Group Camp	Lake Shetek State Park	*U. rubra*	12	44.10827	-95.694178	greenhouse trial winter 2016-17
MNT 0365	Loon Island	Lake Shetek State Park	*U. americana*	19.5	44.11004	-95.702049	field-planted for clonal cultivation
MNT 0366	Loon Island	Lake Shetek State Park	*U. americana*	21	44.11181	-95.700552	unsuccessful graft
MNT 0367	Loon Island	Lake Shetek State Park	*U. americana*	24	44.11313	-95.700408	unsuccessful graft
MNT 0405	Loon Island	Lake Shetek State Park	*U. rubra*	12.5	44.11016	-95.701958	field-planted for clonal cultivation
MNT 0406	Loon Island	Lake Shetek State Park	*U. rubra*	19.1	44.11031	-95.701905	unsuccessful graft
MNT 0407	Loon Island	Lake Shetek State Park	*U. rubra*	23.8	44.11099	-95.7028	unsuccessful graft
MNT 0321	Camden Park South	Camden State Park	*U. americana*	14.75	44.35167	-95.923743	field-planted for clonal cultivation
MNT 0338	Camden Park South	Camden State Park	*U. americana*	17	44.35245	-95.924134	unsuccessful graft
MNT 0339	Camden Park South	Camden State Park	*U. americana*	15	44.35243	-95.923037	unsuccessful graft
MNT 0340	Camden Park South	Camden State Park	*U. americana*	N/A	44.34607	-95.928939	unsuccessful graft
MNT 0341	Camden Park South	Camden State Park	*U. americana*	25	44.35	-95.927434	unsuccessful graft
MNT 0318	Lower Campground	Camden State Park	*U. americana*	30.5	44.36692	-95.924698	unsuccessful graft
MNT 0319	Lower Campground	Camden State Park	*U. americana*	24	44.36798	-95.924541	unsuccessful graft
MNT 0320	Lower Campground	Camden State Park	*U. americana*	27.5	44.36797	-95.924918	unsuccessful graft
MNT 0400	Lower Campground	Camden State Park	*U. rubra*	10.5	44.3659	-95.924899	field-planted for clonal cultivation
MNT 0401	Lower Campground	Camden State Park	*U. rubra*	25.5	44.36646	-95.924073	unsuccessful graft
MNT 0402	Lower Campground	Camden State Park	*U. rubra*	21.5	44.36801	-95.924493	unsuccessful graft
MNT 0372	ND (hill by tracks)	Camden State Park	*U. americana*	26	44.22158	-95.552213	field-planted for clonal cultivation

Table (4): UMN Elm Selection Program—2015 Collections from Lake Shetek and Camden State Parks

University of Minnesota Summer Youth Programs Come to the UFore Nursery

Chad Giblin, Research Fellow

Monica Randazzo, Undergraduate Research Assistant

University of Minnesota, Department of Forest Resources

Throughout the summer of 2016 scientists, staff, and students from the Urban Forestry Outreach, Research & Extension (UFore) Nursery hosted several groups of school age youth attending day camps as part of the University of Minnesota's Summer Youth Programs. These programs are themed, weekly day camps held on the UMN campus that have a wide range of instruction and activities tailored to the age of participants. Campers attending programs in cooperation with UFore ranged in age from about 5 to 12 years old.

On weeks with "green" themes, the campers explored the campus to learn about all of the different work people do within the green industry and how trees in urban and community forests create benefits for everyone. UFore and Summer Youth Programs staff partnered to create ten, unique one-hour sessions with lessons and activities centered on urban forestry, arboriculture, and horticulture. Many youth campers visited the UFore Nursery, where they interacted with trees at all different life stages and learned about various components of tree nursery production. Kids had a chance to sample ripe cherries and pears picked from right from trees in the nursery and got to see some of the funky things that can make trees "sick." Campers were also introduced to dendrochronology and tested their skills in counting tree rings using samples from many different tree species.

Fig (66): Tree care professional and a young recreational tree climber give climbing demonstration.

Fig (67 & 68): UFore staff sharing wood samples and fresh cherries with YP participants.

As the summer neared the end, older campers had an exciting opportunity to join UFore staff and Damian Day, a volunteer arborist from Morgan's Tree Service, where they got to test their own tree ascension skills under the guidance of an expert tree climber. Younger campers had a fun time exploring production arboriculture when Danielle Ringle, an arborist from UMN Landcare, provided a fun and interactive tree climbing demonstration. Each group really directed their own experience differently, exploring different parts of the nursery or focusing on different aspects of tree climbing and arboriculture.

UFore staff are excited about this new youth outreach opportunity and will be joining the U's Summer Youth Program for summer camps throughout 2017! Registration information is available at recwell.umn.edu/youth.

Fig (69 & 70): Children inspect "baby" oak trees in the UFore Nursery.

Elm Performance and Inoculation Trials at Minnesota Landscape Arboretum

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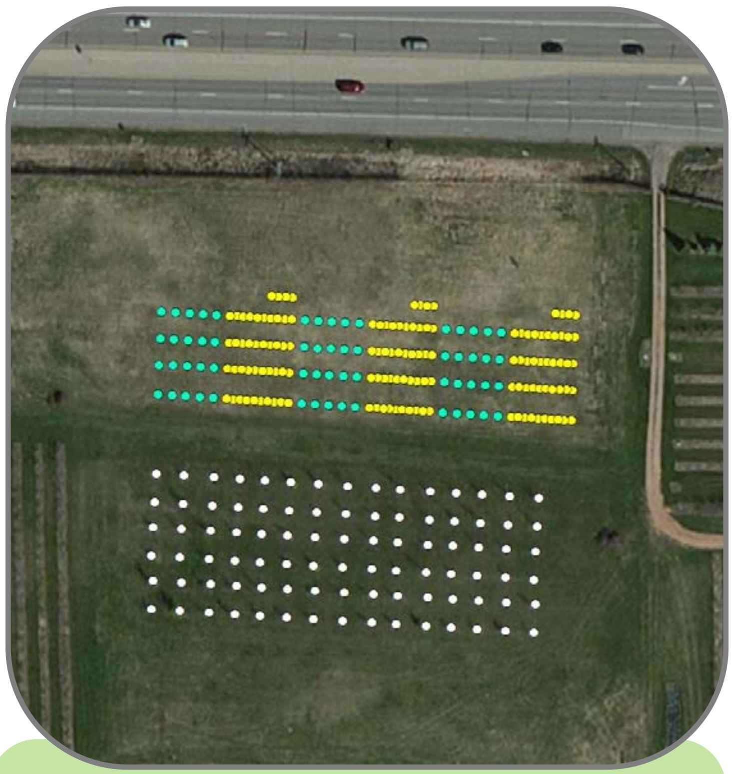
Executive Summary:
The University of Minnesota Elm Selection Program (UMESP) has been working to discover Minnesota survivor elms with putative resistance to Dutch elm disease (DED) caused by *Ophiostoma novo-ulmi*. UMESP consistently uses commercially available elm selections during inoculation trials for comparison with newly discovered genotypes. This project continues the screening of elm selections in field plots at the Minnesota Landscape Arboretum (MLA). These field plots include utilizing the former National Elm Trial (NET) plot for DED inoculation research as well as the installation of new elm performance and inoculation plots adjacent to the former NET plot.

Site Summaries:
All research plots are located in the northeast section of the MLA grounds along Arboretum Boulevard. Plots are being maintained as joint effort between UFore lab staff and MLA maintenance personnel. All new trees are established using the Grow Tube Method™ (GTM). This consists of a protective grow tube combined with a fiberglass stake used to support and nurture developing young trees. This method provides protection against foraging and against trunk damage that may occur with weed whipping and mowing. The grow tubes are designed to allow for upward growth of the tree and do not hinder sun exposure. The stake provides support and helps keep the tube straight when exposed to weather. A net is placed on the top of the tube so that birds, specifically the blue bird, do not fall within the tube. To aid in weed control within and surrounding the grow tube trees 3ft x 3ft polyethylene black and white sided tarp was placed. This plastic mulch was installed black side up to reduce maintenance requirements for weeds and also improve soil moisture and temperature conditions. This process of weed control traps heat and moisture within the surrounding soil. This causes any existing weed seeds to germinate and sprout, however, having no access to direct sunlight the weeds die. This can be beneficial for even perennial weeds as it may weaken their stems and allow for easy removal. These tarps have also helped to prevent lawn mowers from having to drive adjacent to the grow tubes. Mowing too close can cause damage to the tube and tree itself, decreasing growth and potentially increasing tree exposure to outside stressors. With the tarp installation these risks are decreased, and maintenance requirements are decreased as well for mowing and weeding.



Fig(71): Bird's eye view of the National Elm Trial Plot and the Elm Performance and Inoculation Plot located in the northeast section of the MLA grounds along Arboretum Boulevard. Each white point indicates a study tree in the NET plot, and each yellow point represents a tree in the elm performance and inoculation plot. The cyan points are open spaces for future planting.

Fig (72, above): Valley Forge: A Valley Forge elm located in the National Elm Trial plot. Notice its arching and broad reaching crown .

Fig (73, above): Grow Tube and Tarp: A finished tarp and grow tube installation in the elm performance and inoculation plot.

Fig (74, below): Princeton Elm: A Princeton elm located in the National Elm Trial plot. Notice its upright, dense, and almost vase shaped form.

Fig (75, above): Fall Cleaning, a team from the UFORE lab cleaned out debris from inside the grow tubes, and performed general maintenance during an autumn site check.

Fig (76, below): Installation of Grow tubes in the elm performance and inoculation plot.

Fig (77): An example of a Chinese elms display of beautiful red and orange autumn foliage

One unique, introduced species of elm under study at MLA plots is *Ulmus parvifolia* (Chinese elm). This rapid growing elm has a small to medium upright form ranging from 30 to 45 feet tall at maturity. Maximum height in the Upper Midwest region is expected to be closer to 30 feet. *U. parvifolia* is generally hardy to USDA plant hardiness zones 5-9 and prefers partial to full sunlight conditions. This species also displays beautiful red and orange foliage in the autumn making it a practical yet attractive, ornamental species. *U. parvifolia* is particularly intriguing to study as it has showed promise in being Dutch elm disease resistant along with many of other elms of Asian origin. We are currently studying this species in our inoculation trials and performance tests. This will allow us to test this tree's hardiness to the climate of Minnesota and further test its resistance to Dutch elm disease

Inoculation Protocol

Trees are injected with a spore suspension of the DED pathogen (Ophiostoma novo-ulmi) and evaluated for disease progression every two weeks during the remainder of the growing season. A liquid spore suspension of Ophiostoma novo-ulmi will be grown in a shaker for three days and diluted to a concentration of 1.0 x 10^6. Thirty microliters of the spore suspension will be injected into a small (2.5mm) hole drilled into branches or the main stem. Holes will then be covered with laboratory film to prevent drying.

Fig (78): Drilling for inoculation: Here a researcher drills into a study tree so the DED pathogen can be injected.

Elm Performance and Inoculation Plot

This plot is dedicated to conducting inoculation trials on possible DED resistant *Ulmus* genotypes as well as studying the performance of *U. parvifolia*. As stated above, *U. parvifolia* has shown promise in being DED resistant, however little is known about how this species performs in Minnesota. The USDA hardiness zones of Minnesota are 5a-3a which would encompass *U. parvifolia's* range of survival. Characteristics we look for while studying performance include survival, growth rate, and other characteristics that feed into a selection program. This will allow us to reduce the population in our trial down to the specimens that perform, survive, and thrive the best. By studying the performance of *U. parvifolia*, we may then start to think about the possibility of it becoming a suitable and well qualified urban tree in Minnesota. By introducing a DED resistant *Ulmus* species, like *U. parvifolia*, that performs will in Minnesota, we can help to build back the canopy that was lost.

Fig (79): Inoculation: A researcher injects a spore suspension of the DED pathogen (Ophiostoma novo-ulmi) into a study tree. These inoculated trees are then evaluated for disease progression every two weeks during the remainder of the growing season.

In addition to studying the performance of *U. parvifolia* we are also screening potentially DED resistant elm genotype selections in this plot. All genotypes except *U. parvifolia* within the Elm Performance and Inoculation Plot are being tested in this inoculation trial. Similarly to a performance study, we look for survival, growth rate, and if a tree is thriving after it has been inoculated to test resistance to DED. If a tree does not survive the inoculation trial, a new selection will be planted in its place in our next autumn planting session. If a tree does survive, a repetition trial would be done on this specific genotype to ensure resistance has been found.

Elm Performance and Inoculation Plot Genotypes

In total there are 130 planted trees in the Elm Performance and Inoculation plot as well as 2 open positions that were not replanted in the fall of 2016. Eleven genotypes are in this plot:

- **BF** (Ramsey County, Saint Paul, MN): 6
- **F9** (Otter Tail County, Fergus Falls, MN): 4
- **LR** (Hennepin County, Bloomington, MN): 2
- **MA** (Ramsey County, Saint Paul, MN): 5
- **MO** (St. Louis County, Duluth, MN): 6
- ***Ulmus parvifolia*** (Seedlings from parent tree in Hennepin County, Minneapolis, MN): [0] 4
- **UW** (Hybrid elm from unconfirmed source): 30
- **VE** (Hennepin County, Rogers, MN): 3
- **VF** ('Valley Forge' USDA National Arboretum Release, Beltsville, MD): 12

Inoculation of the Former National Elm Trial Plot

The National Elm Trial (NET) was a 10 year study coordinated by Colorado State University which sought to evaluate the growth and performance of commercially available elm varieties in differing climatic zones across the United States, with MLA hosting one of the 17 evaluation sites. The trial plot at MLA was established between 2004 and 2007. In total, 16 different commercially available genotypes were planted. There are 78 trees in the NET plot and 12 open positions as of fall 2016. The 16 cultivar names, scientific names, and how many of each selection planted are listed as follows:

All growth and performance data for the National Elm Trial has been collected from this trial plot as of 2015. With the conclusion of the National Elm Trial evaluation period, the trial plot at the MLA presents itself as a good opportunity to test commercially available DED tolerant elm cultivars against a local isolate of *O. novo-ulmi* which is currently used in UMESP inoculation trials. Inoculation with a local isolate of the DED will complement the ten years of growth and performance data already obtained from the trial plot. Furthermore, this inoculation trial will give up-to-date tolerance data for the commercially available elm cultivars to a potentially more virulent strain of the DED causing fungus.

Fig (80): NET and performance plot: A ground view of the NET plot and the elm performance and inoculation plot during the summer season.

- **Accolade™** (*U. japonica* x *U. wilsoniana* 'Morton'): 9
- **Allee®** (*Ulmus parvifolia* 'Emer II'): 5
- **Cathedral** (*U. pumila* x *U. davidiana* var. *japonica* 'Cathedral'*)*: 5
- **Commendation™** *(U. carpinifolia* x *U. pumila* x *U. wilsoniana* 'Morton Stalwart'): 4
- **Danada Charm™** (*U. japonica* x *U. wilsoniana* 'Morton Red Tip'): 8
- **Emerald Sunshine®** (*U. davidiana* var. *japonica* 'JFS-Bieberich'): 4
- **Homestead** (*U. glabra* x *U. carpinifolia* x *U. pumila* 'Homestead'): 9
- **New Horizon** (*U. pumila* x *U. japonica* 'New Horizon'): 9
- **Patriot** (*U. glabra* x *U. carpinifolia* x *U. pumila* x *U. wilsoniana* 'Patriot'): 8
- **Pioneer** (*U. glabra* x *U. carpinifolia* 'Pioneer'): 9
- **Prairie Expedition®** (*Ulmus americana* 'Lewis & Clark'): 9
- **Princeton** (*U. americana* 'Princeton'*)*: 6
- **Prospector** (*U. wilsoniana* 'Prospector'): 9
- **Triumph™** (*U. pumila* x *U. japonica* x *U. wilsoniana* 'Morton Glossy'): 9
- **Valley Forge** (*U. americana* 'Valley Forge'): 54
- **Vanguard™** (*U. pumila* x *U. japonica* 'Morton Plainsman'): 9

Fig (81): Fall Planting, here the UFORE team replaced failed trees from the elm performance and inoculation plot in the autumn with new nursery stock.

2016 Fall Planting:

In October and November we managed weeds within the Arboretum grow tube plots. There was overgrowth within the plots and the tubes and some damage to the tubes and trees. We performed tube maintenance, replacing damaged tubes, upgrading ties to the more UV durable ties, replacing nets to protect from blue bird migration, and also upgrading to larger stakes where needed. During this tube maintenance we also needed to weed inside the tubes, and weed whipping was done around the outsides of the tubes. To decrease outside weed re-growth spraying occurred around and in-between mats with glyphosate at a 3oz per gallon rate. Throughout this weeding and upgrading we took note of elm mortality within each tube. We found some elms were in need of being replaced and we did so with some of our nursery stock.

Future Work

In the spring of 2017 more planting needs to occur, using more clonal genotypes to replicate the inoculation study. There are 3 open blocks that have the potential for up to 120 additional plants. These may consist of chinese elm and clonal eml genotype, and can be added to the existing and proposed inoculation trial. With black sided tarps already being in use within the study a new addition of other weed barrier options may occur.

Future Work on NET plot

Once data has been collected in June on the upgraded plots the next step is to review the data and determine how best to proceed. This may further the research including possible planting of new trees and removal and replacement, if deemed necessary.