Turning Over A New Leaf:
The Emerald Ash Borer Threat and The Importance of Diversity In Minneapolis' Urban Forests

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INTRO

Agrilus planipennis, or better known as the emerald ash borer, native to Asia, made its way to North America by means of infected wood pallets used for importing foreign goods. Centralized in Michigan, the invasive flat head beetle is making its rounds, destroying ash trees from coast to coast. With the first sighting of the ash borer in the twin cities area in May 2009, city officials are planning for a full-fledged outbreak of EAB on its ash trees, accounting for about 20% of the city's 910,000 trees. With the arrival of the emerald ash borer in Minneapolis and the Twin Cities area, city forestry officials plan to maintain and restore the city tree numbers by implementing a variety of different species of trees to obtain a high rate of diversity to better contain the potential threat of future invasive species.

Minneapolis, the city of lakes, is known for its beautiful landscape and abundance of trees and parks. Although Minneapolis boasts the largest metropolitan area in the state, it maintains the feel of an upper Midwest setting with its urban forests scattered about the city in parks and neighborhoods. The benefits of having an urban forest setting bring more to the table than just aesthetics. Human's posses a symbiotic relationship with nature, an inherent relationship that is reflected through physical, social, and psychological needs.

The emerald ash borer is now threatening the integrity of Minneapolis' urban forests. With the city still feeling the effects from the loss of thousands of American Elms due to the Dutch Elm Disease outbreak of the 1970's, the city will face yet another significant loss of its Ash trees from the emerald ash borer.

INVASIVE SPECIES

An invasion of a non-indigenous species can threaten native, natural environments. With globalization and the mixing of goods throughout societies around the world, there has also been a global mixing of biota.[1] "The vast numbers of species that populate the earth provide innumerable goods and services that society values. Equally important for society are the services that natural systems provide free of charge. On the other hand, invasive alien species can represent 'ecosystem bads and disservices' to systems on which society depends."[2] With the ability to transport goods across land and sea in a small amount of time, it has left the door open for invasive alien species to reach, and adapt to new environments. Although very little of our native land is "native," meaning most of the animals, insects, and vegetation found in the United States were brought here from foreign lands, many species have been able to adapt well with the native ecosystems. However, it is the invasive species or pests, which pose threats to native environments. The term "invasive" represents the rate of spread in an ecological sense. Furthermore, "an invasive alien species that is extending its range in a new region and is having a large negative impact on the native biota or local economies, generally is easily identified and targeted."[3] Economically, invasive species can be very costly in terms of loss and in terms of control. With the threat of the emerald ash borer reaching the Twin Cities area, the costs will be seen in loss of ash trees, which result in a downward spiral of economical loss, including cost to remove infected trees, cost to replace the trees, loss of property value, and costs to control the problem.

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[1] Harold A. Mooney et al., *Invasive Alien Species: A New Synthesis* (Washington, D.C.: Island Press, 2005), 2.
[2] Harold A. Mooney et al., *Invasive Alien Species: A New Synthesis* (Washington, D.C.: Island Press, 2005), 1.
[3] Harold A. Mooney et al., *Invasive Alien Species: A New Synthesis* (Washington, D.C.: Island Press, 2005), 5.

The major problem with alien invasive species is controlling them. If they were easy to control, they probably wouldn't be called invasive species or pests in the first place. Many invasive species are self replicating, making them hard to get rid of completely. Many species can also adapt easily to control methods, creating or evolving immunities to control efforts. Transportation also makes it tough. With thousands, upon thousands of potential invasive species throughout the world, it would be near impossible to check or scan imported, or exported goods for all possible suspected pests. Lag time, from the establishment of the species in a new area, to the invasion of the species is also a problem. It may takes months, years, even decades for a species to fully become invasive to an area. Even though the emerald ash borer has been discovered in the Twin Cities area, Ralph Sievert, head of the Minneapolis forestry department states, "No one can determine when EAB will arrive in Minneapolis but if left to its own natural progression it may take 60 years before it is present."[4] Controlling invasive species is the only solution, and the most difficult problem. Since the emerald ash borer only feeds on Ash trees, the only solution Minneapolis faces is " to attrition existing Ash trees out of the Minneapolis Park and Recreation Board system", and to establish a plan to diversify the Minneapolis urban forest with a wider variety of trees.[5]

[4] MPRB Forestry Division, *The Minneapolis Park and Recreation Board's Emerald Ash Borer Preparedness Plan*, Minneapolis Park and Recreation Board, Ralph Sievert, March 17, 2008, 1.
[5] MPRB Forestry Division, *The Minneapolis Park and Recreation Board's Emerald Ash Borer Preparedness Plan*, Minneapolis Park and Recreation Board, Ralph Sievert, March 17, 2008, 1.

URBAN FORESTRY

Trees enrich city life by establishing a common ground between an urban setting and the intrinsic feeling of being in nature. Urban forestry has been a practice for hundreds of years. With its roots stemming from Europe, the concept of urban forestry branched out to North America, when in 1792, citizens of Philadelphia petitioned for public trees to be planted around the city.[6] Since then, urban forestry has been implemented in cities worldwide. "This field of knowledge…has gradually emerged mainly from the disciplines of arboriculture, landscape architecture, and forestry, and includes subjects such as horticulture, soil science, plant pathology, entomology, and social sciences."[7]

Although urban forestry dates back hundreds of years, the true meaning and philosophy of the practice was established in a scholarly sense by Professor Erik Jorgensen at the University of Toronto in 1965. He stated, that urban forestry is "'a specialized branch of forestry (that) has as its objective the cultivation and management of trees for their present and potential contributions to physiological, sociological, and economic well-being of urban society.'"[8] Unlike traditional forestry practices, which are used primarily for the harvesting of lumber, the appeal of natural urban settings is for aesthetic purposes as well as environmental benefits. Although these may be the underlining benefits of urban forests, other gains for society include increased property values from landscaping, atmospheric pollutant removal and carbon storage, energy savings to buildings from proper tree placement, and psychological benefits for people. Also, cities can benefit from aesthetically pleasing natural environments by attracting tourists, attracting

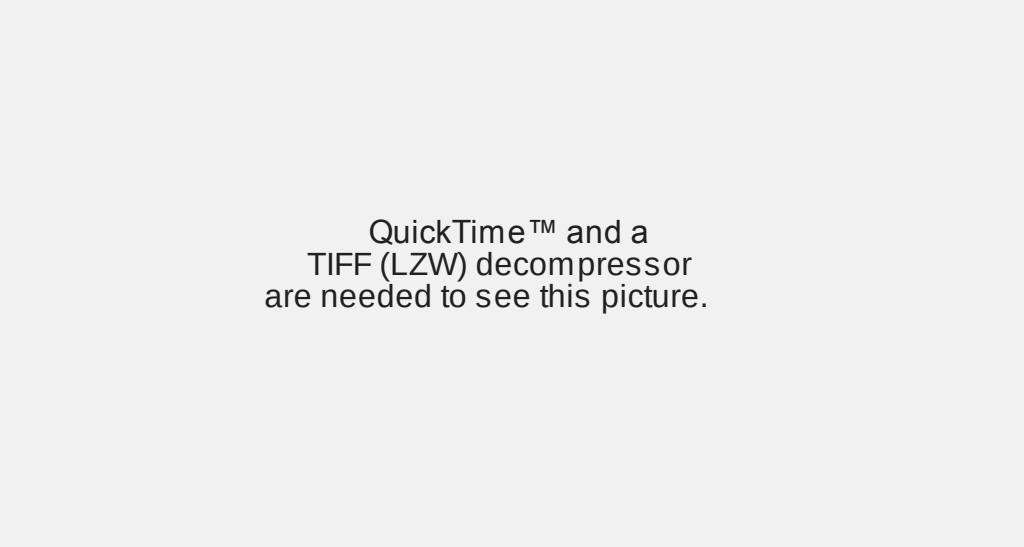
[6] John E. Kuser, *Urban And Community Forestry In The Northeast* (New Jersey: Springer, 2007), 1.
[7] John E. Kuser, *Urban And Community Forestry In The Northeast* (New Jersey: Springer, 2007), 2.
[8] John E. Kuser, *Urban And Community Forestry In The Northeast* (New Jersey: Springer, 2007), 2.

business and helping the economic well-being of the city.[9] Urban forests play an important role in society. Although the benefits of city trees may go unnoticed or taken for granted on a daily basis, the destruction or removal of an urban forest, even on a small scale, will not only negatively effect the given city, but it will also be very noticeable to its inhabitants and visitors.

MINNEAPOLIS FORESTRY

Minneapolis, like many cities, benefits greatly from its urban forest system. Within its system there are an estimated 979,000 trees. The canopies of these trees cover 26.4 percent of the city. The Minneapolis city forest contains a mixture of both native vegetation, which existed before the city was established, and non-native species of trees and plants that were introduced by humans or by other means. Of the 979,000 estimated trees in Minneapolis, "the three most common species are green ash (21.6 percent), American Elm (17.1 percent), and box elder (9.1 percent). The 10 most common species account for 75 percent of all trees."[10] Surprisingly, almost three fourths of the trees found in Minneapolis are native to Minnesota, and fourth fifths of them are native to North America.

[9] John E. Kuser, Urban And Community Forestry In The Northeast (New Jersey: Springer, 2007), 2-3.
[10] Forest Service, Northeastern Research Station, *Assessing Urban Forest Effects and Values: Minneapolis' Urban Forest*, David J. Nowak et al., Newtown Square, Pennsylvania, 2006, 4.



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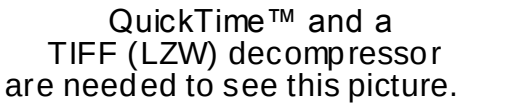
Research and testing occur quite often to help understand the benefits of the Minneapolis urban forest. One test, the Urban Forest Effects (UFORE) model, developed by the USDA Forest Service, is used to assess and to better understand the benefits of the urban forest resource as a whole. 110 random plots in Minneapolis were sampled using the UFORE model to assess the results and values of forest structure, risk of invasive pests and diseases, air pollution removal, carbon storage, annual carbon removal, and energy efficiency in buildings. The graph below shows the results of the UFORE model and the environmental, as well as economic benefits of implementing and maintaining an urban forestry system.[12]

[11] Forest Service, Northeastern Research Station, *Assessing Urban Forest Effects and Values: Minneapolis' Urban Forest*, David J. Nowak et al., Newtown Square, Pennsylvania, 2006, 4.
[12] Forest Service, Northeastern Research Station, *Assessing Urban Forest Effects and Values: Minneapolis' Urban Forest*, David J. Nowak et al., Newtown Square, Pennsylvania, 2006, 1.



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HISTORY: LACK OF DIVERSITY

The Minneapolis urban forest has a natural diversity of tree species. Mentioned in the previous section, the Minneapolis urban forest consists of a variety of native species, which were of pre-city establishment, with a mix of non-native species that were somehow transported later on. Although Minneapolis is thought to have a diverse amount of vegetative species, when looking at the statistics for tree species and abundance in the above table, only three species of trees account for fifty percent of the total trees found in Minneapolis. The following seven abundant species (top ten) account for seventy-five percent of the total Minneapolis tree population. Although there may be a number of different tree species growing in the city,

[13] Forest Service, Northeastern Research Station, *Assessing Urban Forest Effects and Values: Minneapolis' Urban Forest*, David J. Nowak et al., Newtown Square, Pennsylvania, 2006, 1.

diversity of species is very unevenly distributed. This lack of biodiversity in tree species has, and will pose threats to the integrity of the Minneapolis urban forest system.

Biodiversity was overthrown by homogeneity in Minneapolis during the turn of the 20th century. "Globalization has ecological as well as social consequences, and the same forces that are eroding the diversity of the world's cultural landscapes are to a significant degree responsible for the ongoing impoverishment of its biological diversity as well."[14] This can be recognized by the detrimental effects that the Dutch Elm Disease (DED) had, and is still having on the Minneapolis urban forest.

American elms once lined eighty to ninety percent of the boulevards of the Minneapolis city blocks. They were planted in abundance along boulevards to create a uniform tree canopy for each city block.[15] In the 1900's, elms were one of the few species known to city officials to grow well in the upper Midwest region. Minneapolis lined nearly all of its streets with elms, "because they were tall, stately, fast-growing, easy to transplant, and tolerant of a wide range of soils and sites."[16] DED was introduced to North America in the 1930's from imported veneer logs infected with the disease from Europe. DED is a fungus that is most commonly transported to elms by the elm bark beetle, but can be transmitted to other near by trees through grafted root systems. DED was not in full effect until the late 1970's, when more than 50,000 trees were infected and removed in Minneapolis. Due to the prominence of elm trees in Minneapolis, DED was easily transmitted from tree to tree, resulting in a full-blown tree disease epidemic. To this day,

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[14] Jason Van Driesche and Roy Van Driesche, *Nature Out of Place: Biological Invasions in the Global Age* (Washington, D.C.: Island Press, 2000), 1.
[15] MPR, "Taking Lessons from Elm Losses, Minneapolis Prepares for Ash Borer," MPR NewsQ website: Minnesota's Online Source for News That Matters, QuickTime Media Player, http://minnesota.publicradio.org/display/web/2009/07/02/ash_borer_minneapolis/ (accessed October 26, 2009).
[16] John E. Kuser, Urban And Community Forestry In The Northeast (New Jersey: Springer, 2007), 313.

hundreds to even thousands of elm trees are removed each year in Minneapolis as a result of the 1970's DED epidemic.[17]

Minneapolis has a continuing trend of homogeneity. Thousands upon thousands of elm trees were lost to the invasive Dutch elm disease due to a lack of diversity in the Minneapolis urban forest. In the wake of the DED epidemic, Minneapolis set forth quickly to fill the void left by the removal of thousands of infected elm trees. American elms were replaced with five species of trees, the majority of them being green ash. Although five species of replacement trees is slightly better than just one, the continuing lack of tree diversity in Minneapolis will yet again pose threats to the integrity of the urban forest.[18]

ASH TREES

Representing the most abundant tree species in Minneapolis is from the *genus Fraxinus*, or more commonly known as the ash tree. Green ash (*Fraxinus pennsylvanica*) in particular account for 210,000 of the estimated 979,000 trees found in Minneapolis (roughly 21 percent). 38,000, or about 19 percent of Green ash can be found on Minneapolis street boulevards. Green ash was widely planted throughout Minneapolis as a replacement for the fallen American elms. Similar to the American elm, Green ash was planted in abundance, because "they are fast-growing, adaptable, and relatively invulnerable to the various traumas that try trees."[19] Many of the benefits received from trees are directly linked to a large and healthy leaf surface area.

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[17] MPR, "Taking Lessons from Elm Losses, Minneapolis Prepares for Ash Borer," MPR NewsQ website: Minnesota's Online Source for News That Matters, QuickTime Media Player, http://minnesota.publicradio.org/display/web/2009/07/02/ash_borer_minneapolis/ (accessed October 26, 2009).

[18] Mary Hoff, "Big Trouble for Ash Trees," *Minnesota Conservation Volunteer*, May-June, 2009, 34.

[19] Mary Hoff, "Big Trouble for Ash Trees," *Minnesota Conservation Volunteer*, May-June, 2009, 29.

Benefits from trees or their importance values (IV) can be calculated using a formula that accounts for the relative composition of the tree and the relative leaf area. "Green ash has the greatest importance to the Minneapolis urban forest based on relative leaf area and relative population."[20] Green ash accounts for 21.6% of the tree population, and 24.8% of leaf area, which results in a 46.4 importance value (%population + %leaf area).[21] Although these numbers may seem relatively unimportant to the average citizen, once the ash trees of Minneapolis are gone, these numbers will make more sense, especially in terms of tree canopy shade.

EMERALD ASH BORER

The Twin Cities area has recently become host to an un-welcomed guest, the emerald ash borer (EAB). The emerald ash borer (Agrilus planipennis Fairmaire) is a non-indigenous, invasive flat head beetle species from Asia that feeds on living ash trees. Scientists at Michigan State University who first discovered the beetle "proposed the name 'emerald ash borer' in recognition of its jewel-like appearance and its behavior."[22] Globalization combined with fast and easy transport, have made it possible for EAB to reach North America. Although the primary source contributing to the arrival of EAB is still uncertain, current hypotheses assume that it arrived in wood packaging materials used to ship consumer goods and auto parts, either by air or sea.

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[20] Forest Service, Northeastern Research Station, *Assessing Urban Forest Effects and Values: Minneapolis' Urban Forest*, David J. Nowak et al., Newtown Square, Pennsylvania, 2006, 6.
[21] Forest Service, Northeastern Research Station, *Assessing Urban Forest Effects and Values: Minneapolis' Urban Forest*, David J. Nowak et al., Newtown Square, Pennsylvania, 2006, 6.
[22] Mary Hoff, "Big Trouble for Ash Trees," *Minnesota Conservation Volunteer*, May-June, 2009, 29-30.

The pest will spend all, or most of its life within their host plant. Adults have a green metallic color, measuring from ½ inch in length and 1/8 inch wide. In easier terms, the beetle is smaller than a dime. Like any insect, the emerald ash borer develops in stages: egg, larva, pupa, and adult. In terms of damage to the given tree itself, the adult contributes very little. Adult beetles feed on the ash leaves, cutting notches on the sides of the foliage. If a tree has an unreasonably high population of adult beetles, there may be a noticeable defoliation. Because of this, the crown of the tree may appear to look rough or "ragged," but this will not kill the tree. However, from another perspective, the adult ash borer lays the eggs, continuing the cycle, which is the cause of the damage. After the adults mate, the females lay their eggs singly under bark scales or in bark cracks and crevices. The eggs are very tiny and appear to be unnoticeable inside the bark.[23]

When the eggs hatch, they produce a larva. Fully grown, EAB larvae can reach 32 mm in length (3 cm). The larvae feed in between the sapwood and bark along the entire length of the tree. They also feed on branches that are more than 2 cm thick. An infected tree can host anywhere from hundreds to thousands of larvae. It is the feeding from the larvae that disrupts and cuts off the tree's ability to transport water and nutrients to the rest of the tree, eventually killing it. The larva stage is the most destructive stage in the life cycle of the EAB for ash trees.

In temperate climates, the EAB can grow from egg to adult in as little as one year. The emerald ash borer attacks all species of ash, including green, white, black, and the rare blue ash trees. Although they are relatively good flyers, annually the EAB does not fly more than half a mile a year from its original host plant. This has helped scientists determine the natural spread of

[23] Canadian Forest Service, *A Visual Guide to Detecting Emerald Ash Borer Damage*, Prepared by Peter de Groot et al., Ministry of Natural Resources: Ontario, Sault Ste. Marie, Ontario, 2006.

emerald ash borers in infected areas to be about half a mile each year. Since their flight range is relatively small, the number one factor contributing to the spread of the EAB is human activity.[24]

Another difficult characteristic of the emerald ash borer is their ability to go unnoticed. Infected trees can go undetected for a number of years before they are completely destroyed. For instance, with its first detection in North America coming from southeastern Michigan in 2002, the scientific community believes it was present and remained undetected for up to 12 years. Once a tree is infested, it may take one to three years for the tree to die, depending on the number of larvae inside the tree. Their ability to go undetected for years makes it difficult to treat or remove infected trees. This also gives the beetles time to reproduce and continue their spread.[25]

SIGNS FOR DETECTING INFECTED TREES

One of the major problems in detecting an EAB infestation is that the decline of the tree is typically very gradual. It is possible for the beetle to lay dormant for years before it shows true signs of infestation, and by then the tree will most likely be too far gone to save and/or has allowed the destructive beetles to move to another host tree. The EAB larva feed under the bark of the host tree, which results in damage to the tree's vascular system, disrupting nutrient and water flow to the rest of the tree.[26] Early signs of an infestation may include dead branches near the top of the tree, random leafy shoots growing from the lower trunk of the tree, discoloration of the foliage and the loss of part of the crown. "D-shaped exit holes and bark splits exposing S-

[24] Animal and Plant Health Inspection Service, *Emerald Ash Borer: The Green Menace*, United States Department of Agriculture, Washington D.C., April, 2005.
[25] Animal and Plant Health Inspection Service, *Emerald Ash Borer: The Green Menace*, United States Department of Agriculture, Washington D.C., April, 2005.
[26] Canadian Food Inspection Agency, *Survey Guide For Detection of Emerald Ash Borer*, Prepared by D. Barry Lyons et al., Canadian Forest Service and The Canadian Food Inspection Agency: Ontario, London, Ontario, 2007, 11.

shaped tunnels are significant signs of EAB."[27] Also, increased woodpecker feeding on the crowns of ash trees may also be a sign that the given ash tree is infested with EAB.

THE SPREAD

The emerald ash borer established its home in North America long before anyone was aware of its presence. EAB was first discovered in Canton Michigan, during June of 2002. Although it was discovered in 2002, many scientists believe the EAB had been present in Essex County, Michigan as long as 12 years before that. The Agrilus planipennis species is native to parts of Asia, predominantly China, but it can also be found in Japan, Korea, Mongolia, far eastern Russia, and Taiwan. Studies indicate that samples of the ash borer species from Michigan are closely linked to samples found in various provinces of China, although more research is needed to conclude the exact destination from where they were transported.[28]

Detroit, Michigan and Essex County, Ontario, also known as ground zero, was the starting point for the spread of the emerald ash borer across North America. EAB was first reported in June 2002 in the Great Lakes region of the United States. Reports show that it was present in southeastern Michigan and southwestern Ontario around the same time.[29] Shortly after its discovery, surveys showed surrounding counties of ground zero encompassing 2,500 square

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[27] Animal and Plant Health Inspection Service, *Emerald Ash Borer: The Green Menace*, United States Department of Agriculture, Washington D.C., April, 2005.
[28] Jim Smith et al., "Genetic Analysis of Emerald Ash Borer (Agrilus planipennis Fairmaire) to Determine Point of Origin of North American Infestations," Michigan State University, 2005.
[29] Jim R. Muirhead et al., "Modeling Local and Long-Distance Dispersal of Invasive Emerald Ash Borer *Agrilus planipennis* (Coleoptera) In North America," *Diversity and Distributions12* (2006): 72.

miles, were heavily infested with the EAB.[30] Since its arrival it has taken a hard toll on the ash tree population of Michigan and its surrounding areas, wiping out tens of millions, to potentially hundreds of millions of ash trees. The most problematic issue with EAB is its rate of spread. Although the natural spread of the emerald ash borer is only about ½ a mile annually, it is quickly making its way across the U.S. and Canada, to other areas with high ash tree populations. Since its discovery in 2002, it was discovered in Ohio in 2003, northern Indiana in 2004, northern Illinois and Maryland in 2006, western Pennsylvania and West Virginia in 2007, Wisconsin, Missouri and Virginia in the summer of 2008, and New York and Minnesota in the spring of 2009.[31]

The natural spread of the emerald ash borer is relatively small, making humans the most dominant factor for dispersal.

> Consider this: current research suggests that the natural spread or movement of the EAB is about ½ mile each year. If that estimate is accurate and the length of time EAB has been present is 12 years, at press time (April 2005) the generally infested area in Michigan* should cover about 113 square miles. But as of 2005, Michigan's generally infested area covers almost 13,000 square miles! Human behavior is a defining factor in the spread of EAB.[32]

It is evident that humans play a large role in the dispersal of the EAB. After all, the EAB made it to North America by means of human transport. The emerald ash borer has continued its spread across the continent, "through a combination of diffusive range extension, associated with local flights, and by long-distance 'jump' dispersal associated with human movement of infested

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[30] Forest Service, Animal and Plant Health Inspection Service, *Emerald Ash Borer: Research and Technology Development Meeting,* Victor Mastro and Richard Reardon. Forest Health Technology Enterprise Team, Morgantown, West Virginia, January, 2004, III.

[31] Emerald Ash Borer Official Website, "Emerald Ash Borer: Research On Emerald Ash Borer and How It Affects Different Species of Ash," EAB Official Website, http://www.emeraldashborer.info/index.cfm (accessed October 16, 2009).

[32] Animal and Plant Health Inspection Service, *Emerald Ash Borer: The Green Menace,* United States Department of Agriculture, Washington D.C., April, 2005.

sapling or contaminated firewood."[33] Various studies have shown that human population size and activity is highly associated with the dispersal of the EAB. Most commonly, EAB is transported to different sites by infected firewood or infected ash saplings. For example, the introduction of the emerald ash borer in Maryland was due to the transport of infected ash saplings from a Michigan nursery. So far, it seems that the most efficient way for the invasive beetle to spread is by the transport of infested ash wood, such as ash firewood, ash saplings, and other ash tree products that are able to house the EAB larva.

ECONOMIC IMPACT

The loss of thousands of trees will severely impact many aspects of the Minneapolis urban forest. One area that will be hit hard is from an economic standpoint. With the country in a recession, state and municipal funding is not being thrown around to just anybody. A major problem facing the fight against the emerald ash borer is overall funding for the project. One setback to the current situation regarding EAB is a city ordinance in response to the prospective dilemma in terms of loss of trees.

> The current MPRB ordinances pertain only to Dutch Elm Disease (DED) and does not allow the city to abate or mitigate EAB or other destructive tree pests…The proposed amendments would enable the MPRB to respond when EAB is inevitably discovered in Minneapolis. It would also allow action to be taken on tree pests that have not yet been discovered.[34]

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[33] Jim R. Muirhead et al., "Modeling Local and Long-Distance Dispersal of Invasive Emerald Ash Borer *Agrilus planipennis* (Coleoptera) In North America," *Diversity and Distributions12* (2006): 71.

[34] MPRB Forestry Division, *MPRB Updating Tree Ordinances To Respond To EAB and Other Tree Diseases: Minneapolis Tree Advisory Commission Presents Annual Report,* MPRB, October 22, 2009.

A new ordinance to respond to EAB and other tree related diseases besides DED will allow city officials to allocate more funding for the emerald ash borer project. However, since the discovery of the emerald ash borer in Minnesota was relatively recent, the MPRB and state legislature are still working on projected, as well as potential costs and funding. Taken from an October 27, 2009 interview with Ralph Sievert, Director of the Minneapolis Forestry Division, Sievert stated:

> At this point we aren't sure where the money will come from. Everyone in MN's urban forest community harkens back to the late 70's / early 80's when the state legislature put forth $30 million to fight DED. Those days are gone, but $2 million is available from the state via a grant for next year. Cities in MI, like Ann Arbor, actually delayed building projects so they had money to cut down ash trees. When EAB hits Minneapolis and really ramps up, we expect our city government to reallocate financial resources so that a response can be mounted. My fear is that the response will, by necessity, have to focus on just removals. Stumping and replanting will probably take a back seat to removals since that's where liability lies.[35]

Since the status of the emerald ash borer is not at the level of full-fledged infestation, current funding is being used for survey purposes; looking for EAB rather than treating it. Officials from the Agriculture and Natural Resources department are currently working on receiving more funding from the U.S. Department of Agriculture. "Only $120,000 each year is spent by the department to look for the emerald ash borer, according to Geir Friisoe, senior program administrator in the department."[36] Currently there is no foreseen evidence of federal funding. Since the devastating effects of Hurricane Katrina in 2005, there has been no federal funding to help fight the emerald ash borer in any state.

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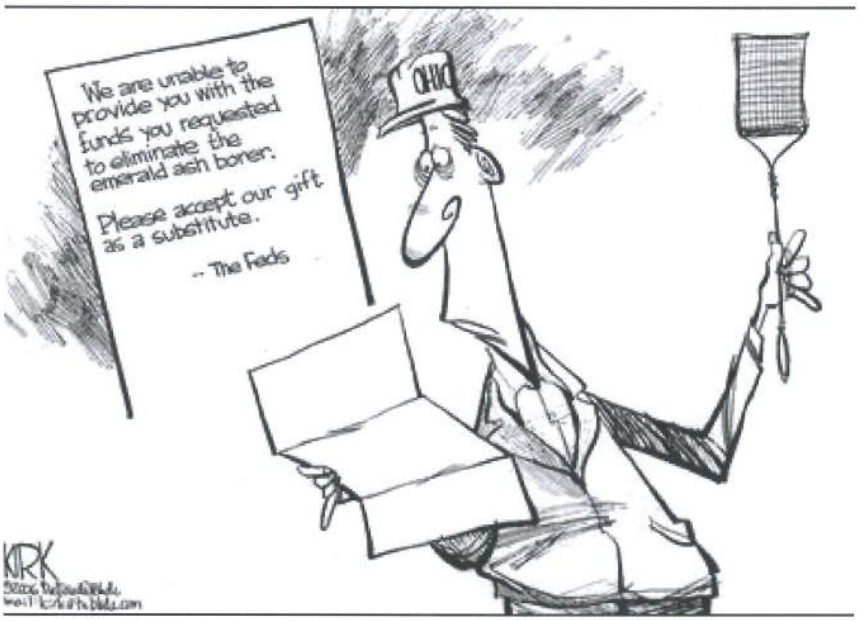
[35] Ralph Sievert, Email Interview by Andrew Kintop, St. Joseph, MN, October 27, 2009.
[36] Susan Hegarty, "Emerald Ash Borer: Wildfire In Slow Motion," Twin Cities Daily Planet: Local News For Local Citizens, http://www.tcdailyplanet.net/article/2009/05/01/emerald-ash-borer-wildfire-slow-motion.html (accessed October 26, 2009).



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The worst-case scenario for Minneapolis would be a total removal of the city's 210,000 ash trees, which are located on both public and private property. Aesthetically, this would be a disaster; economically, it would cost a fortune. A simple formula used to calculate potential costs from EAB for the city of Minneapolis includes the cost of removals, stumping, and replanting. An average removal cost is $150, an average stumping cost is $75, and the average cost to replant a tree is $150. At these monetary rates (about $375 per tree) plus the cost of labor, the economic impact of losing the city's 210,000 ash trees would amount to an estimated $152,000,000.00 in total costs.[38] The "Beat the Beetle" campaign has been in close relations with the Ohio forestry divisions, comparing research on the EAB. In relative comparison to Ohio, "the potential total costs are estimated to be between $157,000 and $665,000 per 1000 residents."[39] That would

[37] Alan Siewert, Email Interview by Andrew Kintop, St. Joseph, MN, October 30, 2009.
[38] MPRB Forestry Division, *The Minneapolis Park and Recreation Board's Emerald Ash Borer Preparedness Plan*, Minneapolis Park and Recreation Board, Ralph Sievert, March 17, 2008, 2.
[39] T. Davis Sydnor et al., "The Potential Impacts of Emerald Ash Borer (Agrilus planipennis) on Ohio, U.S., Communities," Arboriculture & Urban Forestry, .33(1) (2007): 48.

amount to $60 to $254 million for Minneapolis alone.[40] Cy Kosel, St. Paul's natural resources manager for parks and recreation, estimates the cost to hire more staff members and purchase new equipment to fight EAB will be around $3 million next year alone.[41]

Other states need funding as well. For example, grand total costs for the potential landscape, removal and replacement costs for Ohio's ash trees are estimated at a staggering $7.5 billion in losses from EAB. Although this, again, is a worst-case scenario situation in terms of losses and costs, these numbers are still overwhelming. It is no wonder why Ohio, along with Michigan and Indiana are seeking assistance on a federal level, in order to fight the emerald ash borer. Although these values for costs and losses are for the state of Ohio, other communities in North America can use these figures to develop contingency plans regarding EAB.[42]

On a more global note, EAB could severely impact a major industry involving the national pastime. The emerald ash borer threatens the nations ash tree reserves. The baseball bat industry primarily uses ash wood to construct their bats, which are used world wide, from a recreational scale all the way up to professional. The $25 billion industry, if affected by EAB, will add to the failing U.S. economy, as well as baseball in general.[43]

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[40] Ralph Sievert, "'Beat the Beetle': 15 Steps for EAB Preparation," (Minneapolis, MN, March 15, 2007).
[41] MPR, "Officials Wait for Next Move In Emerald Ash Borer Fight," MPR NewsQ website: Minnesota's Online Source for New That Matters, QuickTime Media Player, http://minnesota.publicradio.org/display/web/2009/07/09/emerld_ash_borer_fight/ (accessed October 24, 2009).
[42] T. Davis Sydnor et al., "The Potential Impacts of Emerald Ash Borer (Agrilus planipennis) on Ohio, U.S., Communities," Arboriculture & Urban Forestry, .33(1) (2007): 48.
[43] Dale McFeatters, "May Our Trees Survive Threats and Stand Tall," Minneapolis Star Tribune, October 24, 2009.

MINNESOTA: SPREAD & INITIATIVE

Minnesota is prime real estate for the emerald ash borer. Statewide, an estimated 937 million ash trees, including green, white, and black ash are vulnerable to the EAB.[44] Interestingly enough, Minnesota has the highest population of ash trees in the United States, making its vulnerability even greater. Minneapolis is not the only place in Minnesota with a large population of ash trees either. Statewide, many communities have ash tree populations consisting of 50 percent or more of their community forests, which means bad news for the majority of Minnesota communities and their ash tree populations.

The first discovery of the emerald ash borer in Minnesota was on May 10th, 2009. Minnesota EAB ground zero is located in the St. Anthony Park neighborhood of St. Paul in a small park off Raymond Avenue, just a few blocks north of University Ave.[45] It is likely that the EAB reached Minnesota from LaCrosse, Wisconsin, which discovered an EAB infestation a month prior to the St. Paul discovery.[46] Cy Kosel, the natural resources manager for parks and recreation in St. Paul believes, "the beetles were probably in the St. Anthony Park trees for four or five years before they were discovered."[47] The state of Minnesota, facing the inevitable demise of its ash tree population, is taking many steps in securing the integrity of its urban and non-urban forests, by containing the spread of the beetle.

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[44] Mary Hoff, "Big Trouble for Ash Trees," *Minnesota Conservation Volunteer*, May-June, 2009, 28.
[45] MPR, "Officials Wait for Next Move In Emerald Ash Borer Fight," MPR NewsQ website: Minnesota's Online Source for New That Matters, QuickTime Media Player, http://minnesota.publicradio.org/display/web/2009/07/09/emerld_ash_borer_fight/ (accessed October 24, 2009).
[46] MPRB Forestry Division, Emerald Ash Borer Found in St. Paul, MPRB, May 15, 2009.
[47] MPR, "Officials Wait for Next Move In Emerald Ash Borer Fight," MPR NewsQ website: Minnesota's Online Source for New That Matters, QuickTime Media Player, http://minnesota.publicradio.org/display/web/2009/07/09/emerld_ash_borer_fight/ (accessed October 24, 2009).

In an interview on October 17th, 2009, with Minneapolis city forestry director Ralph Sievert, Sievert stated that,

> Minnesota is in a way very lucky. Unlike Michigan, who had very little, to no knowledge of the emerald ash borer, Minnesota, and Minneapolis in general has had time to prepare for the inevitable introduction of the invasive species. However, it is very tough to know when and where the next invasion will turn up. That is why Minneapolis has implemented a survey strategy, as well as a removal strategy to contain the spread of the emerald ash borer.[48]

As a result of the St. Paul EAB discovery, the Minnesota Department of Agriculture (MDA) prompted a state quarantine on firewood, ash trees, and ash tree products in Hennepin and Ramsey counties.[49] This prohibits the movement of potentially infested wood products, including firewood, to prevent the accidental spread of the emerald ash borer to other parts of the state.[50] Wood chip piles, located in various sites around Minneapolis, which citizens are allowed to take free of charge, have discontinued the use of ash wood chips for its supply, due to the fact that the emerald ash borer larvae are able to survive in wood chips that are greater than 1.5 inches in length. The diseased wood needs to be ground to one inch or less in order to fully destroy the EAB larvae.[51]

[48] Ralph Sievert, Telephone Interview by Andrew Kintop, St. Joseph, MN, October 17, 2009.
[49] MPRB Forestry Division, Emerald Ash Borer Found in St. Paul, MPRB, May 15, 2009.
[50] BioCycle, "Treating Beetle-Infested Wood," *BioCycle* 48(11) (November, 2007): 34.
[51] BioCycle, "Treating Beetle-Infested Wood," *BioCycle* 48(11) (November, 2007): 34.

SOLUTIONS: MINNEAPOLIS TREE DIVERSITY

Will the Minneapolis urban forest succumb to the destructive effects of the emerald ash borer? If left up to nature, EAB will surely infect, and eventually kill every last one of the 210,000 ash trees in Minneapolis and continue on to the remaining 936 million ash trees state wide. There is no fight. The best way for city officials to handle the situation is to decide when the ash will die. They can die on EAB time, which will all be at once, putting Minneapolis and other Minnesota communities in bankruptcy, or they can die on our time, which will help to spread the cost over as many years as possible.

Luckily the Minneapolis Department of Forestry and other environmental groups have teamed up to establish a plan to prevent a city wide, as well as state wide spread of the invasive beetle. Although much of the immediate focus is spent on preventing the spread of the emerald ash borer throughout the city of Minneapolis, long-term goals have not been pushed aside in terms of future forestry planning. After its run in with the Dutch Elm disease and the loss of thousands, upon thousands of its elms, Minneapolis set out quickly to replenish its empty boulevards and bare parks. However, the replacement plan did not look far enough into the future, and it most certainly did not take into account the potential for another destructive pest destroying the urban forest. What the city did not learn from the destructive Dutch elm disease, they will learn from the emerald ash borer.

The key to preventing future biological impacts on the Minneapolis urban forest is to increase the diversity levels of trees throughout the city. The future tells all in terms of new pests, known or unknown, which could have a negative impact on the city's trees. It is known that the Dutch elm disease only impacts elms, and the same goes for the emerald ash borer, which only impacts ash trees. High concentrations of both elm and ash tree species makes it easier for the pests to spread from one tree to the next. Unless a pest comes along that is capable of impacting all tree species, increased tree diversity is the best way to prevent mass loss of a specific tree

species. Gary Johnson, a professor of urban community forestry at the University of Minnesota states, "Insects and diseases tend to like the taste of one type of tree, so the more diverse your urban forest is, the urban landscape, the more protected it is from severe damage from one problem."[52]

Upon the discovery of the emerald ash borer in Michigan in 2002, Minneapolis forestry officials recognized the potential impact EAB could have on the Minneapolis urban forest. They have taken a "not IF but WHEN" stand on the subject matter. Recognizing the serious threat EAB could have on city trees, the Minneapolis Tree Advisory Commission endorsed the "Beat the Beetle" campaign in 2006. This is a fifteen-step plan used to "proactively implement procedures that will lessen the aesthetic, environmental and economic impact of EAB's arrival."[53] Important aspects of this plan include: "Inventorying trees to provide the exact locations of ash trees, which will be used as a pest management tool. Staff training through educational opportunities and the International Society of Arboriculture's Certified Arborist and Certified Tree Worker programs. MPRB has stopped planting ash trees and is replacing them with other species when ash trees are removed due to attrition, and Partnering and advocacy with MDA, MnDNR, the Minnesota Legislator's Forest Protection Plan Task Force and policy makers."[54]

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[52] MPR, "Taking Lessons from Elm Losses, Minneapolis Prepares for Ash Borer," MPR NewsQ website: Minnesota's Online Source for News That Matters, QuickTime Media Player, http://minnesota.publicradio.org/display/web/2009/07/02/ash_borer_minneapolis/ (accessed October 26, 2009).

[53] MPRB Forestry Division, *The Minneapolis Park and Recreation Board's Emerald Ash Borer Preparedness Plan*, Minneapolis Park and Recreation Board, Ralph Sievert, March 17, 2008, 2.

[54] MPRB Forestry Division, Emerald Ash Borer Found in St. Paul, MPRB, May 15, 2009.

ALTERNATIVE TREATMENTS FOR INFECTED TREES

Infected ash trees have the possibility to be spared, rather than removed. There are currently no control measures for EAB. However, extensive research is being put into various treatment methods to save ash trees that have been infected by the emerald ash borer. Some treatment methods are being implemented in various sites around Minneapolis for research purposes. Although some treatments have been proven to be effective, they are costly and time consuming. This is especially relative when all 210,000 city ash trees are taken into consideration. Unless a certain treatment prevails as an effective EAB deterrent and proves to be less costly than removing the tree, the decision to treat an infected tree (primarily regarding boulevard or property trees) will be left up to the property owner at their own expense. They also must use a private contractor that has been permitted by the MPRB Forestry Division to perform the treatments.[55]

Scientists have proven that the emerald ash borer is attracted to the color purple. Purple traps, strategically placed in areas with high infestation potential, act as a flypaper of sorts. They are usually placed in mature ash trees to attract adult beetles. This "treatment" method is more or less a tactical way to assess ash borer numbers in a particular area.[56]

The use of a sacrificial method for containing the spread of the beetle will help save many ash trees. In a highly concentrated ash tree area, a layer of bark will be removed from one specific tree. This attracts adult beetles to the seemingly injured and vulnerable tree, directing them away from high concentrations of healthy ash trees.

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[55] MPRB Forestry Division, *The Latest On Emerald Ash Borer Strategy*, MPRB, August 20, 2009.

[56] Susan Hegarty, "Emerald Ash Borer: Wildfire In Slow Motion," Twin Cities Daily Planet: Local News For Local Citizens, http://www.tcdailyplanet.net/article/2009/05/01/emerald-ash-borer-wildfire-slow-motion.html (accessed October 26, 2009).

Insecticide treatments are available, however, they are controversial. Much research is being done on the use of pesticides to treat infected trees. Many scientists believe that the chemicals may harm non-target insects or birds in the treatment process, which will negatively impact the environment, defeating the purpose for treating in general. Ralph Sievert has chosen not to use pesticide treatment for infected trees in Minneapolis, although other cities are. Pesticides must be applied to infected trees every couple of years, which can, and will be costly. However, they have been proven to slow down the spread of EAB. Minneapolis may benefit from pesticide treatment, preventing the need to remove thousands of ash trees, in turn buying time to properly assess infected specimens for further research.[57]

TREE REPLACEMENT STRATEGIES

Cutting down every ash tree in Minneapolis would certainly avert the emerald ash borer situation altogether. If this were the case, letting the EAB literally go to town on the Minneapolis ash tree population would be the easiest solution to rid the city of its ash resources. This, however, would lead to far more problems, including costs, aesthetics, environmental problems, and the list goes on. Luckily, city officials have decided to take a more logical route in dealing with the problem. Unlike the mistakes of poor planning and limited tree selection during previous eras, city Forestry officials are now taking new steps to improve the diversity of the Minneapolis urban forest, as well as techniques for limiting impacts of future invasive species. Minneapolis plans to diversify its urban forest on a block-to-block plan, assigning city blocks to a certain type of tree, as opposed to a tree-by-tree plan. Although this was the master plan for the turn of the

[57] MPR, "Taking Lessons from Elm Losses, Minneapolis Prepares for Ash Borer," MPR NewsQ website: Minnesota's Online Source for News That Matters, QuickTime Media Player, http://minnesota.publicradio.org/display/web/2009/07/02/ash_borer_minneapolis/ (accessed October 26, 2009).

century, which led to the DED outbreak, this plan will implement a wide variety of trees for replacement instead of just American elms or Green ash like before. The benefit of assigning certain trees to certain blocks is for financial reasons. For instance, if a block of Silver maples is infested by a new invasive species that only attacks Silver maples, it will be much easier to contain the pest and it will make it easier for city officials to treat the one block, as opposed to treating numerous sites around the city. However, if an invasive species were to attack a certain tree species, it would mean the loss of a whole block of trees, which would most likely develop a negative response from citizens of that given block/neighborhood. Although this is the immediate plan, city officials are open to specific requests from property owners. If a tree is removed from an elm block, it will be replaced by another elm. However, if a property owner requests a maple tree instead, the city is relatively flexible in terms of property owner desires, within reason.[58]

Ever since the EAB was discovered in Michigan in 2002, the city of Minneapolis realized the potential threat the emerald ash borer could have on its many ash trees. Since 2006, Minneapolis has only planted nine new ash trees, which were most likely upon property owner requests. In the last three years, Minneapolis has not planted any new ash tree species. Looking towards the future, Minneapolis Forestry officials have set about developing a plan to diversify the Minneapolis urban forest by implementing a wide variety of new trees to replace existing ash trees. Different trees will be assigned to different city blocks, as well as various public areas around the city. Although the city is still in the process of searching for new tree species to implement, there is an already long list of potential candidates. In 2009 alone, Minneapolis has planted numerous different types of tree species to increase the diversity of its urban forests. A spread sheet from the MPRB forestry division lists a total of 44 new tree species based on size,

[58] MPR, "Taking Lessons from Elm Losses, Minneapolis Prepares for Ash Borer," MPR NewsQ website: Minnesota's Online Source for News That Matters, QuickTime Media Player, http://minnesota.publicradio.org/display/web/2009/07/02/ash_borer_minneapolis/ (accessed October 26, 2009).

ranging from small (25-30 feet), medium (35-50 feet), and large (50+ feet), as well as type, for potential replacement options.[59] A few current options are:

> **Elms**: new elms resistant to DED, including American elms and some hybrids. American: Princeton elm, Valley Forge elm. Hybrids: Accolade elm, Triumph Elm.
> **Maples**: Sugar Maple, Freeman Maple (cross between red and silver maples), Norway Maple (known to be invasive in Europe), Silver Maple (roots near soil surfaces prevent it from being boulevard replacement), Miyabe Maple (similar to Norway maple, but smaller and known to be less invasive).
> **Honeylocust**: (tall growing trees, but has messy foliage, good for Minnesota weather)
> **Ginkgo**: (good tree, few known pests, dioecious: both male and female trees, females produce bad smelling fruit (smells like vomit)).
> **Kentuckycoffeetree**: (very shady tree, does well in most soils, overtime can reach heights of 70 feet).
> **European black alder**: (small but tough, handles poor soils very well, may invade native species).
> **Hackberry**: (tolerates poor soils and is a good choice for a poor site, susceptible to pests but none too damaging, when mature they form a dense canopy).
> **Lindens**: (dense canopy, compact size of 40-60 feet in height, attractive tree that produces small flowers with a pleasant fragrance).
> **Other Species Listed**: Autumn splendor buckeye, River birch, Bur oak, Hop hornbeam, Prairie Gem pear, Prairie Horizon Manchurian alder, Swamp white oak.[60]

These are just a few options being sought by Minneapolis forestry officials as possible replacement species for ash trees, as well as other old or dying trees that are in need of replacement. For example, if an older Boxelder tree has reached its life expectancy and is due for replacement, it will likely be replaced by a new tree species instead of another Boxelder, in order to continue the trend of diversifying the Minneapolis urban forest. However, this may not always be the case for all replacement strategies, keeping in line with the block-to-block strategy, as well as citizen requests. The idea is to increase diversity throughout the city in hopes of minimizing future threats from invasive species. The most current statistics for tree species diversity are as follows:

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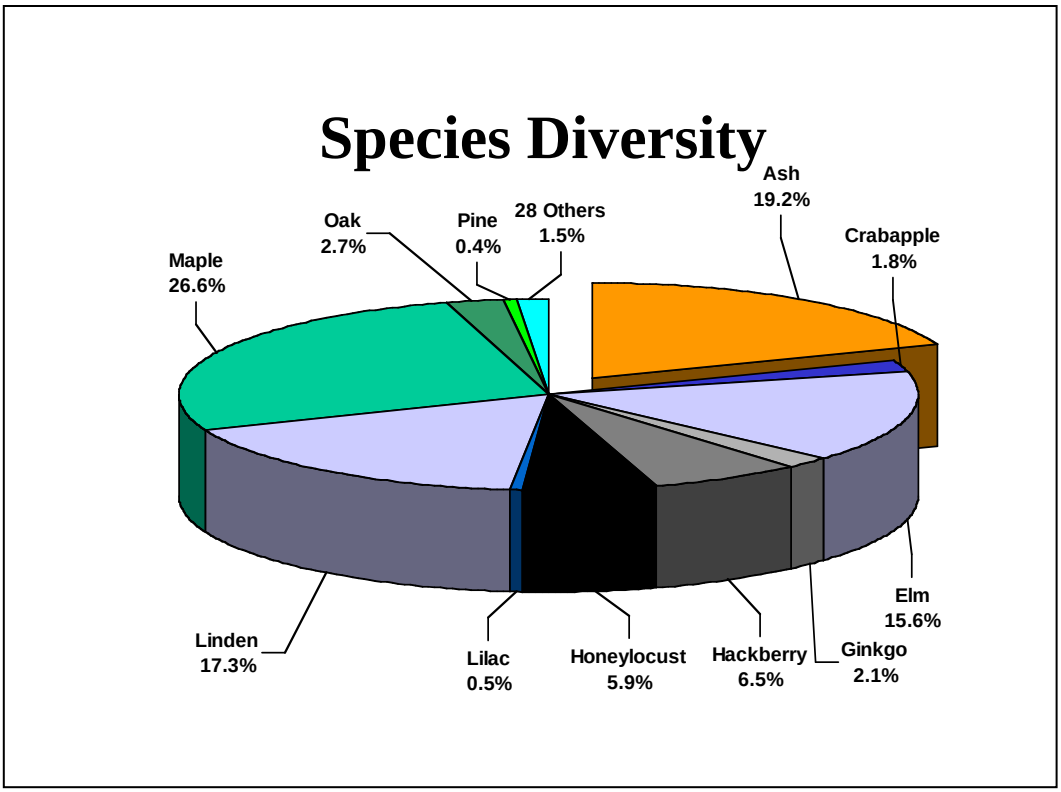
[59] MPRB Forestry Division, *The Minneapolis Park and Recreation Board's Emerald Ash Borer Preparedness Plan*, Minneapolis Park and Recreation Board, Ralph Sievert, March 17, 2008, 2.
[60] Jeff Gillman, "Out of the Ashes," *Minneapolis Star Tribune,* September 2, 2009.



[61]

This pie chart from March of 2008 shows evidence of an increasing diversity of tree species throughout Minneapolis' urban forests. The ash tree population in 2008 is at 19.2%, compared to 21.6% in 2006. The maple tree population has increased, but unlike the ash, which consists primarily of Green ash trees, there is a greater variety of maple tree species, which also helps to increase diversity.

[61] MPRB Forestry Division, *The Minneapolis Park and Recreation Board's Emerald Ash Borer Preparedness Plan*, Minneapolis Park and Recreation Board, Ralph Sievert, March 17, 2008, 2.

CONCLUSION

When reviewing the quickness of the spread, and the signs of EAB now evident in the twin cities area, it is more than likely that the invasive emerald ash borer beetle will wreak havoc on the Minneapolis urban forest within the next couple of years. When looking at the destruction EAB had caused to ash tree populations, spanning from Michigan, to Canada, to Ohio, and numerous other sites, one can only imagine what the emerald ash borer will do to the 210,000 ash trees of Minneapolis. Minneapolis may also be the least of the state's worries. Minnesota has the most ash trees out of any other state in the U.S., totaling some 900 million ash trees vulnerable to EAB.

There may, however, be hope for the cause. Minneapolis has been lucky in the sense that it has had time to prepare for the inevitable demise of its ash resources. The MPRB and its "Beat the Beetle" program has developed a fifteen step plan, involving not only the city, but the public as well as policy makers, to inform them of the emerald ash borer threat. This will also give the city the opportunity to reassess their tree population in terms of diversity. In preparation for the ash borer, while still in the shadow of the Dutch Elm Disease epidemic of the 1970's, Minneapolis will be able to develop a new urban forest plan in hopes of preventing future losses of one tree species.

AFTER THOUGHT

Although Minneapolis city officials are currently working on ways to diversify the Minneapolis urban forest, along with new planning strategies, it has come to my attention that there may be some flaws in their new plan. I am not disagreeing with the diversity proposal. It is necessary to maximize the diversity of tree species to prevent the loss of mass amounts of one

specific tree species due to natural occurrences, such as EAB or other invasive species. However, the block-to-block plan for replanting the urban forest, which consists of assigning certain city blocks with a specific type of tree, does not seem diverse enough in terms of tree species distribution. The block-to-block plan is used to distribute trees in clumps, making it easier to contain an invasive species. If this were the case, whole city blocks will potentially have no trees, which is a current threat from the EAB. With this in mind, I became interested in how other places around the country, affected by the emerald ash borer, have handled the same problem, which Minneapolis will soon be facing.

Alan Siewert, the head forester for Ohio's DNR gave me some perspective on how many cities in Ohio have dealt with EAB. He, too, assured me that diversity is the only tool to work with for preventing mass losses of certain tree species. He did give me a better insight on the rules for diversifying an urban forest. In an interview on October 30th, 2009, he stated that:

> There has been the 10-20-30 rule around since Dutch elm disease ravaged the east coast in the 1950's and 60's. The rule states that no more than 10% of a population should be any one species (Red maple, Bur oak, pear, etc.), and no more than 20% of that population should be any one genus (maple, oak, crabapple, etc.), and no more than 30% of that population should be more than any one family (Maple family, Beach family which includes oaks, rose family, etc). The 10-20-30 rule is very doable, but here in Ohio where we can grow many more trees than you in Minnesota, we have been pushing the 5-10-15 rule, the same deal just cut in half. The challenge is to get uniform diversity in the urban forest. Planned diversity is the only way.[62]

With this concept in mind, diversity must be evenly implemented throughout the Minneapolis urban forest. Although the current block-to-block plan distributes diversity on a block-to-block ratio, it does not account for the potential losses certain block may face. I propose that each block be given a three species title, instead of just one. With three species per block, evenly distributed

[62] Alan Siewert, Telephone Interview by Andrew Kintop, St. Joseph, MN, October 30, 2009.

throughout Minneapolis, it will provide enough diversity for containing invasive species, but more importantly it will prevent total loss of trees from a given block.

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