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Analysis Of Trees Damaged From Flooding And Ice In Columbus, Nebraska

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ANALYSIS OF TREES DAMAGED FROM FLOODING AND ICE IN COLUMBUS, NEBRASKA

by

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Abstract

In the spring of 2019, an intense storm system came through eastern Nebraska resulting in a historic flooding event. This flood caused many trees throughout the state to be uprooted, broken, or scarred. This study looks at trees on the Quail Run golf course in Columbus, Nebraska to determine the extent of damage on trees caused by flooding and recommend tree care solutions to ensure safety. The cottonwood trees endured the most damage compared to other species on the property. All of the trees showed wound wood meaning that the trees were recovering from their injuries. Dead and broken branches from the storm should be pruned, trees that show signs of decay should be removed, and all other damaged trees should be monitored in the years to come for signs of declining health.

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Introduction

Nebraska has a history of natural disasters including floods, blizzards, and tornadoes. The Missouri River flooded in 1881 resulting in hundreds of livestock deaths and multiple riverside towns being washed away. In 1935, the Republican River flooded causing damage to hundreds of miles of highways and 94 deaths. When the Missouri River flooded in 1993, known as the Great Flood, millions of acres of cropland were destroyed and multiple levees were overtopped (Pearson) . Natural disasters have severe consequences and are still a present-day threat. In March of 2019, an intense storm system came through eastern Nebraska resulting in a historic flooding event of the Missouri River. Several deaths occurred and estimated damage of roads, infrastructure, private homes, and losses of cattle and crops exceeded $1.4 billion (Nebraska Flood Damage Losses Estimated to Hit $1.4 Billion, 2019). Along with the many homes and farms that were lost or destroyed, a multitude of trees were impacted and not accounted for in damage costs. Throughout the state, urban trees have been found broken, scarred, or uprooted as a result of the flood and ice.

Trees are present in our everyday lives and have an abundance of positive impacts on the environment and to people. Benefits of trees include shade, clean air, decreased stress, and storm water management (Turner-Skoff & Cavender, 2019). Despite the benefits that trees provide for people and ecosystems, most people overlook trees and have little understanding of how they work or how to properly care for them; this tendency to overlook trees is known as “plant blindness” (Jose, Wu, & Kamoun, 2019). Due in part to the “plant blindness” phenomena and a lack of specific knowledge regarding the community trees, it can be difficult for people to accurately assess trees after serve weather events.

Understanding common weather occurrences at a particular location can be important to consider when choosing between an excurrent or decurrent tree. Conifers tend to resist ice damage more than deciduous trees due to their branching pattern (Hopkin, Sajan, Williams, Pedlar, & Nielsen, 2003). Trees often have adaptations to stressors or disturbances (Wonkka, Lafon, Hutton, & Joslin, 2012). There are species that are more resistant and resilient to flooding and ice damage. Stressors would include factors like drought and nutrient deficiency while disturbances could be wind, ice, or flooding. Knowing the environmental conditions of a site is something to keep in mind when choosing which tree species to plant.

Some tree species are more susceptible to storm damage than others. According to a list of trees susceptible to ice storm damage in the great plains created by Justin Evertson of the Nebraska Statewide Arboretum, green ash (*Fraxinus pennsylvanica*), silver maple (*Acer saccharinum*), American linden (*Tilia americana*), and eastern cottonwood (*Populus deltoides)* are among the species that are highly susceptible to ice damage, while oaks (*Quercus spp.),* silver linden (*Tilia tomentosa),* and Norway maple (*Acer platanoides)* are among species with exceptional resistance to ice (Evertson, 2007). To further enforce this list, a study done by researchers at Virginia Tech looked at a variety of a trees species that were damaged in an ice storm and categorized which species received the most and the least damage. They discovered that oaks resisted damage better than other species (Rhoades & Stipes, 2007). In addition to these species, floodplain species tend to recover from floods easier than non-floodplain species because they are adapted to these conditions (Heklau, Jetschke, Bruelheide, & Seidler, 2019). Cottonwoods are a riparian species, meaning they grow well along rivers in wetter areas; although cottonwoods are susceptible to ice damage, they should be able to recover from this damage relatively quickly.

Damage to trees can be seen in many ways; branches can break, bark can be scraped or scarred, or the whole tree can be uprooted. Research done on ice damage recovery rates of cottonwoods along a river in Montana found that the trees were more likely to recover from scarring over bent and broken branches or sheared or toppled trees (Smith & Pearce, 2000).

This kind of damage to a tree, as well as other factors like included bark, weak branch attachments, and broader crowns all increase a trees susceptibility to ice damage (Hauer, Dawson, & Werner, 2006). Weak branch attachments and included bark can be pruned out of trees at a young age in order to reduce risk of damage during storms. It is important to manage urban trees to prevent these problems in the future

The effects of floods and other damage can be seen not only on the exterior of the tree, but within the inner biology of the tree as well. Dendrochronology can reveal the history of a tree through examination of annual tree rings. A study done in North Dakota showed that oaks had smaller vessels in earlywood for years when floods occurred (Wertz, St. George, & Zeleznik, 2013). Years in which other weather events such as droughts or periods of heavy rainfall occurred can often be determined by the width of the tree rings, as well.

This study takes a look at trees that were damaged by flooding and ice on the Quail Run golf course in Columbus, Nebraska. The golf course is bordered by the Loup River on the southwest side; this is the river that flooded and caused damage to the trees. Data was collected from twenty trees on the golf course to quantify the damage and decide what actions need to be taken to care for these trees moving forward. This paper will assess the extent of damage on twenty trees and address recommendations for the managers of the golf course to better care for these trees and ensure that they are safe for the public.

Methods

Measurements and observations that were taken for this project include tree species, height and circumference of tree, age, area and direction of damage, depth of displaced sand, crown width, foliage rating, presence of fungus and wound wood, and live crown ratio. Live crown ratio is the percent of the whole tree, from the very base of the trunk all the way to the top of the tree, that is living foliage. Presence of wound wood indicates that the tree is recovering from the damage. Trees do not heal from wounds, instead they seal over the wounds. Callus tissue begins to grow over the wound and is it becomes hard and rigid it turns into wound wood (Clatterbuck).

The data collected on these trees will useful for determining which trees are safe and healthy as well as the trees that may cause threats to the golfers. Assessing the damage on the tree helps to determine the condition of the tree. Assessment of the foliage and wound wood helps decide the health of the tree. Together, this data can be used to inform the golf course management on the risk the trees pose to the public. Additionally, this information can help the community better understand the tree species that are present in the area and the health and condition of those trees.

In total, twenty trees were observed and measured at the Quail Run golf course. Ten of these trees were *Populus deltoides* (cottonwood) near the riverbank, and ten were a variety of species including *Quercus spp.* (oak), *Fraxinus spp.* (ash), and *Acer spp.* (maple) that were further from the riverbank. The name of the species was recorded and a numbered tag was nailed into the tree on the north side. The direction of the damage on the tree was noted. The height and width of the ice damage on the tree was measured using a tape measure. A 6-foot pole was used to assist in reaching the top of the damaged area when it was too high to reach by hand. The damaged areas were not perfectly rectangular in shape, so to get a more accurate area, the top width and bottom width of the damage was measured and an average of the two numbers was used to calculate the total area. The circumference of the tree was measured at breast height using the tape measure. Breast height is 1.37 meters off the ground. These numbers can be used to estimate surface area of the tree and determine the ratio of damage inflicted on the tree.

To measure the crown width, a tape measure was placed at the trunk and pulled out to the edge of the crown. This measurement was taken from all four cardinal directions and then divided by 2 in order to determine an average crown width. The height of the tree is determined using a clinometer and a distance laser. A clinometer will read the percentage of the distance from an object. The distance from the tree was taken using a laser. The distance was then multiplied by the percentage reading from the clinometer to determine the height. Live crown ratio is the percent of the whole tree, from the base of the trunk to the very top of the tree, that is living foliage. The degree that the tree was leaning was noted using a protractor.

During the storms, the sand on the golf course was displaced and many of the trees were buried. Using a meter-long probe and a tape measure, the depth of the sand around the tree was measured. The presence of decay or fungus as well as the presence of wound wood was recorded. A rating system (1-4) was used to determine the foliage condition. Four meant that the crown was healthy, one meant that it was dead.

The last piece of data collected was the age of the tree. To determine the age, a tree core must be taken using an increment borer. The cores were then placed in straws to be transported back to the lab. In the lab, the cores were mounted, sanded, and then the annual rings were counted underneath a microscope to determine the tree’s age.

Results

The flow of the water was moving northeast, and therefore the damage on the trees was seen on the south and west sides of the trunks. Figure 1 shows the kind of damage that was created due to ice rubbing against the bark and sand being displaced from the river.

Figure 1. Ice damage on the southwest side of a cottonwood.

To calculate the percentage of the tree that had damage, the surface area of the tree was estimated using the height and circumference at breast height. Although circumference changes with height of the tree, this consistent calculation allowed an estimation of trunk damage. The average damage ratio is broken down by species in Chart 1.

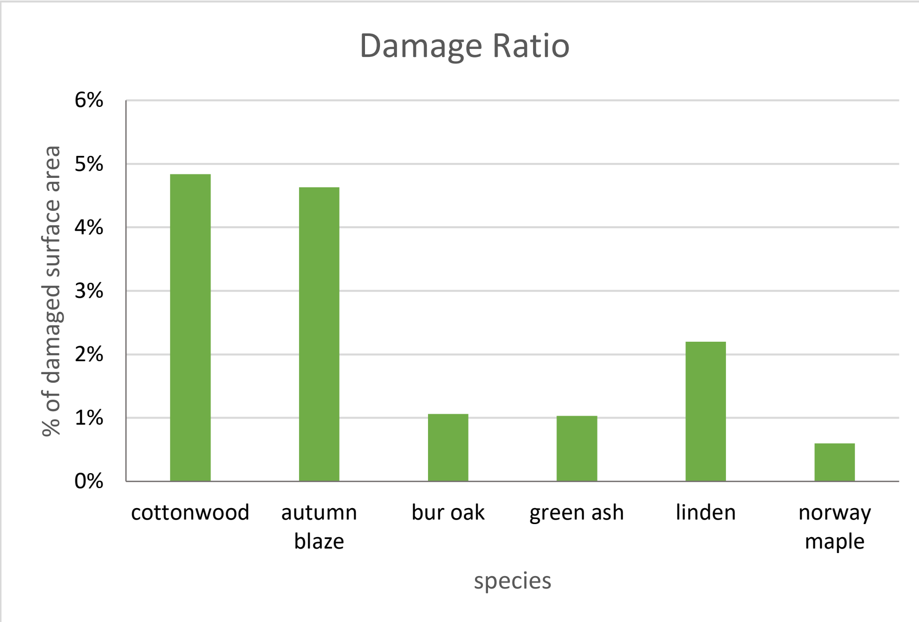

Chart 1. Damage ratio by species

The green ashes and autumn blaze maples are the only species that showed unhealthy foliage. The autumn blaze maples were all slightly chlorotic, and the green ashes had small leaves or dead branches and twigs. Crown width is an average diameter of the foliage in the canopy of the tree. Table 1 displays the crown width measurements organized by species.

Species	**Crown Width (m)**
autumn blaze maple	7.975
autumn blaze maple	11.43
autumn blaze maple	12.95
bur oak	7.81
bur oak	10.6
cottonwood	6.67
cottonwood	7.445
cottonwood	7.92
cottonwood	9.81
cottonwood	10.275
cottonwood	11.255
cottonwood	11.94
cottonwood	12.365
cottonwood	17.775
cottonwood	14.76

green ash	10.445
green ash	12.125
green ash	14.59
linden	9.38
Norway maple	6.585

Table 1. Crown widths by species

All of the trees had wound wood present. Four of the trees had fungus or decay, but all of the decay was due to previous events. A couple of trees were leaning at angles greater than 10°. More than half of the trees were buried by displaced sand.

Discussion

The amount of damage seen on each species is consistent with Justin Evertson's list of trees susceptible to ice damage in Nebraska. The cottonwoods endured the most amount of ice damage. This could be due to their high susceptibility to storm damage or the fact that these trees were closest to the river bed. Autumn blaze maples, which are a hybrid between red and silver maples, experienced quite a lot of damage, whereas the Norway maples resisted most of the damage. This observation lines up with Evertson's list, as well. The green ash trees resisted damage unusually well, but this could be due to the location and distance from the river bed and protection from surrounding trees.

All green ashes were given a foliage rating of 2 due to small leaves or asymmetrical growth. This is most likely related to Emerald Ash Borer rather than the flood damage. These trees should be removed because they will continue to decline as EAB becomes more present in Nebraska and are likely to be a safety hazard to players on the golf course.

Table 1. shows crown width measurements for all the trees in the study. Crown width is a good observation to use when weighing the benefits of a tree. Crown width can help to

determine the amount of shade provided by a tree and can provide information on how much foliage is on the tree to estimate tree growth and health (Brack, 1999). This information should be considered when determining if a tree should be removed or not. It is important to weigh the benefits with the risks.

A couple of trees were leaning at concerning angles beyond 10°. The leaning could be due to the storm or it could have happened prior to the flood. All of the trees had wound wood which shows that they are recovering from the flood. A few trees showed decay in previous injuries. If fungus or decay is visible on the outside of the tree, there is no way to know how far the decay extends inside the tree. Even though the purpose of this study is to make recommendations for flood damaged trees, injuries and damage that occurred prior to the flood still needs to be considered when decided which trees should be removed to keep the public safe.

Conclusion

The data collected and observations made on twenty trees gives the Quail Run golf course management a good idea of the extent of damage done to all of the trees on the golf course. All of the ash trees on the property should be removed due to Emerald Ash Borer presence in Nebraska. Trees that show signs of decay and have fungus should be removed because the uncertainty of how much rot and decay is present in the tree poses a threat to players and staff. Branches that were broken from the storm or that are dead should be pruned out.

Many trees do not need to be removed due to damage, but should be monitored in the years to come. The autumn blaze maples have chlorotic leaves, most likely due to an iron deficiency; these trees should be watched in the years to come to determine if treatment is necessary. All of the trees that have scrapping from the ice in the flood should be monitored for signs of declining health. This can be determined by examining the new growth on the twigs to see if it has grown less than previous years. Foliage is also a good way to determine the health of a tree. If the leaves are abnormally small or discolored, this could be a symptom of declinging health.

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