ARBORESCENCE

THE OFFICIAL PUBLICATION FOR MEMBERS OF THE MINNESOTA SOCIETY OF ABORICULTURE

SPRING 2019

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Vista pruning on the St. Croix River
Photo by Dan Wemeier

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MINNESOTA SOCIETY OF ARBORICULTURE

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Dear MSA

VALERIE MCCLANNAHAN, MSA PRESIDENT

I wanted to take this opportunity to tell you how honored and excited I am, to not only be a part of MSA but, to be President! With every MSA event I have attended, I have gained knowledge which has made me more proficient at my job and made connections to people in the industry that have become lifelong friends that I get to geek out with about trees. To quote our Arborescence Chairperson Charlie Perington, "Tree people are the best!"

I had never thought to run for a leadership role and a little over two years ago, after chatting with a friend about encouraging my husband to run, I was asked the question, "Why not you?". I think sometimes it takes that push for everyone, someone reminding you that you have something to offer. If you're reading this, you are somehow tied to MSA. You are tied to increasing the professionalism of arboriculture in Minnesota, and you have a unique perspective that adds to the industry, so... Why not you?

Going through this Arborescence, you'll see a number of ways that folks have gotten engaged with MSA and the arboriculture industry as a whole. Even if you're not ready to volunteer for MSA, hopefully, at one of our events, you will find someone to geek out with about trees.

Contents

The Future of Community Forests: Diversity and Involvement

ERIC NORTH, UNIVERSITY OF NEBRASKA – LINCOLN

In the 19th and early 20th century, the American elm—with its graceful form, arching branch structure and seeming ability to grow anywhere, under nearly any conditions—made it a “perfect” tree for cities and shelterbelts alike. Cities were planting elms by the thousands and this single species (*Ulmus americana*) made up 90 percent or more of some community forests. The heavy reliance on a single species would prove devastating in the 1930s when a new disease began killing the elms. Dutch elm disease spread across North America and significantly changed our landscapes. Many of the current shade tree conferences, tree ordinances, arboricultural practices and the science of managing rural and urban trees began as a result of Dutch elm disease.

Move forward to 2002 when a new pest discovered in Michigan began terrorizing ash trees. The emerald ash borer or EAB is currently moving through North America and decimating our native ash species (*Fraxinus*). We seem not to have learned our lesson about over-reliance on a single species. Though once cities may have had as much as 90 percent elm trees, many cities today have from 30-60 percent ash. We are learning, but there is always room for improvement. Emerald ash borer is not the first, and will certainly not be our last, tree pest. In many Minnesota communities and across the U.S., maples are significantly over-planted and a potential future pest, the Asian long-horned beetle (ALB), loves maples. The future of our landscapes will depend on our ability to diversify.

Similar to the decline seen in pollinator populations, our community forests are diminished due to a variety of factors: lack of diversity, invasive pests, storms and aging trees, to name a few. In the same way that awareness of pollinator issues has helped increase pollinator habitat and policies, we can and should advocate as vigorously for our community trees.

Tree diversity is an important part of creating healthy and sustainable forests and communities. Several guidelines for diversity exist, most commonly the 30-20-10 rule (no more than 30 percent of trees from a plant family, 20 percent from a genus and 10 percent from a species). Dr. John Ball, Professor of Forestry at South Dakota State University, suggests even more diversity—no more than 5 percent from any genus. Diversity on the level of genus is likely to be the most important as many pests tend to impact a genus rather than a family or a single species. For example, EAB affects all ash native to North America, but is not much of an issue for lilac, which is in the same family. Whatever goal you adhere to, diversity is essential to both our native and managed landscapes.

Funding is an ongoing and increasing challenge for community forests. Unlike traditional forestry, where timber harvesting serves as straightforward economic incentive for management, our community forests are more complicated. We talk about the benefits of trees—from improved human health to increased property values, from energy reduction to creating more livable communities—but there is no single market, no single paycheck. While we all benefit, any individual benefit is likely to be small in the grand scheme. The benefits to an entire community, on the other hand, can be thousands to millions of dollars annually.

With EAB and more frequent and severe droughts, our community trees and forests need as much help as ever. In the 2017 federal budget, funding for Community Forestry was initially set to zero. Thanks to fast action by advocates the most recent budget does include funding for Urban and Community Forestry, although the money allocated to individual communities is still relatively small compared to the need. That means the future of our community forests and landscapes will depend on the direct involvement of community members as advocates, volunteers, and business owners to help diversify and maintain trees as assets in our communities.

DIVERSITY CONSIDERATIONS

Nursery production: In order to diversify our forests, we need nurseries to produce a diverse palette of species. Growing trees is expensive, so that means we also need to support nursery efforts by requesting and purchasing a variety of species. Communities may also want to consider contracting with nurseries to grow the unique species they want, and to think well beyond maples and oaks.

Spatial diversity—spread the love: Some communities as a whole have great diversity, while individual neighborhoods within the city might consist of just one species. The more widespread the diversity, the less damage future issues are likely to pose. Private lands can make up 75 percent or more of the trees in a community forest, so our home landscapes are important as well. If a particular species is common in your neighborhood, plant something different.

Pollinator habitat: Planting a variety of trees and shrubs also improves habitat for birds and other pollinators. Examples include basswood, linden and black chokeberry which offer spring flowers; willows are early season food source for bees; cottonwood, aspen and some pines produce resins with antimicrobial properties important to bees for making propolis, which aids in colony health; and buttonbush attracts pollinators of all kinds.

Energy savings: Consider planting different species at specific locations around buildings to reduce energy costs. Conifers planted along the north side will block winds, and deciduous trees planted south and west of buildings will block the hot summer sun while still allowing sunlight during winter months.

Management: Greater diversity can reduce management costs over time. It costs the same to plant a diverse community forest as it does to plant only a few species. However, if only 5 percent instead of 20 percent of your community trees are impacted by the next pest (and it *will* come), that is an enormous savings to your community.

Why Not You?

Help lead, serve, and advance Minnesota's arboriculture industry by running for the MSA Executive Committee!

This October, MSA members will elect two new executive committee members to serve terms starting in 2020. This is an exciting opportunity to serve the industry by bringing your unique perspective and skills to MSA.

OPEN POSITIONS Start date: January 1, 2020

- Vice President (Term: Serve two years as Vice President followed by two years as President)
- Treasurer (Term: Two years)

BENEFITS

- Build your professional network statewide and internationally
- Strengthen leadership and communication skills
- Attend one MSA event per year free of charge and the International Society of Arboriculture Leadership Workshop
- Add to your resume through serving in a leadership position
- Make decisions that benefit and impact the industry

DESCRIPTION

Work with other members to lead, serve, and advance Minnesota's arboriculture industry through identifying member needs, coordinating with and leading other volunteers, and through building and sharing your knowledge and expertise. The Executive Committee works as a team to discuss policy, education, and other things effecting the membership.

NOMINATE NOW!

Submit your nomination by sending an email to msa@msa-live.org with a brief bio, photo, and explanation of why you would make a good candidate. Nominations taken now until August 15, 2019.

Voting will take place by e-ballot October 1-15, 2019. Results will be announced at the Annual Fall Conference on October 24.

Explore other ways to get involved at msa-live.org/get-involved/volunteer

Lake Nokomis Root Type Study

LYDIA VOTH, UNIVERSITY OF MINNESOTA
CHAD GIBLIN, UNIVERSITY OF MINNESOTA

INTRODUCTION

One of the most critical points in a tree's lifetime is during and immediately following transplant. Trees experience transplant shock, which is a period where trees must adapt to their new environment all while recovering from distress caused by injury, resource loss, and reduced function. This stress comes from damage to or loss of the root system, which impairs a tree's ability to take up water and nutrients. Additionally, carbohydrates and nutrients stored in the roots are lost (Struve, 2009). Other factors that contribute to stress during transplant include tree species, type of root system, environmental conditions, time of year, and cultural practices (Watson, 2005). During the time of transplant shock, a tree is not able to allocate resources into defense against pests, diseases, or other threats (1). Instead of investing in vegetative growth, newly transplanted trees must use their resources to create new roots to establish in a new planting location. Healthy trees should have a root system approximately three times the diameter of the canopy width (Watson, 2005). For a newly transplanted tree to become established, the height-to-root spread ratio must be re-established, and the tree must be able to begin allocating resources back into shoot growth (Struve, 2009).

The root type (containerized vs. gravel bed bareroot) and size of a newly transplanted tree may influence long-term survival. Containerized trees are produced in pots and transplanted throughout their life at the nursery. Through this method, they typically maintain their full root system. Bareroot trees are grown in the field, are harvested during dormancy, and have all the soil removed from the roots during harvest. With this method, a larger proportion of the root system still remains intact, especially when compared to balled & burlapped (B&B) production (Dierich, 2014). Gravel bed bareroot stock is typically cultured in an irrigated "gravel bed" to increase the root system quality and prepare the tree to be planted later that season. Time in the gravel bed increases the density of fibrous roots, which enhances water and nutrient uptake after transplant, theoretically increasing health and chances of survival (1). Research conducted on red oak cultured in Missouri gravel beds found that the root spread-to-height ratio was re-established the second year after transplant, which was significantly faster than what would be expected using another nursery production system (Struve, 2009).

Figure 1. Gravel bed bareroot catalpa.

Both root types have their strengths and weaknesses. Bareroot trees are reported to have a moderate transplant success rate. Their exposed roots require constant moisture to maintain viability (Dierich, 2014) and are at a higher risk of damage before and during planting. Both of these factors create higher levels of post-transplant stress (Grossnickle & El-Kassaby, 2016). Despite these challenges, bareroot stock is a more economical planting option, at only about half the cost of containerized trees. Bareroot stock is also much easier to install, reducing labor and equipment costs (1). Because the root system is fully visible with bareroot stock, it is easier to plant these trees at the correct depth (Buckstrup & Bassuk, 2000). Containerized trees are reported to have a moderate to high transplant success rate (Dierich, 2014) and may have an enhanced ability to resist drought, because they have a higher root growth potential and a lower shoot to root ratio (Grossnickle & El-Kassaby, 2016). Drawbacks of containers include the risk of deformed root systems and stem girdling roots due to improper nursery practices as well as increased production cost (Dierich, 2014).

Past research does not show a strong correlation between survival and these root types. A study of 16 Douglas-fir in Ireland found these two different stock types had a negligible effect on growth and survival; no significant differences were found in root number, root area, or rooting depth between these root types (Sundstrom & Keane, 1999). A performance comparison between bareroot and container root types in forest restoration showed comparable survival in areas with low stress and comparable performance post-establishment. No conclusive evidence was drawn on the effects of the root types on physiological attributes, or how these attributes could affect stress levels. However, the comparison did note that, of 122 comparison trials, 60.7% reported higher survival for containerized trees, 14.8% reported higher survival for bareroot trees, and 24.6% showed them to be similar (Grossnickle & El-Kassaby, 2016).

The size of nursery stock can also influence survival of transplanted trees. It is generally acknowledged that small-caliper trees establish more quickly than large-caliper trees. This is partially because it takes less time for the root spread-to-height ratio to re-establish after transplant. An experiment comparing survival and growth of different caliper trees found higher mortality rates in the large-caliper trees, but also found greater caliper increase in the surviving large-caliper trees versus the small-caliper trees (Struve, 2009).

This study will compare mortality, caliper growth, and tree condition between containerized trees and two sizes of gravel bed bareroot trees to see which option is the most cost-effective and productive.

MATERIALS & METHODS

This research project follows a completely randomized (CR) design. The species included in the replicated study are *Ostrya virginiana* (ironwood), *Catalpa speciosa* (northern catalpa), and *Ginkgo biloba* ('Princeton Sentry' ginkgo). The treatments are shown in the table below.

Species	Replications (*n*)	Root Type	Container Size or Stem Caliper
Catalpa speciosa	10	Containerized	#15
Catalpa speciosa	9	Gravel bed bareroot	1.25"
Catalpa speciosa	10	Gravel bed bareroot	4' Whip
Ginkgo biloba	9	Containerized	#15
Ginkgo biloba	9	Gravel bed bareroot	1.25"
Ginkgo biloba	7	Gravel bed bareroot	4' Whip
Ostrya virginiana	11	Containerized	#15
Ostrya virginiana	10	Gravel bed bareroot	1.25"
Ostrya virginiana	9	Gravel bed bareroot	5' Light Branched

Table 1. Treatments

Due to unforeseen circumstances, the number of replications was not equal across all treatments, as was originally intended. There was some nursery stock mortality among the gravel bed bareroot trees, especially in the ginkgo.

Figure 2. Containerized catalpa one year after planting.

In addition to these species, 10 *Quercus macrocarpa* (Bur Oak) trees were planted, but were not included in the study because of the high levels of mortality. Several other species were planted as a performance trial but were not included as part of the study: Chinese catalpa, Highland Park® maple, MPRB Heritage northern catalpa, Rocky Mountain Glow maple, and Snowdance™ tree lilac.

Planting took place in the fall of 2016. All trees were planted into 30 in. wide by 8-10 in. deep, machine-augured holes. If machine-auguring was not possible due to unforeseen conditions (e.g. buried utilities, large tree roots, etc.), holes were hand-dug to the same dimensions as those machine-augured. All trees were well-watered at planting and received a uniform application of wood mulch to the soil surface following standard MPRB Forestry planting protocols. After-care of trees followed standard operating procedures as specified by MPRB Forestry.

At planting, or shortly thereafter, University of Minnesota staff collected the following information at each planting location:

1. Geographic location including house number and street name or number
2. Stem caliper of tree (measured at 15cm and 30cm)

Subsequent data collection will be performed annually by University of Minnesota staff for the first five years of the study and will consist of the following variables:

1. Mortality (Years 1, 3, 5)

2. Stem caliper increase (Year 5)
3. Stem and crown condition rating (Year 5)
4. Soil compaction (measured at 15cm and 30cm below the surface)

After the initial five year period data will be collected at five year intervals and will consist of the same variables collected during the first five years.

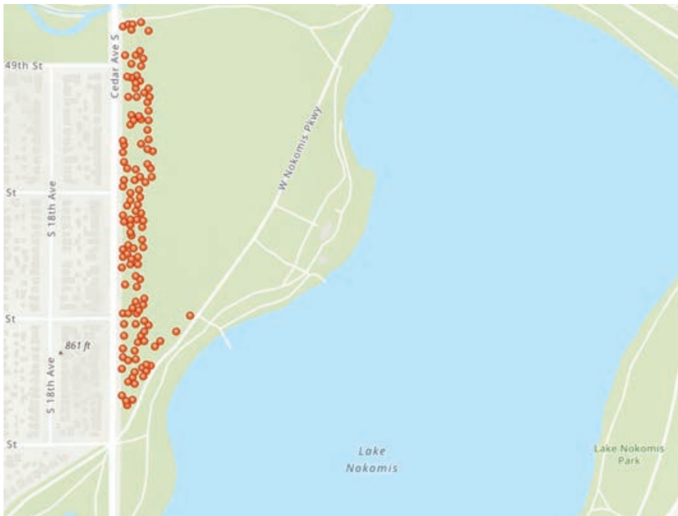

Figure 3. Study Area Northwest of Lake Nokomis

At the end of year one (fall 2017), preliminary data was collected to discover the mortality status of the trees. Each tree was given a condition rating number of 1-8 based on its appearance. The condition rating system is as follows:

1= Planted Tree Removed
2= No Tree Planted
3= Poor Appearance
4= Top Dead
5= Damaged
6= Questionably Dead
7= Dead
8= Tree Okay

Trees rated as okay (8) and damaged (5) were categorized as "Alive - Good." Those with the rating of poor appearance (3) or top dead (4) were classified as "Alive - Fair." Both removed (1) and dead (7) trees were classified as "Dead," because it was assumed that trees were removed because they did not survive. Trees given a rating of 2 or 6 were not included in the preliminary data analysis, because their mortality status was still uncertain.

PRELIMINARY DATA AND DISCUSSION

Chi-squared cross-tabulation tests were run to determine if there were any statistically significant relationships in the preliminary data.

Species	Alive - Good (%)	Dead (%)
Catalpa speciosa	93	7
Ginkgo biloba	96	4
Ostrya virginiana	48	52

Table 2. Condition by species one year after planting (2017).

There was a high amount of mortality among *Ostrya*, but low mortality in the other two species. Thus, a significant relationship was found between species and mortality ($p < 0.001$).

Across all species, seven gravel bed bareroot trees died, eight bareroot whip trees died, and four containerized trees died. While this was not found to be significant, although a non-significant trend between bareroot and containerized tree mortality can be seen, as roughly twice the number of bareroot trees died per root type versus the containerized root type.

Root Type	Alive - Good (%)	Dead (%)
Containerized	90	10
Gravel Bed Bareroot	100	0
Bareroot Whip	90	10

Table 3. Condition of *Catalpa speciosa* by root type one year after planting (2017).

There was no statistical significance found between root type and mortality status for the *Catalpa* trees ($p = 0.62$) and overall survival was high.

Root Type	Alive - Good (%)	Dead (%)
Containerized	100	0
Gravel Bed Bareroot	89	11
Bareroot Whip	100	0

Table 4. Condition of *Ginkgo biloba* by root type one year after planting (2017).

The high survival across all *Ginkgo* root types also revealed no significant relationship between root type and mortality status ($p = 0.40$).

Root Type	Alive - Good (%)	Dead (%)
Containerized	82	11
Gravel Bed Bareroot	40	60
Bareroot Whip	22	78

Table 5. Condition of ***Ostrya virginiana*** by root type one year after planting (2017).

For the *Ostrya* group, there was a significant relationship found between root type and mortality status ($p = 0.02$). The data shows a much higher mortality rate for the two bareroot treatments. This could mean that bareroot is not the most viable root type for this particular species. Anecdotal information from practitioners suggests that species in the Betulaceae (birch) family should be preferentially transplanted in the spring, so a fall transplanting may be a contributing factor to the high percentage of dead trees in this species.

These numbers only represent preliminary year one data; they do not yet show results. Thus far, the only significant relationship being seen is that root type does influence *Ostrya* survival. When complete, this research can help guide root type decisions for different species to reduce mortality.

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The Marks of a Good Knot

JEFF JEPSON

An exerpt from Knots At Work.

A good knot is one possessing the qualities that most favorably contribute toward accomplishing the task it was chosen for. The most important and prominent ones are shown below. The more of these qualities a knot can claim the better.

1. Ease of Tying and Untying

The ease of tying and untying a knot is an extremely important characteristic, especially when it's a knot repeatedly tied and untied during the course of the day, as with a running bowline when tying off limbs for lowering.

Knots that are easy to tie are also ones easily learned and easily remembered. These are important factors when it's necessary to tie a knot frequently, quickly, or when one is distracted or confused. What's more, easily tied knots can often be tied without looking ("blind" or "feel" knots"). In some cases they are also knots that can be tied while using only one hand (e.g., slip knot).

Though ease of untying may not be the most necessary attribute of a knot, it certainly ranks as one of the most appreciated. The expression "knife knot" is an accurate description of what can occur with an unyielding knot, usually the result of a knot that hasn't been tied, dressed, and set properly, has been used for the wrong application, or has been loaded beyond what it was intended to be. A general rule for untying knots is to find the "sweet spot," or vulnerable part of the knot, which by bending, twisting, pushing, or pulling on it, will cause it to loosen and come untied. This will vary from knot to knot. Doing this is much more efficient than trying to pick the knot apart with your fingers, teeth, or pliers.

2. Ease of Recognition and Inspection

A well crafted knot will also be one that is easy to recognize and inspect, ideally from several angles and even from a distance of 20 to 30 feet. This allows even an observant coworker to notice if the knot's tied correctly or incorrectly. Two people tying the same knot should have a final product looking exactly the same (unless one ties it in a clock-wise direction and the other counter-clockwise).

3. Strength and Security

Every knot tied in rope, cordage, or webbing weakens it to a certain extent. How much the rope is weakened is knot specific, but also determined by a number of other factors, including rope diameter and construction. Knots that are incorrectly tied, or not dressed and set properly, can weaken the rope even more. As a general rule, knots with larger bend radiuses weaken the rope less than do knots which have more severe bends.

A secure knot is one that stays tied before, during, and after it is put to work. If there is any question as to a knot's security, choose another knot, or at the very least, use an appropriate backup. Though it may sound odd, there are times when an insecure knot is preferable. One example are *slipped* knots. These are knots that by pulling on the tail can be quickly released (e.g., the quick hitch).

4. Compactness

The more compact a knot is, the less rope it takes to tie it. Of all the termination knots for instance, the buntline hitch requires the least amount of rope length, while the figure-8 on a bight requires the most. In most instances, compact knots are also quicker to tie, dress, and set.

5. Versatility

A versatile knot is highly valued. The more applications a particular knot can be used for the less number of knots you'll need to know. And since a versatile knot is used more frequently, it naturally follows that you are more likely to remember how to tie it when you do use one.

TIE, DRESS, & SET

Even a knot appropriately applied and possessing all "the right stuff" is deficient (and dangerous) if it's constructed improperly. Therefore, each attempt to tie a knot always involves two basic and vitally important tasks: (1) tying it correctly, and (2) dressing and setting it properly.

1. Tie the Knot Correctly

Obvious as it may seem, the first requirement of a well constructed knot is that it must be tied correctly. Don't snicker—for who among us hasn't incorrectly tied even a "familiar" knot at some point or another? How does this happen? An incorrectly tied knot can result from a number of things: improper learning of the knot, forgetfulness (due to infrequent use of the knot), hurriedness, distraction, or fatigue. Fortunately, an improperly tied knot often becomes immediately apparent before it is employed. But in many cases the error goes unnoticed until the knot is put to work and either performs poorly, or fails completely.

The Blake's hitch is one knot that arborists often tie incorrectly, resulting in what's been called, the "sui-slide" knot. The error occurs when the tail is mistakenly passed in *front* of the standing line before being threaded through the first two wraps, rather than *passed behind* the standing line first.

2. Dress and Set the Knot Properly

Getting a knot exactly right means more than just following "the procedure," like making the "rabbit come out of the hole, go around the tree, and back in the hole" as with the bowline knot (as important as this step is). But tying it right also means the knot must be properly finished by *dressing* and *setting* it. To *dress* a knot means to properly align or arrange all the parts of the knot so it matches the descriptions and illustrations in the book. Improperly dressed knots can result in significant strength loss.

To *set* the knot is to tighten it so all its parts properly touch, grab, and press against each other. This creates the friction on the rope that allows the knot to work. If a knot isn't set properly it could *capsize* (or distort) into something completely different, or nothing at all, or even come untied completely. It can also become one that is almost impossible to untie afterward.

As a side note to the last two steps, it is important to leave a tail length that is appropriate for the knot. In most cases common sense will dictate, but consider a length of 6 times the rope's diameter as a minimum, unless, of course, a stopper knot is required. Then a tail length of at least 16 inches is required to tie a figure-8 knot and 10 inches for an overhand knot (in 1/2-inch line).

THE LANGUAGE OF KNOTS

Knot Categories

***Knot*:** In this book, the term *knot* is used in two contexts: in a general sense to refer to all knots, hitches, and bends and in a more strict sense to refer to the category called knots, which consist of bindings, loops, or stopper knots.

***Bend*:** A knot that joins two rope, cord, or webbing ends together (e.g., water knot, beer knot, sheet bend).

***Hitch*:** A knot that secures rope or webbing to an object or its own standing part (e.g., clove hitch, Prusik hitch).

***Binding knot*:** A knot used to hold separate objects together (e.g., constrictor knot).

***Loop knot*:** A knot with a fixed loop used for attaching to an object. It can be tied using the ends of a line or mid-rope, on a bight (e.g., bowline knot, figure-8 on a bight).

***Stopper knot*:** A knot tied in a rope to "stop" the rope from pulling through another object such as a climbing hitch or pulley (e.g., figure-8 knot, slip knot).

Rope Parts

***Bight*:** Any well-defined U-shaped (or doubled section) of rope that doesn't cross itself.

***Loop*:** A turn or bight of rope that crosses itself.

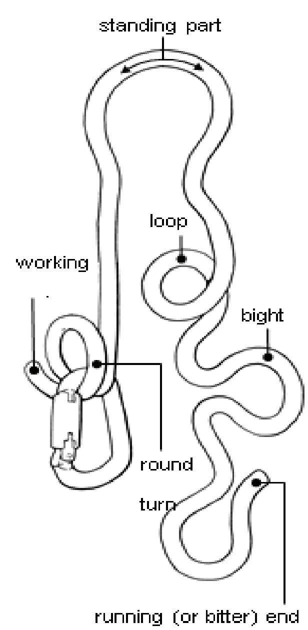
Running (or bitter) end: The free end of the rope or the end not being used to tie or rig with.

***Standing part*:** All the inactive parts of the rope uninvolved with rigging or knots.

Round turn*:** Two loops of rope around an object. A ***crossed round turn is made by passing the round over the second (used when tying a clove hitch).

***Turn*:** One loop of rope passing around an object.

Working end: The active end of the rope used to rig or tie off to something.



MPRB-City of Minneapolis Biochar Amendment Research Project: Year Three Progress Report

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CHAD GIBLIN, UNIVERSITY OF MINNESOTA

INTRODUCTION

Trees planted in urban environments, especially boulevards, are exposed to a variety of stressors, such as soil compaction, limited soil moisture, and transplant shock; all of which can negatively impact growth and survival of young trees. The use of soil amendments has potential to alter soil properties that can improve structure, water retention, drainage, nutrient availability, and soil pH, thus improving conditions for tree establishment and growth. These soil amendments can be in organic or inorganic forms. An organic soil amendment that has been of interest to the Minneapolis Park & Recreation Board (MPRB) for use with newly planted boulevard trees is biochar.

Biochar is an organic soil amendment that is carbon-rich and is derived from biomass such as wood, manure, or leaves, after it has been combusted in a container with little or no oxygen (Lehmann & Joseph 2009). Novak et al. (2008), found that biochar amendments increased soil pH, calcium, potassium, manganese, and phosphorus while decreasing exchangeable acidity, sulfur, and zinc. Biochar for this study was blended with compost prior to application.

The purpose of this study is to measure the effects that a biochar/compost blend has on Minneapolis boulevard trees with respect to survival, establishment, and growth when incorporated into the backfill soil at the time of planting.

MATERIALS & METHODS

Experimental Design

Eleven species were included in the study including: *Gymnocladus dioicus* 'Espresso' (Espresso Kentucky coffeetree), *Malus* 'Prairifire' (Prairifire crabapple), *Platanus x acerfolia* 'Bloodgood' (Bloodgood London planetree), *Quercus bicolor* (swamp white oak), *Syringa reticulata* 'Ivory silk' (Ivory Silk Japanese tree lilac), *Tilia cordata* 'Glenleven' (Glenleven littleleaf linden), *Ulmus americana* 'Princeton' (Princeton American elm), *Ulmus americana* 'Valley Forge' (Valley Forge American elm), *Ulmus* 'Morton' (Accolade™ hybrid elm), *Ulmus* 'Morton Glossy' (Triumph™ hybrid elm) and, *Ulmus* 'Patriot' (Patriot hybrid elm).

These species were planted at random boulevard locations throughout Minneapolis and randomly received one of five soil amendment treatments: biochar + compost (full rate), biochar + compost (half rate), compost only (full rate), compost only (half rate), or control (no amendment). A full rate of amendment treatments were 41.6L, and half rate amendment treatments, 20.8L. Each amendment treatment was replicated eight times per species.

Trees were planted in holes that were 76.2 to 85.3 cm wide by 20.3 to 25.4 cm deep. The amendment treatments were incorporated into existing backfill at planting. Trees were watered and received wood mulch following standard MPRB Forestry planting protocols. After planting, care and maintenance of trees followed MPRB Forestry standard operating procedures.

Data Collection

At the time of planting in 2014, geographic location, street use classification, boulevard width, and stem caliper at 15 and 30 cm was collected. Year one data was collected in 2015 and consisted of stem caliper readings at 15 and 30 cm, mortality status, and a condition code. Year three (2017) data collection included collection of a condition code for each tree, as well as documenting it with a photograph. Condition codes included: 'Planted Tree Removed', 'No Tree Planted', 'Poor Appearance', 'Top Dead', 'Damaged', 'Questionably Dead', 'Dead', and 'Alive in Good Condition'.

Statistical Analysis

Condition ratings were grouped into three different categories for statistical analysis. Trees that were coded as, 'Planted Tree Removed', and 'Dead' were classified as, 'Dead'. Trees were classified as 'Alive-Good' if they received a condition rating of, 'Damaged' or 'Alive in Good Condition', and trees coded as 'Poor Appearance', 'Top Dead', and 'Questionably Dead', were classified as, 'Alive-Fair'. Trees that received the condition code of, 'No Tree Planted' were omitted from the analysis. Chi-Square tests were executed to explore the relationship between tree species, amendment, and mortality status using SPSS Statistics 23.0 (IBM Corp. 2015).

Species	Replication (n)	Amendment Treatment
Gymnocladus dioicus 'Espresso'	8	Biochar + Compost (Full Rate)
Gymnocladus dioicus 'Espresso'	7	Biochar + Compost (Half Rate)
Gymnocladus dioicus 'Espresso''	8	Compost Only (Full Rate)
Gymnocladus dioicus 'Espresso'	6	Compost Only (Half Rate)
Gymnocladus dioicus 'Espresso'	9	Control (No Amendment)
Malus 'Prairifire'	7	Biochar + Compost (Full Rate)
Malus 'Prairifire'	8	Biochar + Compost (Half Rate)
Malus 'Prairifire'	7	Compost Only (Full Rate)
Malus 'Prairifire'	8	Compost Only (Half Rate)
Malus 'Prairifire'	8	Control (No Amendment)
Platanus xacerfolia 'Bloodgood'	8	Biochar + Compost (Full Rate)
Platanus xacerfolia 'Bloodgood'	8	Biochar + Compost (Half Rate)
Platanus xacerfolia 'Bloodgood'	7	Compost Only (Full Rate)
Platanus xacerfolia 'Bloodgood'	8	Compost Only (Half Rate)
Platanus xacerfolia 'Bloodgood'	7	Control (No Amendment)
Quercus bicolor	8	Biochar + Compost (Full Rate)
Quercus bicolor	8	Biochar + Compost (Half Rate)
Quercus bicolor	8	Compost Only (Full Rate)
Quercus bicolor	7	Compost Only (Half Rate)
Quercus bicolor	9	Control (No Amendment)
Syringa reticulata 'Ivory Silk'	8	Biochar + Compost (Full Rate)
Syringa reticulata 'Ivory Silk'	8	Biochar + Compost (Half Rate)
Syringa reticulata 'Ivory Silk'	8	Compost Only (Full Rate)
Syringa reticulata 'Ivory Silk'	8	Compost Only (Half Rate)
Syringa reticulata 'Ivory Silk'	7	Control (No Amendment)
Tilia cordata 'Glenleven'	7	Biochar + Compost (Full Rate)
Tilia cordata 'Glenleven'	8	Biochar + Compost (Half Rate)
Tilia cordata 'Glenleven'	7	Compost Only (Full Rate)
Tilia cordata 'Glenleven'	8	Compost Only (Half Rate)
Tilia cordata 'Glenleven'	8	Control (No Amendment)
Ulmus americana 'Princeton'	8	Biochar + Compost (Full Rate)
Ulmus americana 'Princeton'	8	Biochar + Compost (Half Rate)
Ulmus americana 'Princeton'	8	Compost Only (Full Rate)
Ulmus americana 'Princeton'	8	Compost Only (Half Rate)
Ulmus americana 'Princeton'	8	Control (No Amendment)
Ulmus americana 'Valley Forge'	8	Biochar + Compost (Full Rate)
Ulmus americana 'Valley Forge'	8	Biochar + Compost (Half Rate)
Ulmus americana 'Valley Forge'	6	Compost Only (Full Rate)
Ulmus americana 'Valley Forge'	7	Compost Only (Half Rate)
Ulmus americana 'Valley Forge'	8	Control (No Amendment)
Ulmus 'Morton Glossy'	8	Biochar + Compost (Full Rate)
Ulmus 'Morton Glossy'	8	Biochar + Compost (Half Rate)
Ulmus 'Morton Glossy'	8	Compost Only (Full Rate)
Ulmus 'Morton Glossy'	7	Compost Only (Half Rate)
Ulmus 'Morton Glossy'	8	Control (No Amendment)
Ulmus 'Morton'	8	Biochar + Compost (Full Rate)
Ulmus 'Morton'	7	Biochar + Compost (Half Rate)
Ulmus 'Morton'	8	Compost Only (Full Rate)
Ulmus 'Morton'	8	Compost Only (Half Rate)
Ulmus 'Morton'	8	Control (No Amendment)
Ulmus 'Patriot'	8	Biochar + Compost (Full Rate)
Ulmus 'Patriot'	8	Biochar + Compost (Half Rate)
Ulmus 'Patriot'	8	Compost Only (Full Rate)
Ulmus 'Patriot'	8	Compost Only (Half Rate)
Ulmus 'Patriot'	8	Control (No Amendment)

Table 1. Species and their replications for each amendment treatment in the study.

RESULTS

This research project included a total of 430 boulevard trees (Table 1). Seven trees were not included in the study due to planting error or other unforeseen circumstances (Table 2).

Species	Replication (n)	Amendment Treatment
Syringa reticulata 'Ivory Silk'	1	Biochar + Compost (Half Rate)
Malus 'Prairifire'	1	Compost Only (Full Rate)
Syringa reticulata 'Ivory Silk'	1	Compost Only (Full Rate)
Gymnocladus dioicus 'Espresso'	1	Compost Only (Half Rate)
Malus 'Prairifire'	1	Compost Only (Half Rate)
Ulmus 'Patriot'	1	Compost Only (Half Rate)
Gymnocladus dioicus 'Espresso'	1	Control (No Amendment)

Table 2. Species and their amendments not included in the study due to unforeseen circumstances.

After the first year of the study in 2015, 68.9% of the total trees were classified as 'Alive-Good', 11.1% as 'Alive-Fair', and 20.0% classified as 'Dead-Removed'. Year one Chi-Square analysis showed that there was a significant relationship between tree species and year one condition (χ^2 (20, n = 431) = 110.12, p < 0.001), however, there was no significant relationship between amendment treatment and year one condition (χ^2 (8, n = 431) = 5.02, p = 0.756). There were non-significant trends that were observed including the positive effect the amendment treatments had on *Gymnocladus dioicus* 'Espresso' as well as negative effects that amendment treatments had on *Ulmus americana* 'Valley Forge'.

In year three of the study 68.4% of the total trees were classified as 'Alive-Good', 3.2% as 'Alive-Fair', and 28.4% classified as 'Dead-Removed'. Chi-Square analysis showed that there was a significant relationship between species and year three mortality status (χ^2 (30, n = 430) = 85.22, p < 0.001). Another Chi-Square test revealed that the relationship between amendment treatment and year three mortality status was non-significant (χ^2 (12, n = 430) = 16.18, p = 0.183). The data also shows some non-significant trends. The combination of biochar + compost at the full rate yielded the highest count of 59 trees categorized as 'Alive-Good' condition. Year three data analysis continued to suggest a non-significant positive effect that amendment treatments had on the mortality status of *Gymnocladus dioicus* 'Espresso' (Fig. 1). 62.5% of the *Quercus bicolor* trees were rated as 'Dead', while the relationship between amendment and mortality status was non-significant (χ^2 (8, n = 40) = 4.72, p = 0.787) (Fig. 2).

DISCUSSION

This is a three year progress report of a five year study. This data suggests that there may be differences in how species

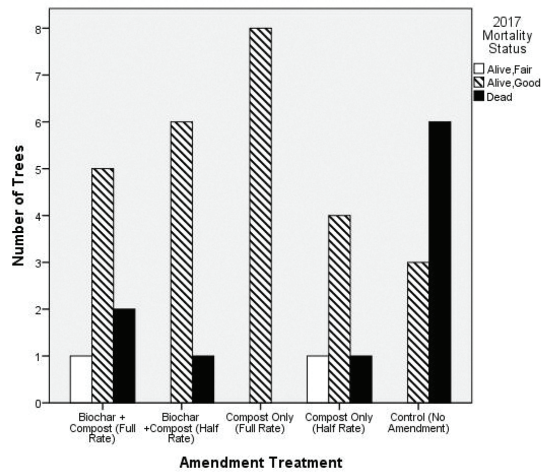

Figure 1. Year three mortality status as affected by four bichar amendment treatments and a control for *Gymnocladus dioicus* 'Espresso'. (χ^2 (8, n = 38) = 14.95, p = 0.060).

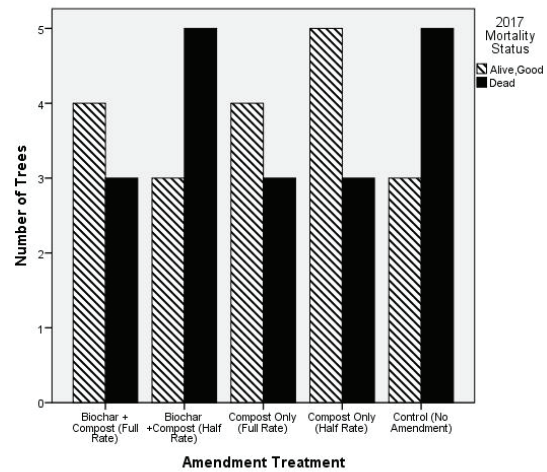

Figure 3. Year three mortality status among four different biochar amendment treatments and a control for *Tilia cordata* 'Glenleven' (χ^2 (4, n = 38) = 1.79, p = 0.775)

react to amendment treatments. Statistical analysis shows that that the relationship between species and mortality status is significant (χ^2 (30, n = 430) = 85.22, $p < 0.001$). Using a biochar + compost or compost amendment at the time of planting may help the establishment of young trees. Species that have a high percentage of individuals coded as 'Alive-Good' include *Malus* 'Prairifire' (81.8%), *Platanus* x *acerfolia* 'Bloodgood' (82.5%), *Ulmus* 'Morton Glossy' (83.3%), and *Ulmus* 'Morton' (86.5%). *Gymnocladus dioicus* 'Espresso' showed highest mortality in the control treatments (66.7%), while lowest mortality was was observed in the group that received the full rate of compost only treatment(0.0%), the half rate of biochar + compost treatment had the highest percentage of trees coded as 'Alive-Good' (85.7%) (Fig. 1).

High mortality rates may be related to planting stock quality in *Quercus bicolor* (Fig. 2) and *Tilia cordata* 'Glenleven' (Fig. 3), as both saw high rates of mortality across all amendment treatments and the control group. This theory is further supported by Chi-Square tests which reveal a non-significant relationship between amendment treatment and mortality status in *Quercus bicolor* (χ^2 (8, n = 40) = 4.72, p = 0.787), and *Tilia cordata* 'Glenleven' (χ^2 (4, n = 38) = 1.79, p = 0.775).

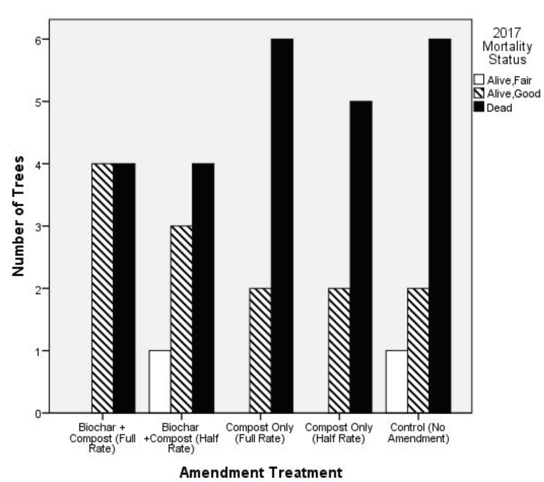

Figure 2. Year three mortality status among four different biochar amendment treatments and a control for *Quercus bicolor* (χ^2 (8, n = 40) = 4.72, p = 0.787)

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What is Incidental Line Clearance?

KEVIN MYERS, ACRT

By now you have probably seen, or at least heard about, the release of the most current Z133 safety standard for tree work. It was debuted in November 2017 at the annual TCIA trade show in Columbus, OH. It has been five years since we have had a revision to the standard, the previous revision being dated 2012. The ANSI Z133-2017 saw many changes, including but not limited to, handsaws being required while working aloft, two wheel chocks required for bucket trucks, and two workers trained in CPR and first aid. However, one of the largest changes was to the Electrical Hazards Section of the standard. The section is broken up into three smaller sections: General, Incidental Line Clearance, and Utility Line Clearance.

The addition of Incidental Line Clearance has created some questions among arborists as to which classification they belong. Previously, either you were qualified to work around energized conductors, in which you would utilize the minimum approach distances specified in the old Table 1, or you were not qualified, in which you would use table two. For the most part, this is still the same; you are either qualified, or you are not, based on your training and experience. However, if you are qualified by training and experience, you belong to one of two other categories. These are the Incidental Line Clearance, or Utility Line Clearance categories.

Table 1. Minimum approach distances to energized conductors for arborists not qualified by training and experience to work within 10 feet (3.05 m) of electrical conductors.

Nominal Voltage (Phase-to-Phase)*	Minimum Approach Distance (MAD)	
kV	ft-in	m
50.0 and less	10-00	3.048
50.1 to 72.5	11-00	3.353
72.6 to 121.0	12-08	3.861
138.0 to 145.0	13-04	4.064
161.0 to 169.0	14-00	4.267
230.0 to 242.0	16-08	5.08
345.0 to 362.0	20-08	6.299
500.0 to 550.0	26-08	8.128
785.0 to 800.0	35-00	10.668

*Exceeds phase-to-ground per 29 CFR 1910.333

The definition of Incidental Line clearance is, "tree work performed where an electrical hazard exists to the arborist, but the arborist is not working for the purpose of clearing space around the conductor on behalf of the utility that controls or operates the wires/lines." A municipal arborist who is pruning/removing street trees along the roadways, or general arborists who may have the occasional service drop running through the tree they are pruning would typically fall into this definition. In any case, as stated in section 4.2.4 of the Z133, the individual still requires a minimum amount of training and experience to be considered as qualified:

4.2.4 Training for qualification of qualified Incidental Line Clearance Arborists requires a minimum of:

(a) the skills and techniques necessary to distinguish exposed live parts from other parts of electric equipment;

(b) the skills and techniques necessary to determine the nominal voltage of exposed live parts; and

(c) the minimum approach distances (MAD) specified in Table 2 and the corresponding voltages to which the qualified person will be exposed.

Table 2 refers to the minimum approach distance chart for Incidental Line Clearance. With the revision and the addition of Incidental Line Clearance, the MAD charts have been reorganized from their location in the 2012 revision. Table 1 is now the minimum approach distance chart for non-qualified individuals, and Table 2 is now

Table 2. Approach distances for incidental line clearance-alternating current.		
Voltage Range (Phase-to-Phase)*	**Minimum Approach Distance (MAD)**	
kV	**ft-in**	**m**
0.300 and less	*Avoid Contact*	*Avoid Contact*
0.301 to 0.750	1-06	0.457
0.751 to 5.0	2-09	0.838
5.1 to 15.0	2-10	0.864
15.1 to 36.0	3-04	1.016
36.1 to 46.0	3-08	1.118
46.1 to 72.5	4-04	1.321
72.6 to 121.0	12-08	3.861
138.0 to 145.0	13-04	4.064
161.0 to 169.0	14-00	4.268
230.0 to 242.0	16-08	5.080
345.0 to 362.0	20-08	6.300
500.0 to 550.0	26-08	8.128
785.0 to 800.0	35-00	10.668

*Exceeds Table S-5 29 CFR 1910.333.

the minimum approach distance chart for Utility Line Clearance.

The main difference between an Incidental Line Clearance Arborist and a Utility Line Clearance Arborist has to do with for whom you are working. If you are not working for a utility, or you are not contracted by a utility for clearing vegetation from electrical conductors to maintain the safety and reliability of the electrical infrastructure, then you are not a Utility Line Clearance Arborist. In Utility Line Clearance the host utility has given you explicit permission to work around their conductors, along with training in that utility's Safety and Operations Protocols. In Incidental Line Clearance you are working around a utility's conductors without the utility knowing about it, and there is no direct relationship between you and the utility. Furthermore, Incidental Line Clearance Arborists, although they may have training and experience, are typically not working within 10' of energized conductors on a daily basis. Therefore, the level of awareness is not going to be the same as a Utility Line Clearance Arborist, who works around electrical hazards daily. To compensate, the MAD is greater for Incidental Line Clearance Arborists than that of Utility Line Clearance Arborists.

The new revision also adds that:

4.1.3 Arborists' training and degree of training in electrical hazards shall be determined by the risk to the employee for the hazard(s) involved.

The paragraph above puts direct responsibility on employers to be sure that they are providing their employees with the appropriate training and amount of training in electrical hazards, based on the work that they do.

For more information on Line Clearance arboriculture and to find out if you are qualified, I encourage you to read 29 CFR 1910.269 as well as the new ANSI Z133-2017. If you are interested in Line Clearance training, please visit the new ACRT Arborist Training website at training.acrt.com.

Kevin Myers, CTSP, ISA-certified arborist and ISA-certified Utility Specialist, is an arborist training instructor with ACRT, and a recipient of the 2016 UAA Silver Shield Award. For more information, visit www.acrt.com. If you or your company are interested in line clearance training, visit the new ACRT Arborist Training website at training.acrt.com.

One for the Ladies

JESSICA BYRON

My name is Jessica, I am an arborist and I work for myself. My husband and I own a very small tree company in southern Ontario.

Had you have asked me 3 years ago if I thought I would be working for myself my answer would have been a hard NO. At the time I would have been pregnant with my second child and considering other career paths than arboriculture. Even though my education had been in arboriculture I found there is little place in the industry for a childrearing woman. My efforts to become superwoman; being pregnant, mothering, and hucking wood all at the same time gave way to a comfortable office job with a much higher pay and energy left over at the end of the day. The frustrated male coworkers were replaced by an environment equal in either gender. The frustrated sighs when pregnant Jessica had to pee were replaced by gifts of tiny knitted boots and thoughtful suggestions on how to supplement my diet during this crucial time. My hormonally ridden body was thankful for the rest, good pay, and lack of danger.

Leaving the industry had not been my intention when I became pregnant, and I was sad to leave. It felt as though I was throwing my passion out the window. Womanhood, particularly motherhood, had simply thrown too many obstacles at me at once and I could not handle them all. I watched my husband somewhat jealously as he pulled his saw pants on in the morning, refining his industry skills every day while my time was entirely saturated with household chores and cubicle time.

Right around the time that my body began to feel more like its old self (I think it was no coincidence that this was around the time that I, I mean my kids, began to sleep through the night) my husband decided we should start our own business. I agreed. We had the support of some friends and equipment we could borrow. We spent our weekends working under our own name, gaining customers through word of mouth.

Pretty soon we secured a conservation contract and made the decision to work for ourselves full time. Giving up the security of two steady paycheques was difficult and it would be foolish to lead anyone to believe that we don't often encounter major hiccups. We work much more than any normal person would ever choose to if not working for themselves. Between juggling my job and the business there come weeks when I wonder when I will see my children next. All this said, I wouldn't have it any other way.

Through working with my husband I found a wonderful balance between my private life and my work life. Since my husband's and the company's well-being both depend on my improvement in the field I am often encouraged to do my best at work (and sometimes even pressured, but that's beside the point). Instead of being scoffed at when I express the desire to enter in a climbing competition I am cheered on. Even customers treat me with more respect; it's difficult to belittle the owner of a company. I am far from where I would like to be, skill wise, in the tree world. I still feel left behind in the dust of the new hires who were approved for training courses at the shop I was working at before I left on maternity leave. I sometimes wonder if there would still be a place for me in the tree world if I wasn't so fortunate to have the support of my husband and our wonderful band of friends and family. Then I remember that there is a reason I am here. Just as there is a reason every woman in the industry is here.

Every woman in the industry is strong and capable. Many are tired of society's vision for women, and choose to go against the grain. To show they can. Because it's in them and it is what they want to do! Every woman in the industry already possesses the courage to be here and therefore to seek out those rooting for her, and those ready to support her. She deserves no less.

In fact women are needed in this industry as role models for future young tradespeople. Every battle won for a working woman is a small step to showing girls what is possible, and showing boys what is normal. Every small battle you "win" at work is a small battle won for women.

UMN Elm Selection Program Research Updates

CHAD GIBLIN, UNIVERSITY OF MINNESOTA
GARRETT BEIER, FARMINGDALE STATE COLLEGE
BENJAMIN HELD, UNIVERSITY OF MINNESOTA
ROBERT BLANCHETTE, UNIVERSITY OF MINNESOTA

This article was originally published in the Fall/Winter 2017 issue of Clippings, produced by the Minnesota Turf & Grounds Foundation.

The University of Minnesota Elm Selection Program has continued in earnest in 2017 thanks to additional funding from the Minnesota Turf and Grounds Foundation. This funding, along with support from the Environment and Natural Resource Trust fund has allowed us to propagate, plant, and screen many more elms in 2017 and to continue the exploration of elm disease resistance mechanisms and research methods that practitioners can use to preserve – and save – elms of all sizes.

NEW ELM COLLECTIONS AND PROPAGATION

In late winter 2017, the propagation season brought much activity to the project. Greenhouses at the University of Minnesota were filled with hundreds of recently cloned young elms. Overall success in propagating species of interest continues to rise as we refine grafting techniques. Additional collections from trees of interest in northern Minnesota has expanded our collection and greenhouse inoculation trials have given us a first glimpse into the potential disease resistance for many new clonal selections.

New trees were identified in various locations throughout Minnesota thanks to recommendations from cooperators from many different regions of Minnesota. While these will not be included in propagation or inoculation trials this year their locations have been recorded and these trees may be visited at a future date.

Additional collections were made in February in Duluth, MN. Propagules from a survivor American elm located at the historic Glensheen Mansion were collected as well as one additional American elm on the west side of Duluth. Additional collections were made on trees previously identified in Duluth but unsuccessfully propagated. These trees add additional hope for finding and successfully screening native elms from northern Minnesota locations.

With the assistance of staff from Three Rivers Parks District (serving Hennepin, Carver, Dakota, Scott and Ramsey Counties), two additional American elms were identified and successfully collected in February. Both are notable not only for surviving in an area of high Dutch elm disease pressure but also for their large size (40 inch DBH and 50 inch DBH).

Four rock elm sourced from Kandiyohi County were successfully propagated and included in rock elm propagation trials during this period. All four have been planted into field plots for evaluations and inoculation trials. In addition, a late season trip to Fergus Falls allowed for additional collections from several trees previously identified as well. These trees were also used for elm resistance mechanisms research and will be propagated in greater numbers moving forward to be included in future field evaluation and disease screening trials.

American elm located in Corcoran, MN. This large elm (40in DBH) and has been under observation by Three Rivers Parks District staff for several years as having possible resistance to Dutch elm disease.

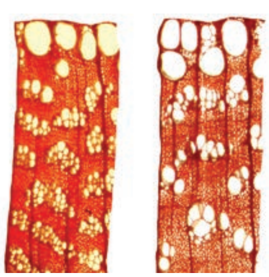
Adams Park in Fergus Falls, home to a large population of survivor elms, has been extensively surveyed and collections of elm material obtained for propagation.

Grafted selections were also prepared for a greenhouse trial using trees produced during the winter of 2015-2016. These trees are now ready for inoculation and evaluation during February & March 2017. This replicated trial is comprised of 10 elm selections procured during Phase I of this project and includes native American, red, and rock elm selections. This trial will provide initial information on disease resistance on elms slated for future inoculations in the field.

DISEASE RESISTANCE MECHANISMS RESEARCH

Studies to identify the characteristics of resistance in elm were initiated with histological and micromorphological investigations. In these trials several elms with putative resistance were compared to susceptible elms.

During the past six months we also examined seven different genotypes with varying levels of resistance to DED to evaluate the protocols for identifying specific mechanisms that may occur in elm. One of the potential mechanisms we examined was differences in xylem anatomy. In previous studies of other trees, it was found that resistant genotypes appeared to have a smaller average vessel diameter compared with those of susceptible genotypes. In our observations, two putative resistant varieties had the smallest average vessel diameter. These findings support the use of average vessel diameter size as a potential preliminary screening method for resistance. Additionally, genotypes were assessed for differences in their ability to compartmentalize infection. By passing an aqueous dye through the plants, we were able to distinguish functional from non-functional xylem. After examining the genotypes being tested, we determined two methods by which these genotypes limited the spread of the pathogen. The most common method was by creating barrier zones, which restricted the spread of the pathogen from moving into newly formed xylem. In addition to creating a barrier zone, the genotype with the lowest mean disease severity rating was able to consistently restrict movement of the pathogen around the circumference of the stem. Ideally, trees could be selected that are capable of consistently producing a strong barrier zone and limiting the spread of the pathogen around the circumference of the stem.



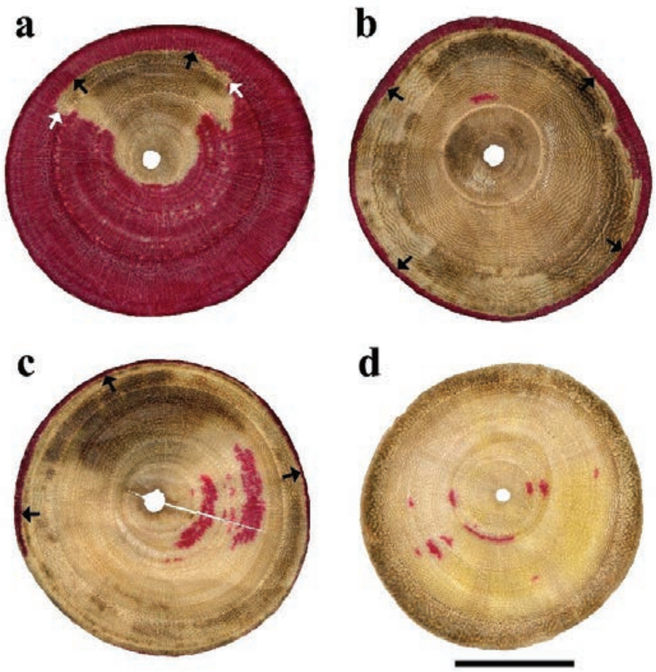
Section of American elm genotypes showing xylem anatomy of putative resistant tree (left) and susceptible tree (right). Smaller diameters of vessels were found in the resistant genotype.

GREENHOUSE INOCULATION TRIALS – SPRING 2017

Nine new elm selections were tested in a greenhouse trial initiated in March. Seedlings were inoculated with similar methods as previous trials in which liquid cultures of the pathogen were grown and used to inject spores into the seedlings in a drill wound 8 cm on the stem up from the soil. The seedlings were rated every 2 weeks until 12 weeks, when the study was concluded. Results were promising, with seven selections having lower disease severity than the wild types and five had a rating less than three (on a 1-5 scale). Seedlings were also tested for the percent circumference of the stem that was conducting using a dye that stains functioning vascular tissue. Significant differences were noted between selections that scored well (top figure below) compared with those that performed poorly (bottom figure below) and intermediaries (middle figure below). These elm selections were also planted in our field research sites and will be inoculated in spring 2019.

Cross sections of elm stems that were inoculated in the greenhouse trial and placed in an aqueous stain enabling quantification of the percent circumference of vascular tissue that was conducting. The selections ranged from very good (top), intermediary (middle) and poor (bottom).

Studies focusing on compartmentalization and hydraulic conductivity of resistant elm selections tested in the field were completed and a manuscript was drafted and published describing results (Forest Pathology, 2017). The main finding of these studies indicated that the most resistant cultivars were able to limit the spread of the pathogen not only in the newly formed cells, known as barrier zones (black arrows in "a, b, and c" in figure below) but also tangentially (around the circumference of the stem, white arrows in "a" in figure below). The results of these studies are important because it provides a possible metric for identifying selections that have effective resistance to the DED pathogen.



Representative transverse sections of *Ulmus americana* cultivars inoculated with *Ophiostoma novo-ulmi* at 90 days post-inoculation (scale bar = 1 cm). Sections were made 30 cm above the inoculation site and stems are oriented so the side of inoculation is at the top. Trees were stained with safranin O to indicate conducting (stained red) and non-conducting (not stained) areas of xylem. Black arrows represent areas likely to be barrier zones separating necrotic tissue from healthy conducting tissue. White arrows represent areas limiting infection likely through a wall 3 reaction zone. (a) Example of limited tangential spread and limited spread into newly formed xylem suggesting both an effective reaction zone and barrier zone; (b) Tree with limited tangential spread but successfully stopped spread into newly formed xylem; (c) Reaction showing failure to limit tangential spread, but partially limited spread into newly formed xylem suggesting an ineffective reaction zone and partially effective barrier zone; (d) Tree with ineffective reaction zone and an ineffective or no barrier zone and little conducting tissue.

FIELD PLOTS AT THE UNIVERSITY OF MINNESOTA

Throughout the spring and summer months staff and students maintained existing field elm plots and established several new ones as well. The exceptional rainfall and warm temperatures provided optimum growing conditions for the young elms this year and they are well on their way to be a suitable size for field inoculation trials in spring 2018 and/or spring 2019.

The third field plot planted at the University of Minnesota in fall 2016 includes a replicated field trial that will be inoculated in spring 2018/spring 2019. This trial will utilize the same genotypes that have undergone a greenhouse inoculation trial in February and March 2017, providing additional insight and confidence in the results obtained from the greenhouse trials.

A fourth research plot has undergone expansion at the Minnesota Landscape Arboretum and Horticultural Research Center in Chanhassen, MN. This plot will be used to assess growth rate and horticultural characteristics of elm selections as well as provide another location to conduct disease resistance field inoculation trials.

Establishing new field plot for selected elms at the Minnesota Landscape Arboretum

FIELD INOCULATIONS – SPRING 2017

Field testing of a variety of selections continued through the summer and early fall. While most of the selections tested were from selections made during Phase I of this project, these trees are being rated and used to determine how age of the tree influences resistance. As we continue to move from main stem inoculations to branch inoculations, these trials provide a good opportunity to fully evaluate branch inoculations on older trees. This was also done at the WWII memorial on the MN State Capitol grounds where large trees destined for removal were used for our inoculation studies. Additional studies were done on trees at field plots located at the University of Minnesota Landscape Arboretum.

Field plots at the Urban Forestry Outreach, Research & Extension Nursery that were planted in summer of 2016 continue to thrive and grow at an exceptional rate. Trees in this plot include those that have undergone a greenhouse trial during the winter of 2016-2017. The additional data acquired during production and subsequent field inoculations will provide valuable information on their suitability for further research and disease screening.

In early June, a field inoculation study was initiated using 18 different elm selections. Not all selections were new, cultivars Valley Forge, Princeton and others were used as well for comparative purposes. Inoculation protocols were similar to previous inoculation trials, where DED inoculum was injected into a drill wound on one branch in the lower crown. Ratings have been taken every four weeks and the study will conclude one year from the inoculation date to determine if recovery will take place. Also at the conclusion of the study, we plan to dissect the branches that were inoculated and study branch attachment architecture. Previous research suggests that the angle of attachment and other anatomical characteristics may affect transmission of the pathogen to the main stem. Results from this work will give important information on physical characteristics of the tree that provide a basis for resistance.

One-year ratings were taken for the Princeton elms that were inoculated at the WWII memorial on the capitol grounds in St Paul last spring. Isolations from the branches that were inoculated and from several points in the crown were taken to determine the distribution of the pathogen within the trees. Results from the isolations showed that many of the trees had samples where the pathogen was no longer present. The results indicate that these trees were effective at walling off the pathogen and limiting its spread after inoculations. This was also indicated by the low wilt symptoms that were observed in the one year ratings.

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Carabiner Maintentence: Cleaning and Lubrication

TAYLOR HAMEL, DMM INTERNATIONAL, LTD.

Cleaning and lubrication is an integral part of carabiner maintenance that is all too often overlooked. These vitally important connectors are constantly subjected to abuse in the harsh environments of tree work. Wood and leaf debris, sap, snow and ice, sand and soil... we have all dealt with sticky, crunchy, grimy, frozen or otherwise malfunctioning carabiner gate mechanisms. You wouldn't dare drag that nice carabiner across the ground would you? Maybe left it hanging off the end of your lanyard as you walked across the parking lot (with your spikes on) to grab lunch? No? Good!

In this article, we will briefly discuss some key points in carabiner cleaning and lubrication. Please keep in mind that a particular manufacturer may have specific or different recommendations. This is meant as a general guide, but with a focus on DMM gates in particular.

CLEANING: Do's and Do Not's

Let's start with the **DO NOT's.**

- **DO NOT** use hot water! *77°F(25°C) maximum*. Some gates contain plastic components which may be adversely affected by hot water.
- **DO NOT** use harsh chemicals (like brake cleaner or gasoline). These chemicals may adversely affect plastic parts. Brake cleaner is also extremely drying and will tend to displace lubricant from the areas where it is needed.

The **DO's**

- **DO** clean in soapy water with a mild detergent.
- **DO** operate the gate mechanism while submerged in the water.
- **DO** use a soft bristle brush (such as a toothbrush) to clean the carabiner.
- **DO** rinse the carabiner thoroughly in clean water.
- **DO** allow the carabiner to dry completely before applying lubricant. You may use a gentle stream of compressed air to facilitate the drying process.
- For stubborn contaminants like conifer sap, **DO** soak the carabiner in room temperature vegetable oil and rub or brush the affected areas to remove the sap. Do this first. Then clean the carabiner in soapy water, rinse and dry before applying lubricant.

LUBRICATING: Do's and Do Not's

- **DO NOT** use graphite powder! Graphite powder builds up in hard-to-reach areas, creates a sticky paste that is very difficult to remove, and does nothing to help displace debris.
- **DO NOT** over lubricate. Over lubrication is not necessary and creates a mess. Apply just enough to keep things working smoothly.

- **DO** use a quality, light-weight lubricant. Duck Oil is recommended on DMM's "Inspection and Maintenance..." pdf, but is not readily available in the United States. As an alternative, 3-In-One "Multi-Purpose Oil", sewing machine oil or similar may be used.
- **DO** apply the lubricant sparingly. Just one drop is usually sufficient at each lubrication point on the carabiner.

Troubleshooting a stubborn gate mechanism

Have you ever cleaned and lubricated a carabiner, only to find that the gate still doesn't function properly? The cause of this is usually debris trapped in the mechanism that was not dislodged by the cleaning process. In the tree world this debris may be from leaves, bark, sap, sand or perhaps some cheese doodle crumbs from your lunch. Now, a bit of compressed air may be able to remove the debris, but we need to use a bit of restraint when it comes to blasting away at the internals of the gate. A better approach is to flush out the gate mechanism with lubricant. Lots of it. Flush it through while operating the gate and also let the gate spring back to the closed position (this jarring motion may knock the debris loose). Once you've done this, clean and dry the carabiner again, removing the excess lubricant. Then apply just a few drops of lubricant as normal.

Care for your equipment and it will care for you

Cleaning and lubrication are vitally important to the proper function and service life of carabiners. However, these are only part of a larger picture when it comes to the care and maintenance of equipment. Inspect your gear regularly, read and follow the user instructions and manufacturer's guidance. Always avoid misconfigurations, misuse and abuse.

Happy cleaning!

1.

Operate the gate mechanism while submerged in soapy water.

2.

Clean the carabiner nose.

3.

Remove debris from the nose slot.

4.

Manipulate the barrel and clean areas near the hinge.

5.

Rinse and dry.

6.

Apply one or two drops of lubricant to the rotation spring. Less is more!

7.

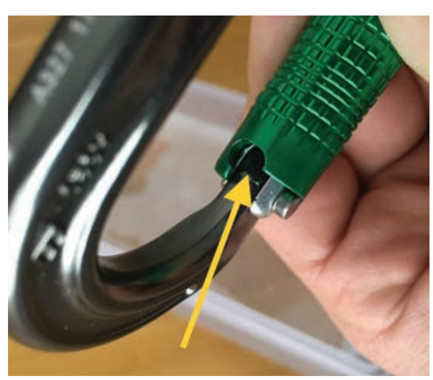
Manipulate the barrel and apply one or two drops of lubricant to the compression spring.

8.

Apply one drop of lubricant to the hinge on either side of the carabiner body.

9.

This is the "spring pusher". Gently clean this area if necessary. Avoid damaging the spring pusher. Do not use high pressure air on the spring pusher.



10.

Turn the carabiner over and open the gate to expose the internal spring slot. Do not use high pressure air. Apply one or two drops of lubricant into the slot.

Inspection and Maintenance of DMM Auto-Lock Carabiner Gate Mechanisms

Start

Inspection and Assessment of Gate Mechanism

- If the carabiner requires disinfection or cleaning for effective visual inspection, clean* the carabiner prior to assessing the gate function.
- Inspect locking mechanism for abrasion, deformity, cuts, and sharp edges.
- Inspect hinge rivet for good condition.
- Inspect nose for contact marks, correct alignment of the nose with the slot.

Gate Action (function tests)

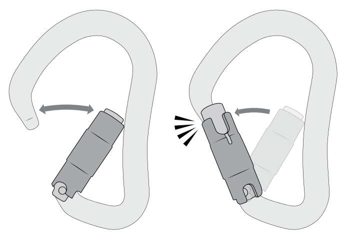
When performing the following tests, ensure that the gate of the carabiner is always released without bias i.e. the operator should **not** influence any action of the gate mechanism.

Test 1 (fully open):

Open the gate fully.

Release the gate *without bias*.

Check that the locking mechanism closes fully and reliably.

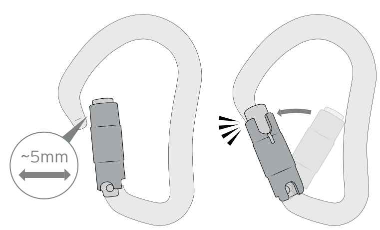


Test 2 (close to nose):

Open the gate to ~5mm clearance from the nose.

Release the gate *without bias*.

Check that the locking mechanism closes fully and reliably.

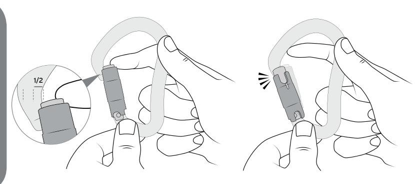


Test 3 (over the nose):

Open the gate to half-way across the nose.

Release the gate *without bias*.

Check that the locking mechanism closes fully and reliably.



Reject

Accept

Quarantine

Hold in isolation so that items cannot be inadvertently introduced into service.

Further information required.

Consult user instructions or contact DMM.

Lubrication

- Apply approved lubricant selectivity to the mechanism and contact areas.
- Remove excess lubricant.

We recommend the use of Duck Oil.

Do **not** use graphite powder.

*Clean

- Thoroughly clean in warm water of domestic quality (maximum temperature 25ºC) with mild detergent at appropriate dilution (pH range 5.5 - 8.5).
- Manipulate the locking mechanism whilst lightly brushing the hinge area, the nose, nose slot, and as much of the rest of the mechanism as possible, removing any stubborn residues.
- Thoroughly rinse in clean warm water.
- Carefully flush the mechanism and contact points with a fine compressed air stream.
- Dry naturally in a warm ventilated and clean space away from direct heat.
- If disinfection is required please refer to user instructions

The Strength and Weakness of Ash

ERIC NORTH, UNIVERSITY OF NEBRASKA – LINCOLN

At the Minnesota Society of Arboriculture Fall Conference 2017, I gave a presentation "*To climb or not to climb: Impacts of EAB on the stability of ash*". The stability of ash (*Fraxinus spp*.) has been shown to be negatively impacted by an infestation of the emerald ash borer (*Agrilus planipennis*). The authors of the study noted an increase in reports of work-related incidents specifically for the people working in emerald ash borer (EAB) infested trees. Their study went on to demonstrate that the mechanical resistance to branch-breakage declined the longer a tree was infested with EAB. The longer a tree is infested with EAB, the greater number of larva in the stem and increased damage to the branch or trunk tissue. Trees infested for greater than two years showed the largest amount of damage (e.g. length of wood cracks) and the lowest amount of stability under static forces. Essentially, EAB-infested trees pose a real danger to arborists. While there have not been any studies investigating the difference in stability for ash infested with EAB compared to ash infested with other native borers, there seems to be a notable increase in work-related incidents supporting the notation that ash responds differently to EAB infestations compared to native borers. Not only are there increased number of reports of EAB-related ash instability, there are also anecdotal reports that EAB-infested ash are unpredictable.

From the scientific evidence we do have, there is a relationship between the moisture content, amount of damage, and length of time EAB has been in a given tree. The longer a tree has been infested with EAB the less moisture and less mechanical strength trees have leading to greater instability. Even when there is not an EAB infestation moisture stress in ash may be seen as Summer Branch Drop or Sudden Branch Drop (SBD). The increased frequency of branch breakage and failure of ash species has been noted elsewhere in scientific literature. In terms of hazard tree management, ash species have been listed as having increased frequency of weak branch attachments and are on the list of highly susceptible to storm damage or loading events. However, there is a fair amount of variability in the data which leads to unpredictable response of ash.

A potential clue to the variability in stability of ash may be due to how quickly branches and trunks lose moisture. There are various ways of classifying wood, but specific gravity and wood structure are common. Specific gravity is essentially a standardized measure of wood density, that is, the ratio of the density of wood to the density of water and can be directly compared between species. Wood structure is fairly complex depending on the level of detail you are looking at. Here, wood structure refers to diffuse- or ring-porous. Angiosperms (hardwoods) have vessels and fibers. Annual ring width can vary greatly based on environmental conditions, but are generally less than a centimeter wide. Fibers provide some of the strength and are typically the darker tissue seen between the vessels. Dark color is a result of thick cell walls containing lignin. Diffuse-porous species (maples, basswood, birch to name a few) have vessels that are spread more or less evenly throughout a tree's annual ring with little difference in vessel size between the earlywood formed in spring and latewood formed in summer. Ring-porous species (oaks, ash, honeylocust to name a few) have large vessels in the earlywood with smaller vessels formed in the latewood. The vessels of ring-porous species can often be seen without magnification.

Ash is a ring-porous species meaning only 1- to 2-annual rings are typically used to actively transport water compared to 3- to 4-annual rings used by diffuse-porous species. When branches of healthy ash were mechanically stressed (i.e., bent) they develop longitudinal cracks and fractures occurred at the boundary between latewood and earlywood of different years for recent growth (i.e., the outer most rings). Looking at the specific gravity

Ring-porous Ash

Diffuse-porous Maple

of ash (white & green) the values are ~0.60, which is similar to other species with notably hard wood (0.60 for honeylocust, 0.69 for blacklocust, 0.64 for bur oak, and 0.55 for black walnut). Whereas, eastern cottonwood has a specific gravity of 0.40 and American elm is 0.50. It is tempting to equate wood density with wood strength, yet American elm is often still solid (and difficult to chop) years after death. In studies that have investigated the relationship between specific gravity and wood strength or other features, significant relationships are difficult to show. Honeylocust and white ash have the same values, yet honeylocust are rarely reported as failing unpredictably or being susceptible to SBD. Other fast-growing trees within a species are thought to be weaker- wooded than a slower growing counterpart, yet a 1933 study on mechanical strength in ash found no relationship between growth rate and mechanical strength of the wood.

The key seems to be in the arrangement, size, and cell wall thickness of the vessels and fibers. Tree species are not all the same when it comes to vessel arrangement along the trunk. Some species have vessels that essentially spiral their way from the roots to the canopy, which may explain why root injury on one side of certain species shows up on the opposite side of the canopy. Vessel arrangement has an impact on how trees respond to injury. Plants are amazing in their genetic diversity when seed-grown and anatomical differences in wood structure can arise within a species. Differences in ploidy level influences length and thickness. Before describing further let me briefly explain ploidy level. Humans are diploid (di = two), which means we get one set of genes from each parent. Plants can be diploid or polyploidy (poly = many). Polyploidy plants receive multiple copies of the same gene from each parent. In some species of ash there are individuals that are diploid and some that are polyploidy. It turns out the difference in ploidy level influences the vessel and fiber length and thickness of the fiber cell walls, with polyploidy individuals having longer and thicker vessels and fibers. The increase in vessel and fiber length and thickness of cell walls also conferred increased wood strength in mature trees. Environment also played a role in vessel and fiber formation, with trees in more stressed environments having shorter and thin vessels and fibers (i.e. less mechanical strength). Unfortunately, there is no field test for determining the ploidy levels and potentially assessing the mechanical strength, but this does give some insight into the unpredictability and variability arborists see in the field when working with ash.

One last point. There are many native borers feeding on ash and if the tree is stressed enough, native borers can be a contributing factor to tree death. So, what's different about EAB? Remember back to the moisture content and mechanical strength relationship. Essentially what appears to be happening in trees that have a large infestation of EAB is they are losing moisture and outer layers of wood fast. The relatively rapid movement of EAB and lack of resistance mechanisms combine to quickly to reduce the mechanical strength of ash. Even if you understand why ash responds the way it does to EAB, those trees are still unpredictable and using caution is best course of action.

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Alternate Tie-In Points

PIERCE WASMUND, CITY OF MINNEAPOLIS

Tree care often asks us to solve problems. Sometimes the problem is diagnosing a disease or insect issue, and sometimes the problem is clearing a house of branches from a nearby tree. Many times people need arborists and tree climbers to solve a difficult removal problem. Storms can create lots of tricky situations. Some removals are put on the back burner and left to rot while others are in small spaces with lots of obstacles. Combinations of these can give the most experienced people a scare. The following will cover three different scenarios of using an alternate tie in point, a safer option than tying into the tree being removed.

Scenario One:
The first scenario is a dead and mostly rotten red pine removal. The tree was not large but had extensive rot and a very small drop zone. Flopping the tree was not an option. It was situated between a fence and the house and was not good to rig off of.

The tree was close to other red pines that we could set a climbing line in. The set-up used for this removal was a Single Rope Technique (SRT) back up. The primary positioning and access to the tree was made in the red pine to be removed. The climber used spikes and a lanyard to climb the tree. In an adjacent tree an SRT system was installed, using a throwline to set the rope in a high union. As the climber spiked up the dead tree, he also advanced his ascender and prussic knot. The prussic used in this situation was tied above the ascender and clipped into the climbers main (center) D ring. When switching to the descent system the climber locked off the prussic with tension and installed a figure eight. A lanyard was the main work positioning used for this removal. When cuts were made with the chainsaw the prussic was tensioned and the figure eight was locked off.

This system provided a high tie in point that ensured a swing away from the hazard if the tree were to have broken. The long prussic was used so the climber never became detached from the line. The new SRT work positioning systems such as the Rope Wrench or Unicender, if available, are recommended for this type of set up.

Scenario Two:
A similar situation to the first scenario, this white oak removal needed to be climbed, but showed signs of extensive decay. The tree was not able to be flopped but did not require any rigging. The top of the tree was dropped outside of the clients septic drain field. The trunk was taken down to about ten or fifteen feet.

Not far from the tree was another white oak that we set a Doubled Rope Technique (DdRT) system in. The system was used for positioning and provided a nice escape if something bad were to happen. The main access into the tree was with spikes and a lanyard. When making cuts with the chainsaw the alternate tie in helped position the climber and provided for a second attachment, as required by the ANSI standards.

When the tree was down and cut up, we realized that the heartwood was still intact, and the tree was mostly sound. But we still agreed it was better to set up an alternate tie in point. There was lots of conks and decayed wood on the exterior of the tree. Our pre-climb visual inspection could not predict a solid interior. We chose the safer option.

Scenario Three:
The third scenario was a removal from the Solstice storm of 2013. An aspen tree had been tipped but not failed. The roots were slightly heaving the soil and the tree was leaning over service wires, a garden, and a shed. The tree could not support a climber on its own and there were no trees large enough, and close enough, to swing into the aspen. Our plan was to set a high line over the tree, and use that for our tie in. Fortunately the tree was almost directly in the center of two red pines. These pines were tall enough and strong enough to set a line through the upper portions of the trees and over the aspen. One part of the line was set from the ground using a throwline, the other portion of the line was set by a climber.

The tree was pre-tensioned through a block and Good Rigging Control System (GRCS) in order to support the damaged roots. The pre-tensioning also created an opportunity to use the tree as the rigging point. This would not have been an option if the tree was not tensioned and the climber was not using an alternate tie in point.

The climbing line was set through a DMM Revolver tied to the high line with an alpine butterfly. The high line was the main tie in point for the climber and was also the primary access.

When using a high line system be sure to select trees strong enough to support the loads produced. In this situation we had angles, at the redirection points, of about 90 degrees (pre tensioned and unloaded) in the red pines. A 90 degree angle will produce about 141% of the load on the redirection points. Once loaded these angles change and the loads will increase.

Taking time to stay safe when trees are questionable is smart. Hazards can be mitigated and climbers put into safer and more confident positions when trees are inspected and situations are evaluated. The trees in question can be removed with without incident.

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