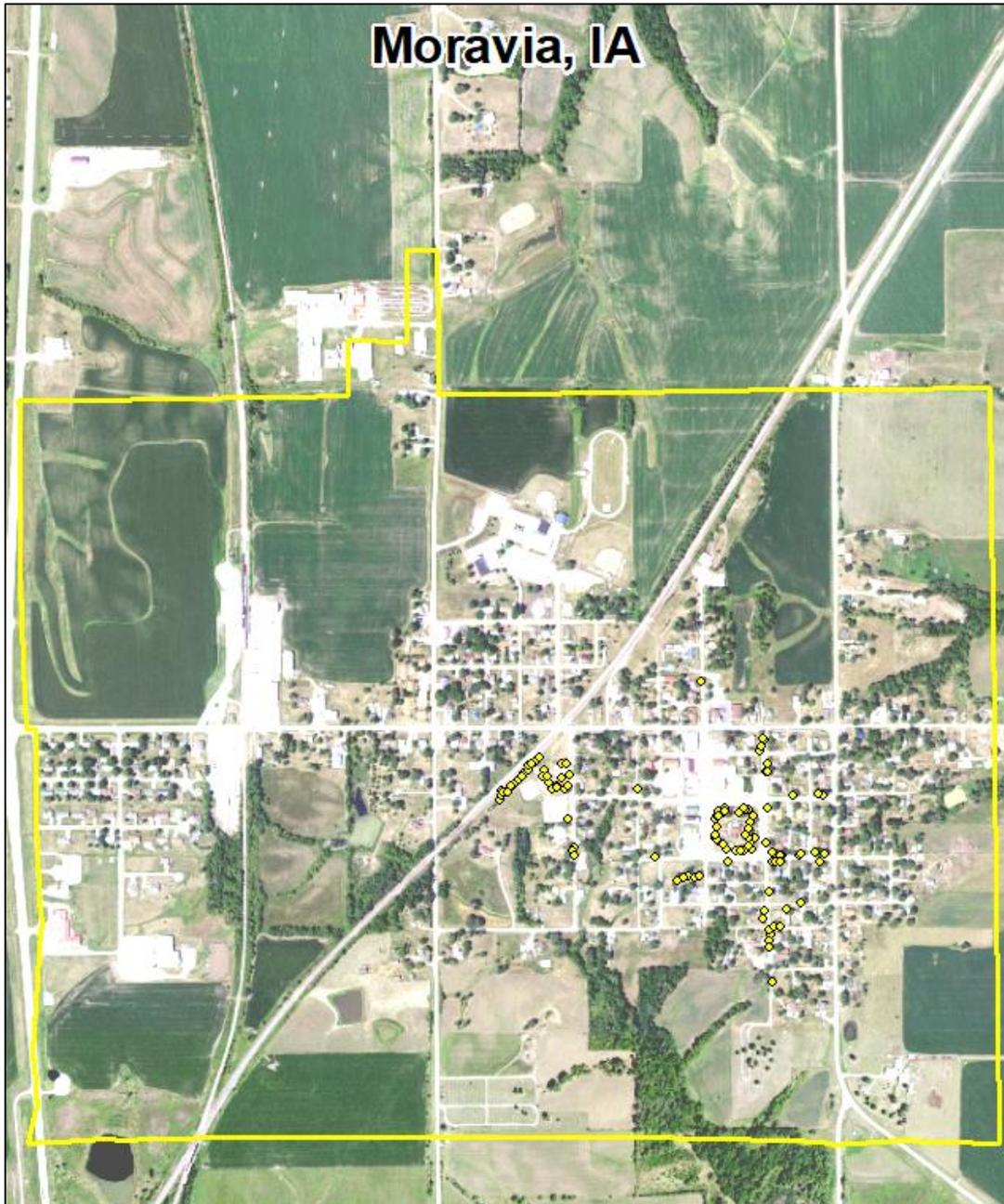# Moravia, IA

2021 Urban Forest Management Plan
Prepared by Jeremy Cochran
Iowa Department of Natural Resources

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Executive Summary

Overview

This plan was developed to assist the City of Moravia with managing its urban forest, including budgeting and future planning. Trees can provide a multitude of benefits to the community, and sound management allows a community to best take advantage of these benefits. Management is especially important considering the serious threats posed by forest pests such as the emerald ash borer (EAB). EAB is an invasive insect imported from Eastern Asia on wood shipping crates that kills all species of ash trees (this does not include mountain ash). The city owned trees (ash) are dead/declining because EAB is established in the community. With proper planning and management, the costs of removing dead and dying trees can be extended over years, mitigating public safety issues.

Inventory and Results

In 2020, a tree inventory was conducted using Global Positioning System (GPS) data collectors. The inventory was a complete inventory of street and park trees. Below are some key findings of the 114 trees inventoried.

- Moravia's trees provide $16,584 of benefits annually, an average of $114 a tree
- There are over 31 species of trees
- The top three genera are: Maple 29%, Spruce 16%, and Oak 19%
- 40% of trees are in need of some type of management
- 12 trees are recommended for removal

Recommendations

The core recommendations are detailed in the Recommendations Section. The Emerald Ash Borer Plan includes management recommendations as well. Below are some key recommendations.

- Of the 12 trees needing removal, 6 trees are dead/dying and should be addressed immediately; and 6 are poor health. *City ownership of the trees recommended for removal should be verified prior to any removal*
- All trees should be pruned on a routine schedule- one third of the city every other year
- Plant a diverse mix of trees that do not include: maple, ash, cottonwood, poplar, box elder, Chinese elm, evergreen, willow or black walnut.
- Enact a 5-year moratorium on planting new maple trees along streets and parks.
- The recommended budget to manage and improve the existing tree canopy is $21,600 or average $3,600 per year

Introduction

This plan was developed to assist Moravia with the management, budgeting and future planning of their urban forest. Across the state, forestry budgets continue to decrease with more and more of that money spent on tree removal. With the anticipated arrival or recovery from Emerald Ash Borer (EAB), an invasive pest that kills native ash trees, it is time to prepare for the increased costs of tree removal or treatment and replacement planting. With proper planning and management of the current canopy in Moravia, these costs can be extended over years and public safety issues from dead and dying ash trees mitigated.

Trees are an important component of Moravia's infrastructure and one of the greatest assets to the community. The benefits of trees are immense. Trees provide the community with improved air quality, stormwater runoff interception, energy conservation, lower traffic speeds, increased property values, reduced crime, improved mental health and create a desirable place to live, to name just a few benefits. It is essential that these benefits be maintained for the people of Moravia and future generations through good urban forestry management.

Good urban forestry management involves setting goals and developing management strategies to achieve these goals. An essential part of developing management strategies is a comprehensive public tree inventory. The inventory supplies information that will be used for maintenance, removal schedules, tree planting and budgeting. Basing actions on this information will help meet Moravia's urban forestry goals.

Inventory

In 2020, a tree inventory was conducted that included 100% of the city owned trees on both streets and parks. The tree data was collected using a handheld Global Positioning System (GPS) receiver. The data collector gives Geographic Information Systems (GIS) coordinates with an accuracy of 3 meters, which can be used in Arc GIS as an active GIS data layer. Because the inventory is a digital document the data can be updated with new information and become a working document.

The programming used to collect tree information on the data collectors was written to be compatible with a state-of-the-art software suite called i-Tree. i-Tree was developed by the USDA Forest Service to quantify the structure of community trees and the environmental services that trees provide. The i-Tree suite is a public domain which can be accessed for free.

To quantify the urban forest structure and benefits, specific data is collected for each tree. This data includes: location, land use, species, diameter at 4.5 feet, recommended maintenance, priority of that maintenance, leaf health, and wood condition. Additionally, signs and symptoms associated with EAB were noted for all ash trees. The signs and symptoms noted were canopy dieback, epicormic shoots, bark splitting, D-shaped borer exit holes, and wood pecker damage.

Inventory Results

The data collected for the 114 city trees was entered into the USDA Forest service program Street Tree Resource Analysis Tool for Urban Forestry Management as part of the i-Tree suite. The following are results from the i-Tree STREETS analysis.

Annual Benefits

Annual Energy Benefits
Trees conserve energy by shading buildings and blocking winds. Moravia's trees reduce energy related costs by approximately $4,079 annually (Appendix A, Table 1). These savings are both in Electricity (19.5 MWh) and in Natural Gas (2,653 Therms).

Annual Stormwater Benefits
Moravia's trees intercept about 220,159 gallons of rainfall or snow melt a year (Appendix A, Table 2). This interception provides $5,966 of benefits to the city and averages $52.34 per tree.

Annual Air Quality Benefits
Air quality is a persistent public health issue in Iowa. The urban forest improves air quality by removing pollutants, lowering air temperature, and reducing energy consumption, which in turn reduces emissions from power plants, and emitting volatile organic matter (ozone). In Moravia, it is estimated that trees remove 250 lbs. of air pollution (ozone (O_3), particulate matter less than 10 microns (PM10), carbon monoxide (CO), nitrogen dioxide (NO_2), and sulfur dioxide (SO_2)) per year with a net value of $700 (Appendix A, Table 3) and average $6.14 per year.

Annual Carbon Benefits
Carbon sequestration and storage reduce the amount of carbon in the atmosphere, mitigating climate change. In Moravia, trees sequester about 82,891 lbs. of carbon a year with an associated value of $622 (Appendix A, Table 5). In addition, the trees store 818,116 lbs. of carbon, with a yearly benefit of $6,136 (Appendix A, Table 4).

Annual Aesthetics Benefits
Social benefits of trees are hard to capture. The analysis does have a calculation for this area that includes: aesthetic value, property values, lowered rates of mental illness and crime, city livability and much more. Moravia receives $5,218 in annual social benefits from trees (Appendix A, Table 6).

Financial Summary of all Benefits
According to the USDA Forest Service i-Tree STREETS analysis, Moravia's trees provide $16,584 of benefits annually. Benefits of individual trees vary based on size, species, health and location, but on average each of the 114 trees in Moravia provide approximately $145.47 annually (Appendix A, Table 7).

Forest Structure

Species Distribution

Moravia has over 31 different tree species along city streets and parks (Appendix A, Figure 1). The entire list is available by contacting your District Forester. The recommended guidelines for your community forest are ≤10% of one species (ex. silver maple) and ≤20% of one genus (ex. maple) The distribution of the most common trees by specie is as follows:

Species	Percent
Silver maple	19.30
Spruce	14.91
Northern red oak	7.02
Siberian elm (Chinese)	5.26
Swamp white oak	5.26
Broadleaf Deciduous Medium	3.51
Northern pin oak	3.51
Sugar maple	3.51
American basswood	3.51
Norway maple	3.51
Other Species	30.70

Age Class

Most of Moravia's trees (39%) are greater than 18 inches diameter at 4.5 feet (Appendix A, Figure 2). For age, it is preferred that the highest amounts of trees are in the smallest size category (a downward slope) to prepare for natural mortality and to maintain canopy cover. Moravia's size curve is on the smaller side, indicating a younger than average stand.

Condition: Wood and Foliage

Both wood condition and leaf condition are good indicators of the overall health of the urban forest. The foliage condition results for Moravia indicate that 83% of the trees are in Good or Fair health, with only 9% of the foliage in Poor health and 5% Dead or Dying (Appendix A, Figure 3 & Appendix B, Figure 3). Additionally, 70% of Moravia's trees are in Good or Fair health for wood condition (appendix A, Figure 4 & Appendix B, Figure 3). Wood condition that is in Poor health, Dead or Dying is about 27% of the population. The combined Good or Fair rating for BOTH leaf and wood condition in Moravia is 68%.

Management Needs

The following outlines the specific management needs of the street and park trees by number of trees and percent of canopy (Appendix B, Figure 3). The trees needing maintenance include 40% or 46 total trees. You may also use the online database to "View my community's trees" https://www.iowadnr.gov/Conservation/Forestry/Urban-Forestry

No critical concern trees-immediate removal-see hazardous trees below

9 Immediate needs (deferring maintenance beyond one to three years would compromise health or longevity of tree) Plan and budget accordingly.
- 6 removal/replacement

- 2 cleaning
- 1 stake/train

39 routine needs (health or longevity of tree is not compromised by deferring maintenance for up to five years) Plan and budget accordingly.
- 6 removal/replacement
- 5 cleaning
- 27 raise
- 1 stake/train

68 trees (60%) do not need maintenance today but should be included in a routine 3-year schedule

Canopy Cover
The total canopy with both private and public trees is 13%, 92.27 acres. The canopy cover on city own properties included in the Moravia inventory includes approximately 2.28 acres (Appendix A, Figure 4). The City's Canopy goal should to increase canopy by 1%, in 30 years on all lands. To achieve this goal, it is estimated that 17 trees need to be planted annually on public and/or private lands. A more ambitious goal would be to increase the canopy by 3% which would need 52 trees planted annually.

Land Use and Location
The majority of Moravia's city and park trees are in planting strips in single family residential neighborhoods (Appendix A, Figure 6 & Appendix A, Figure7). The following describes the land use and locations for the street and park trees.

Land Use	
Single family residential	61%
Park/vacant/other	37%
Industrial/Large commercial	0%
Small commercial	0%
Multifamily residential	0%

Location	
Planting strip	91%
Front yard	9%
Other maintained locations	0%
Cutout (surrounded by pavement)	0%

Recommendations

Risk Management
Hazardous trees can be a significant threat to both people and property. Trees that are dead or dying, or that have large issues such as trunk cracks longer than 18 inches should be removed. Broken branches and branches that interfere with motorist's vision of pedestrians, vehicles, traffic signs and signals, etc. should be removed.

<u>Hazardous trees</u>
Moravia has 0 critical concern trees that need immediate removal. This is a good sign for Moravia's street trees.

<u>Poor tree species</u>
Trees in poor health should be assessed for removal (Appendix B, Figure 3 & Appendix B, Figure 4). This is also discussed in the Management Needs section. Budgeting and planning for these removals will minimize risk and improve the overall health of your community trees. *City ownership of the trees recommended for removal should be verified prior to any removal*

Pruning Cycle
Proper pruning can extend the life and good health of trees, as well as reduce public safety issues. In the Management Needs section of the Findings there are four main maintenance issues to be addressed: routine pruning, crown cleaning, crown raising, and crown reduction. Crown cleaning removes dead, diseased, and damaged limbs. Crown raising is the removal of lower branches that are 2 inches in diameter or larger in the case of providing clearance for pedestrians or vehicles. Crown reduction is removing individual limbs from structures or utility wires. It is recommended that all trees be pruned on a routine schedule every five to seven years. Please refer to the six-year maintenance plan for further information.

Planting
Most of the planting over the next 5 years will replace the trees that are removed. It is recommended to plant 1.2 trees for every tree removed, since survival rates will not be 100%. Please refer to the six-year maintenance plan at the end of this section. It is not essential that the new trees be planted in the same location of the trees being removed. However, maintaining the same number of trees helps ensure continuation of the benefits of the existing forest in Moravia.

It is important to plant a diverse mix of species in the urban forest to maintain canopy health, since most insects and diseases target a genus (ash) or species (green ash) of trees. Current diversity recommendations advise that a genus (i.e. maple, oak) not make up more than 20% of the urban forest and a single species (i.e. silver maple, sugar maple, white oak, bur oak) not make up more than 10% of the total urban forest. Presently, the forest is heavily planted with maple (29%) (Appendix A, Figure 1). <u>Maples should not be planted until this percentage can be lowered.</u> A five-year moratorium on new maple trees should be enacted. At the end of this timeframe or whenever the inventory has been updated, re-evaluate the needs for further moratoriums. Species to avoid because they are public nuisances include: cottonwood, poplar, box elder, Chinese elm, evergreen, willow or black walnut. All trees planted must meet the restrictions in city ordinance.

Continual Monitoring
Due to the threat of EAB, it is important to continuously check the health of ash trees. It is recommended that ash trees be checked with a visual survey every year for tree decline and for the following signs and symptoms: canopy dieback, epicormic shoots, bark splitting, D-shaped borer exit holes, and wood pecker damage.

Budget and Emerald Ash Borer Plan

Six Year Maintenance Plan
Recommended Budget $3,600/year, Total $21,600 over 6 years

FY 2022
    Removal: 2 largest Immediate trees, $1,800
    Planting and Replacement: 3 trees to be planted in open locations, $300
    Young Tree Pruning & Maintenance: $75

FY 2023
    Removal: 2 largest Immediate trees, $1,800
    Planting and Replacement: 3 trees in open locations, $300
    Young Tree Pruning & Maintenance: $75
    Routine trimming: Contract to trim 1/3 of the city trees, up to $2,850

FY 2024
    Removal: 2 largest Immediate trees, $1,800
    Planting and Replacement: 3 trees in open locations, $300
    Young Tree Pruning & Maintenance: $75

FY 2025
    Removal: 2 largest Routine trees, $1,800
    Planting and Replacement: 3 trees in open locations, $300
    Routine trimming: Contract to trim 1/3 of the city trees, up to $2,850
    Young Tree Pruning & Maintenance: $75

FY 2026
    Removal: 2 largest Routine trees, $1,800
    Planting and Replacement: 3 trees in open locations, $300
    Young Tree Pruning & Maintenance: $75

FY 2027
    Removal: 2 largest Routine trees, $1,800
    Planting and Replacement: 3 trees in open locations, $300
    Routine trimming: Contract to trim 1/3 of the city trees, up to $2,850
    Young Tree Pruning & Maintenance: $75

EAB Quarantines

EAB is an extremely destructive plant pest and it is responsible for the death and decline of millions of ash trees. Ash in both forested and urban settings constitute a significant portion of the canopy cover in the United States. Current tools to detect, control, suppress and eradicate this pest are not as robust as the USDA would desire. In order to stay ahead of this hard to detect beetle, the USDA is attempting to contain the beetle before it spreads beyond its known positions by regulating articles.

A regulated article under the USDA's quarantine includes any of the following items:
- emerald ash borer
- firewood of all hardwood species (for example ash, oak, maple and hickory)
- nursery stock and green lumber of ash
- any other ash material, whether living, dead, cut or fallen, including logs, stumps, roots, branches, as well as composted and not composted chips of the genus ash (Mountain ash is not included)

In addition, any other article, product or means of conveyance not listed above may be designated as a regulated article if a USDA inspector determines that it presents a risk of spreading EAB once a quarantine is in effect for your county.

Wood Disposal

A very important aspect of planning is determining how wood infested with EAB will be handled, keeping in mind that quarantines will restrict its movement. Consider who will cut and haul the dead and dying trees? Is there an accessible, secured site big enough to store and sort the hundreds of trees and the associated brush and chips? How will wood be disposed of or utilized? Do you have equipment capable of handling the amount and size of ash trees your tree inventory has identified? Once your county is under quarantine for EAB, contact USDA-APHIS-PPQ at 515-251-4083 or visit the website http://www.aphis.usda.gov/plant_health/plant_pest_info/emerald_ash_b/regulatory.shtml. Wood waste can be disposed of as you normally would if your county is not part of a quarantine.

Canopy Replacement

As budget permits, all removed trees will be replaced. All trees will meet the restrictions in city ordinances. The new plantings will be a diverse mix and will not include maple, ash, cottonwood, poplar, box elder, Chinese elm, evergreen, willow or black walnut.

Postponed Work

While finances, staffing and equipment are focused on the management of ash, usual services may be delayed. Tree removal requests on genera other than ash will be prioritized by hazardous or emergency situations only. This is accounted for based on the Critical Concern, Immediate, or Routine needs.

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Appendix A: i-Tree Data

Table 1: Annual Energy Benefits

Moravia

Annual Energy Benefits of Public Trees

3/25/2021

Species	Total Electricity (MWh)	Electricity ($)	Total Natural Gas (Therms)	Natural Gas ($)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Silver maple	7.1	538	951.8	933	1,471	(N/A)	19.3	36.1	66.88
Spruce	0.2	14	25.3	25	39	(N/A)	14.9	1.0	2.29
Northern red oak	1.0	74	127.8	125	199	(N/A)	7.0	4.9	24.91
Siberian elm	2.3	172	304.8	299	471	(N/A)	5.3	11.6	78.52
Swamp white oak	0.8	58	113.8	111	169	(N/A)	5.3	4.1	28.19
Broadleaf Deciduous Mediu	0.1	9	19.2	19	28	(N/A)	3.5	0.7	6.94
Northern pin oak	1.2	89	174.0	170	259	(N/A)	3.5	6.4	64.76
Sugar maple	0.3	21	38.8	38	59	(N/A)	3.5	1.4	14.66
American basswood	0.0	1	2.0	2	3	(N/A)	3.5	0.1	0.69
Norway maple	1.0	76	138.1	135	211	(N/A)	3.5	5.2	52.73
Red maple	0.6	47	76.6	75	122	(N/A)	2.6	3.0	40.82
Eastern red cedar	0.3	25	49.3	48	74	(N/A)	2.6	1.8	24.57
Eastern redbud	0.3	21	41.3	40	62	(N/A)	2.6	1.5	20.58
Ginkgo	0.2	18	29.2	29	47	(N/A)	2.6	1.1	15.58
Kentucky coffeetree	0.0	0	0.9	1	1	(N/A)	1.8	0.0	0.66
Catalpa	0.9	66	118.0	116	182	(N/A)	1.8	4.5	91.02
Honeylocust	0.7	56	94.8	93	149	(N/A)	1.8	3.6	74.28
Pin oak	0.7	50	90.2	88	139	(N/A)	1.8	3.4	69.31
Bur oak	0.1	9	17.4	17	26	(N/A)	1.8	0.6	13.23
Tulip tree	0.0	0	0.9	1	1	(N/A)	1.8	0.0	0.66
American sycamore	0.3	25	46.9	46	71	(N/A)	0.9	1.7	70.91
Juniper	0.0	4	7.9	8	11	(N/A)	0.9	0.3	11.47
Northern hackberry	0.3	20	33.4	33	53	(N/A)	0.9	1.3	53.09
Broadleaf Deciduous Small	0.0	2	3.8	4	5	(N/A)	0.9	0.1	5.40
Sweetgum	0.1	7	13.7	13	21	(N/A)	0.9	0.5	20.64
American elm	0.3	22	41.8	41	63	(N/A)	0.9	1.5	62.70
Blue spruce	0.1	10	15.2	15	25	(N/A)	0.9	0.6	24.51
Ash	0.1	8	16.9	17	24	(N/A)	0.9	0.6	24.47
Southern magnolia	0.1	6	12.7	12	19	(N/A)	0.9	0.5	18.82
Eastern white pine	0.1	11	19.7	19	30	(N/A)	0.9	0.7	30.47
Black walnut	0.2	18	27.0	26	44	(N/A)	0.9	1.1	44.23
Total	19.5	1,478	2,653.3	2,600	4,079	(N/A)	100.0	100.0	35.78

Table 2: Annual Stormwater Benefits

Moravia

Annual Stormwater Benefits of Public Trees

3/25/2021

Species	Total rainfall interception (Gal)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Silver maple	98,013	2,656	(N/A)	19.3	44.5	120.73
Spruce	2,318	63	(N/A)	14.9	1.1	3.70
Northern red oak	5,714	155	(N/A)	7.0	2.6	19.35
Siberian elm	26,831	727	(N/A)	5.3	12.2	121.19
Swamp white oak	4,339	118	(N/A)	5.3	2.0	19.60
Broadleaf Deciduous Medium	623	17	(N/A)	3.5	0.3	4.22
Northern pin oak	12,487	338	(N/A)	3.5	5.7	84.60
Sugar maple	2,499	68	(N/A)	3.5	1.1	16.93
American basswood	32	1	(N/A)	3.5	0.0	0.22
Norway maple	7,777	211	(N/A)	3.5	3.5	52.69
Red maple	3,833	104	(N/A)	2.6	1.7	34.63
Eastern red cedar	4,904	133	(N/A)	2.6	2.2	44.30
Eastern redbud	1,000	27	(N/A)	2.6	0.5	9.03
Ginkgo	1,026	28	(N/A)	2.6	0.5	9.27
Kentucky coffeetree	36	1	(N/A)	1.8	0.0	0.48
Catalpa	14,478	392	(N/A)	1.8	6.6	196.17
Honeylocust	9,370	254	(N/A)	1.8	4.3	126.96
Pin oak	7,340	199	(N/A)	1.8	3.3	99.45
Bur oak	779	21	(N/A)	1.8	0.4	10.56
Tulip tree	36	1	(N/A)	1.8	0.0	0.48
American sycamore	3,943	107	(N/A)	0.9	1.8	106.85
Juniper	659	18	(N/A)	0.9	0.3	17.86
Northern hackberry	1,427	39	(N/A)	0.9	0.6	38.66
Broadleaf Deciduous Small	69	2	(N/A)	0.9	0.0	1.86
Sweetgum	608	16	(N/A)	0.9	0.3	16.47
American elm	2,779	75	(N/A)	0.9	1.3	75.32
Blue spruce	1,544	42	(N/A)	0.9	0.7	41.85
Ash	586	16	(N/A)	0.9	0.3	15.88
Southern magnolia	677	18	(N/A)	0.9	0.3	18.34
Eastern white pine	2,969	80	(N/A)	0.9	1.3	80.46
Black walnut	1,466	40	(N/A)	0.9	0.7	39.72
Citywide total	220,159	5,966	(N/A)	100.0	100.0	52.34

Table 3: Annual Air Quality Benefits

Moravia

Annual Air Quality Benefits of Public Trees

3/25/2021

Species	Deposition (lb) O$_3$	NO$_2$	PM$_{10}$	SO$_2$	Total Depos. ($)	Avoided (lb) NO$_2$	PM$_{10}$	VOC	SO$_2$	Total Avoided ($)	BVOC Emissions (lb)	BVOC Emissions ($)	Total (lb)	Total ($) Standard Error	% of Total Trees	Avg. $/tree
Silver maple	17.0	2.9	8.4	0.8	92	33.6	4.9	4.7	32.1	210	-9.2	-35	95.2	267 (N/A)	19.3	12.15
Spruce	0.2	0.0	0.2	0.0	1	0.9	0.1	0.1	0.8	6	-0.8	-3	1.5	4 (N/A)	14.9	0.21
Northern red oak	0.9	0.2	0.5	0.0	5	4.6	0.7	0.6	4.4	29	-1.2	-5	10.7	29 (N/A)	7.0	3.64
Siberian elm	5.0	0.9	2.4	0.2	27	10.8	1.6	1.5	10.3	67	0.0	0	32.6	94 (N/A)	5.3	15.67
Swamp white oak	0.5	0.1	0.3	0.0	3	3.7	0.5	0.5	3.4	23	-0.2	-1	9.0	25 (N/A)	5.3	4.21
Broadleaf Deciduous Medium	0.1	0.0	0.0	0.0	0	0.6	0.1	0.1	0.5	4	0.0	0	1.4	4 (N/A)	3.5	0.97
Northern pin oak	2.7	0.5	1.3	0.1	15	5.7	0.8	0.8	5.3	35	-0.6	-2	16.6	47 (N/A)	3.5	11.87
Sugar maple	0.3	0.0	0.2	0.0	2	1.3	0.2	0.2	1.2	8	-0.2	-1	3.2	9 (N/A)	3.5	2.21
American basswood	0.0	0.0	0.0	0.0	0	0.1	0.0	0.0	0.0	0	0.0	0	0.1	0 (N/A)	3.5	0.08
Norway maple	1.4	0.2	0.7	0.1	8	4.8	0.7	0.7	4.5	30	-0.3	-1	12.8	36 (N/A)	3.5	9.04
Red maple	0.7	0.1	0.4	0.0	4	2.9	0.4	0.4	2.8	18	-0.3	-1	7.5	21 (N/A)	2.6	7.05
Eastern red cedar	1.0	0.2	0.8	0.1	7	1.6	0.2	0.2	1.5	10	-2.7	-10	3.1	7 (N/A)	2.6	2.19
Eastern redbud	0.3	0.0	0.1	0.0	1	1.4	0.2	0.2	1.3	8	0.0	0	3.5	10 (N/A)	2.6	3.27
Ginkgo	0.2	0.0	0.1	0.0	1	1.1	0.2	0.2	1.1	7	-0.1	0	2.7	8 (N/A)	2.6	2.55
Kentucky coffeetree	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0	0.1	0 (N/A)	1.8	0.08
Catalpa	2.3	0.4	1.0	0.1	12	4.2	0.6	0.6	4.0	26	0.0	0	13.1	38 (N/A)	1.8	19.04
Honeylocust	1.9	0.3	0.8	0.1	10	3.4	0.5	0.5	3.3	22	-1.5	-6	9.3	26 (N/A)	1.8	12.87
Pin oak	1.3	0.2	0.7	0.1	7	3.2	0.5	0.4	3.0	20	-2.4	-9	6.9	18 (N/A)	1.8	8.87
Bur oak	0.0	0.0	0.0	0.0	0	0.6	0.1	0.1	0.6	4	0.0	0	1.4	4 (N/A)	1.8	1.93
Tulip tree	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0	0.1	0 (N/A)	1.8	0.08
American sycamore	0.5	0.1	0.2	0.0	3	1.6	0.2	0.2	1.5	10	0.0	0	4.4	12 (N/A)	0.9	12.48
Juniper	0.1	0.0	0.1	0.0	0	0.2	0.0	0.0	0.2	1	-0.3	-1	0.3	1 (N/A)	0.9	0.62
Northern hackberry	0.1	0.0	0.1	0.0	1	1.3	0.2	0.2	1.2	8	0.0	0	3.1	9 (N/A)	0.9	8.66
Broadleaf Deciduous Small	0.0	0.0	0.0	0.0	0	0.1	0.0	0.0	0.1	1	0.0	0	0.3	1 (N/A)	0.9	0.71
Sweetgum	0.0	0.0	0.0	0.0	0	0.5	0.1	0.1	0.4	3	0.0	0	1.1	3 (N/A)	0.9	2.99
American elm	0.2	0.0	0.1	0.0	1	1.4	0.2	0.2	1.3	9	0.0	0	3.5	10 (N/A)	0.9	9.99
Blue spruce	0.2	0.0	0.2	0.0	1	0.6	0.1	0.1	0.6	4	-0.6	-2	1.2	3 (N/A)	0.9	2.89
Ash	0.1	0.0	0.0	0.0	0	0.5	0.1	0.1	0.5	3	0.0	0	1.2	3 (N/A)	0.9	3.47
Southern magnolia	0.0	0.0	0.0	0.0	0	0.4	0.1	0.1	0.4	3	-0.2	-1	0.8	2 (N/A)	0.9	2.10
Eastern white pine	0.3	0.1	0.3	0.0	2	0.7	0.1	0.1	0.7	4	-1.4	-5	0.9	1 (N/A)	0.9	1.45
Black walnut	0.1	0.0	0.1	0.0	1	1.1	0.2	0.2	1.1	7	0.0	0	2.6	7 (N/A)	0.9	7.42
Citywide total	37.4	6.4	19.0	1.8	204	92.8	13.5	12.9	88.2	578	-22.1	-83	250.0	700 (N/A)	100.0	6.14

Table 4: Annual Carbon Stored

Moravia

Stored CO2 Benefits of Public Trees

3/25/2021

Species	Total Stored CO2 (lbs)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Silver maple	403,628	3,027	(N/A)	19.3	49.3	137.60
Spruce	1,210	9	(N/A)	14.9	0.1	0.53
Northern red oak	14,896	112	(N/A)	7.0	1.8	13.97
Siberian elm	121,578	912	(N/A)	5.3	14.9	151.97
Swamp white oak	9,128	68	(N/A)	5.3	1.1	11.41
Broadleaf Deciduous	1,151	9	(N/A)	3.5	0.1	2.16
Northern pin oak	44,451	333	(N/A)	3.5	5.4	83.35
Sugar maple	7,996	60	(N/A)	3.5	1.0	14.99
American basswood	50	0	(N/A)	3.5	0.0	0.09
Norway maple	23,139	174	(N/A)	3.5	2.8	43.39
Red maple	8,349	63	(N/A)	2.6	1.0	20.87
Eastern red cedar	3,306	25	(N/A)	2.6	0.4	8.27
Eastern redbud	4,123	31	(N/A)	2.6	0.5	10.31
Ginkgo	2,265	17	(N/A)	2.6	0.3	5.66
Kentucky coffeetree	24	0	(N/A)	1.8	0.0	0.09
Catalpa	78,517	589	(N/A)	1.8	9.6	294.44
Honeylocust	24,490	184	(N/A)	1.8	3.0	91.84
Pin oak	33,170	249	(N/A)	1.8	4.1	124.39
Bur oak	1,220	9	(N/A)	1.8	0.1	4.57
Tulip tree	24	0	(N/A)	1.8	0.0	0.09
American sycamore	15,773	118	(N/A)	0.9	1.9	118.30
Juniper	277	2	(N/A)	0.9	0.0	2.08
Northern hackberry	1,679	13	(N/A)	0.9	0.2	12.60
Broadleaf Deciduous	178	1	(N/A)	0.9	0.0	1.33
Sweetgum	1,035	8	(N/A)	0.9	0.1	7.76
American elm	6,743	51	(N/A)	0.9	0.8	50.57
Blue spruce	1,118	8	(N/A)	0.9	0.1	8.39
Ash	1,101	8	(N/A)	0.9	0.1	8.26
Southern magnolia	484	4	(N/A)	0.9	0.1	3.63
Eastern white pine	3,343	25	(N/A)	0.9	0.4	25.07
Black walnut	3,672	28	(N/A)	0.9	0.4	27.54
Citywide total	818,116	6,136	(N/A)	100.0	100.0	53.82

Table 5: Annual Carbon Sequestered

Moravia

Annual CO₂ Benefits of Public Trees

3/25/2021

Species	Sequestered (lb)	Sequestered ($)	Decomposition Release (lb)	Maintenance Release (lb)	Total Released ($)	Avoided (lb)	Avoided ($)	Net Total (lb)	Total Standard ($) Error	% of Total Trees	% of Total $	Avg. $/tree
Silver maple	29,971	225	-1,937	-79	-15	11,900	89	39,855	299 (N/A)	19.3	48.1	13.59
Spruce	172	1	-6	-5	0	314	2	475	4 (N/A)	14.9	0.6	0.21
Northern red oak	1,438	11	-72	-11	-1	1,635	12	2,991	22 (N/A)	7.0	3.6	2.80
Siberian elm	4,455	33	-584	-25	-5	3,810	29	7,656	57 (N/A)	5.3	9.2	9.57
Swamp white oak	1,506	11	-44	-8	0	1,274	10	2,728	20 (N/A)	5.3	3.3	3.41
Broadleaf Deciduous Medi	240	2	-6	-2	0	197	1	430	3 (N/A)	3.5	0.5	0.81
Northern pin oak	1,680	13	-213	-12	-2	1,957	15	3,411	26 (N/A)	3.5	4.1	6.40
Sugar maple	579	4	-39	-3	0	456	3	992	7 (N/A)	3.5	1.2	1.86
American basswood	14	0	0	-1	0	17	0	30	0 (N/A)	3.5	0.0	0.06
Norway maple	1,712	13	-111	-9	-1	1,670	13	3,261	24 (N/A)	3.5	3.9	6.12
Red maple	1,132	8	-40	-5	0	1,047	8	2,134	16 (N/A)	2.6	2.6	5.33
Eastern red cedar	0	0	-16	-6	0	561	4	539	4 (N/A)	2.6	0.7	1.35
Eastern redbud	419	3	-20	-4	0	470	4	866	6 (N/A)	2.6	1.0	2.16
Ginkgo	194	1	-11	-3	0	400	3	580	4 (N/A)	2.6	0.7	1.45
Kentucky coffeetree	5	0	0	0	0	9	0	13	0 (N/A)	1.8	0.0	0.05
Catalpa	1,824	14	-377	-10	-3	1,469	11	2,906	22 (N/A)	1.8	3.5	10.90
Honeylocust	2,972	22	-118	-5	-1	1,230	9	4,078	31 (N/A)	1.8	4.9	15.29
Pin oak	3,076	23	-159	-7	-1	1,110	8	4,019	30 (N/A)	1.8	4.8	15.07
Bur oak	283	2	-6	-2	0	207	2	483	4 (N/A)	1.8	0.6	1.81
Tulip tree	5	0	0	0	0	9	0	13	0 (N/A)	1.8	0.0	0.05
American sycamore	857	6	-76	-4	-1	552	4	1,330	10 (N/A)	0.9	1.6	9.97
Juniper	40	0	-1	-1	0	82	1	119	1 (N/A)	0.9	0.1	0.89
Northern hackberry	200	1	-8	-2	0	450	3	640	5 (N/A)	0.9	0.8	4.80
Broadleaf Deciduous Smal	38	0	-1	-1	0	37	0	74	1 (N/A)	0.9	0.1	0.55
Sweetgum	209	2	-5	-1	0	159	1	361	3 (N/A)	0.9	0.4	2.71
American elm	342	3	-32	-3	0	481	4	788	6 (N/A)	0.9	1.0	5.91
Blue spruce	91	1	-5	-2	0	213	2	296	2 (N/A)	0.9	0.4	2.22
Ash	224	2	-5	-1	0	176	1	393	3 (N/A)	0.9	0.5	2.95
Southern magnolia	56	0	-2	-1	0	141	1	194	1 (N/A)	0.9	0.2	1.45
Eastern white pine	187	1	-16	-3	0	246	2	415	3 (N/A)	0.9	0.5	3.11
Black walnut	445	3	-18	-2	0	393	3	819	6 (N/A)	0.9	1.0	6.14
Citywide total	54,365	408	-3,928	-218	-31	32,672	245	82,891	622 (N/A)	100.0	100.0	5.45

Table 6: Annual Social and Aesthetic Benefits

Moravia

Annual Aesthetic/Other Benefits of Public Trees

3/25/2021

Species	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Silver maple	2,301	(N/A)	19.3	44.1	104.60
Spruce	124	(N/A)	14.9	2.4	7.32
Northern red oak	139	(N/A)	7.0	2.7	17.34
Siberian elm	290	(N/A)	5.3	5.6	48.36
Swamp white oak	170	(N/A)	5.3	3.3	28.38
Broadleaf Deciduous Medium	34	(N/A)	3.5	0.7	8.61
Northern pin oak	149	(N/A)	3.5	2.9	37.26
Sugar maple	60	(N/A)	3.5	1.2	15.01
American basswood	7	(N/A)	3.5	0.1	1.78
Norway maple	164	(N/A)	3.5	3.2	41.11
Red maple	162	(N/A)	2.6	3.1	53.87
Eastern red cedar	0	(N/A)	2.6	0.0	0.00
Eastern redbud	24	(N/A)	2.6	0.5	7.98
Ginkgo	19	(N/A)	2.6	0.4	6.41
Kentucky coffeetree	11	(N/A)	1.8	0.2	5.26
Catalpa	117	(N/A)	1.8	2.2	58.34
Honeylocust	778	(N/A)	1.8	14.9	388.90
Pin oak	240	(N/A)	1.8	4.6	120.06
Bur oak	43	(N/A)	1.8	0.8	21.64
Tulip tree	11	(N/A)	1.8	0.2	5.26
American sycamore	66	(N/A)	0.9	1.3	65.59
Juniper	21	(N/A)	0.9	0.4	21.34
Northern hackberry	40	(N/A)	0.9	0.8	39.57
Broadleaf Deciduous Small	2	(N/A)	0.9	0.0	2.06
Sweetgum	29	(N/A)	0.9	0.5	28.56
American elm	51	(N/A)	0.9	1.0	51.00
Blue spruce	25	(N/A)	0.9	0.5	25.23
Ash	26	(N/A)	0.9	0.5	26.22
Southern magnolia	22	(N/A)	0.9	0.4	21.93
Eastern white pine	47	(N/A)	0.9	0.9	47.08
Black walnut	46	(N/A)	0.9	0.9	45.86
Citywide total	5,218	(N/A)	100.0	100.0	45.77

Table 7: Summary of Benefits in Dollars

Moravia

Total Annual Benefits of Public Trees by Species ($)

3/25/2021

| Species	Energy	CO$_2$	Air Quality	Stormwater	Aesthetic/Other	Total ($)	Standard Error	% of Total $
Silver maple	1,471	299	267	2,656	2,301	6,995	(N/A)	42.2
Spruce	39	4	4	63	124	233	(N/A)	1.4
Northern red oak	199	22	29	155	139	544	(N/A)	3.3
Siberian elm	471	57	94	727	290	1,640	(N/A)	9.9
Swamp white oak	169	20	25	118	170	503	(N/A)	3.0
Broadleaf Deciduous M	28	3	4	17	34	86	(N/A)	0.5
Northern pin oak	259	26	47	338	149	820	(N/A)	4.9
Sugar maple	59	7	9	68	60	203	(N/A)	1.2
American basswood	3	0	0	1	7	11	(N/A)	0.1
Norway maple	211	24	36	211	164	647	(N/A)	3.9
Red maple	122	16	21	104	162	425	(N/A)	2.6
Eastern red cedar	74	4	7	133	0	217	(N/A)	1.3
Eastern redbud	62	6	10	27	24	129	(N/A)	0.8
Ginkgo	47	4	8	28	19	106	(N/A)	0.6
Kentucky coffeetree	1	0	0	1	11	13	(N/A)	0.1
Catalpa	182	22	38	392	117	751	(N/A)	4.5
Honeylocust	149	31	26	254	778	1,237	(N/A)	7.5
Pin oak	139	30	18	199	240	626	(N/A)	3.8
Bur oak	26	4	4	21	43	98	(N/A)	0.6
Tulip tree	1	0	0	1	11	13	(N/A)	0.1
American sycamore	71	10	12	107	66	266	(N/A)	1.6
Juniper	11	1	1	18	21	52	(N/A)	0.3
Northern hackberry	53	5	9	39	40	145	(N/A)	0.9
Broadleaf Deciduous Sn	5	1	1	2	2	11	(N/A)	0.1
Sweetgum	21	3	3	16	29	71	(N/A)	0.4
American elm	63	6	10	75	51	205	(N/A)	1.2
Blue spruce	25	2	3	42	25	97	(N/A)	0.6
Ash	24	3	3	16	26	73	(N/A)	0.4
Southern magnolia	19	1	2	18	22	63	(N/A)	0.4
Eastern white pine	30	3	1	80	47	163	(N/A)	1.0
Black walnut	44	6	7	40	46	143	(N/A)	0.9
Citywide Total	4,079	622	700	5,966	5,218	16,584	(N/A)	100.0
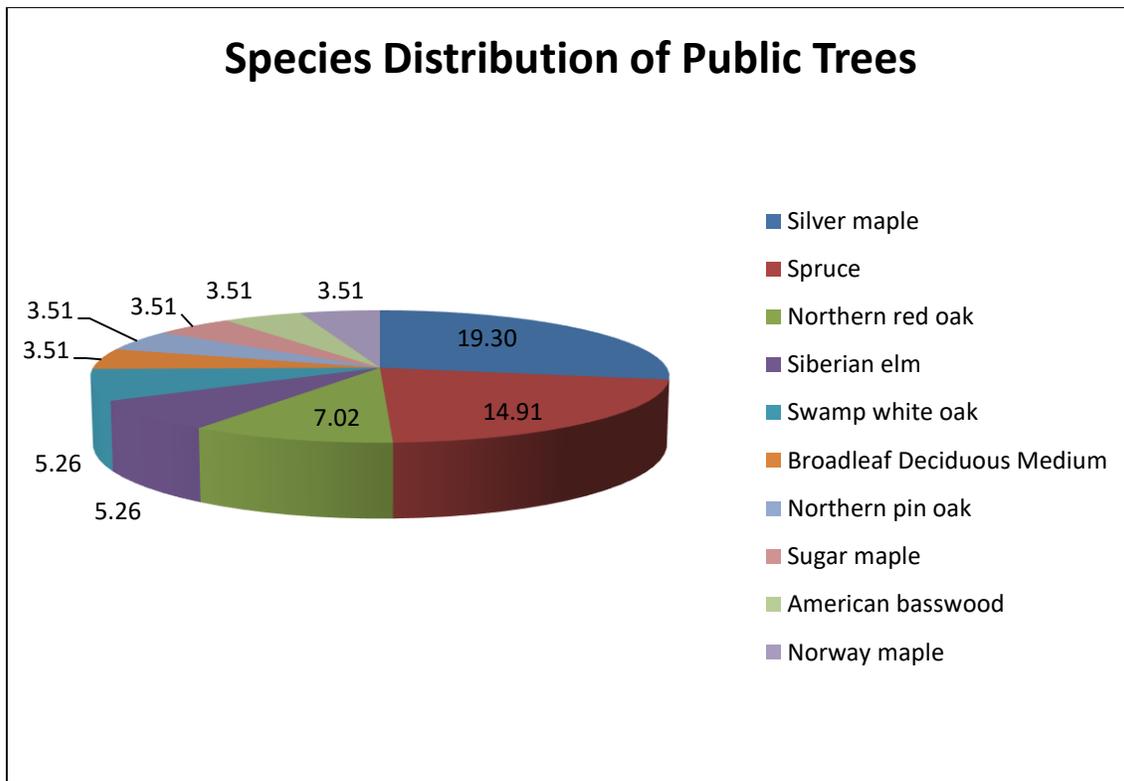
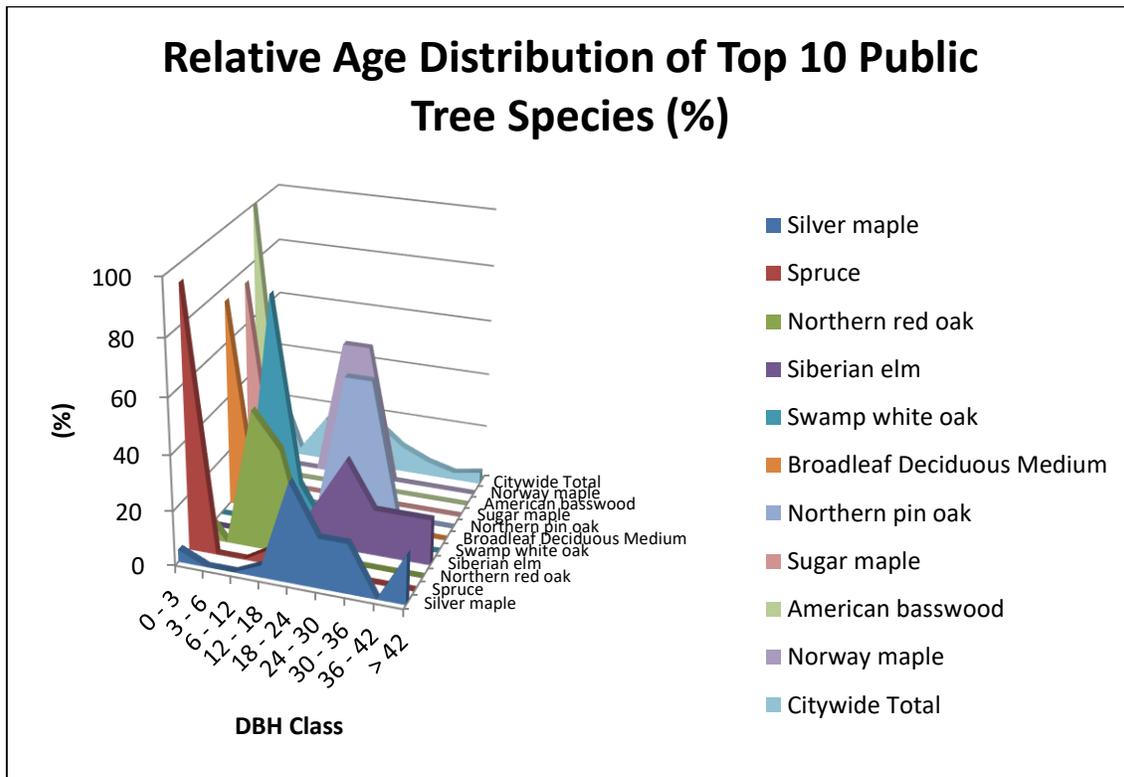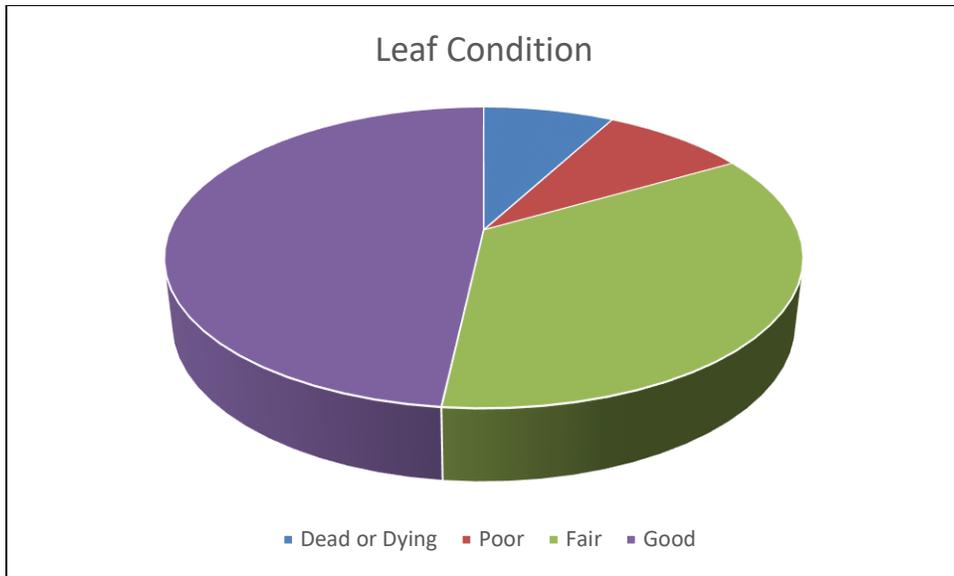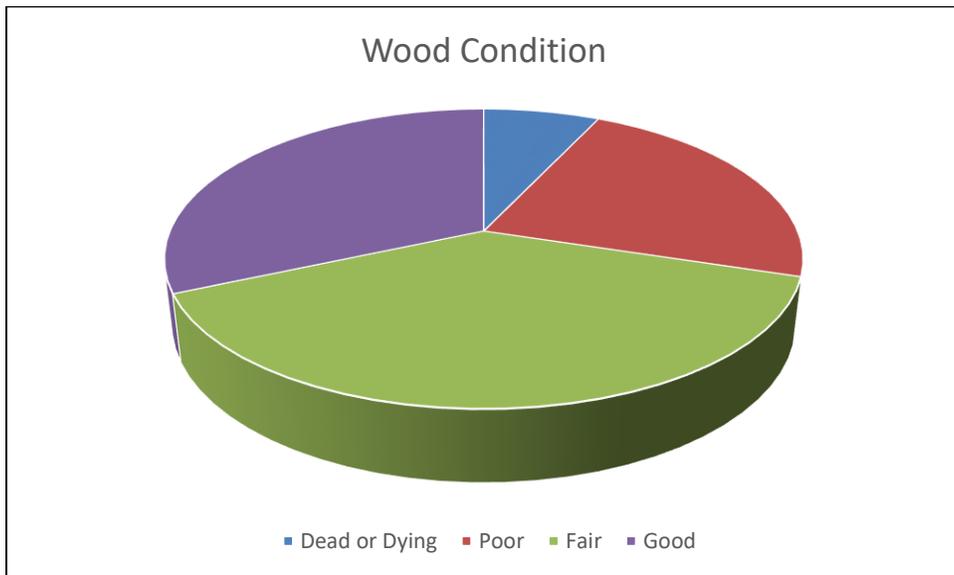**Figure 1: Species Distribution**

Figure 2: Relative Age Class

Figure 3: Foliage Condition

Figure 4: Wood Condition

Canopy Cover of Public Trees (Acres)

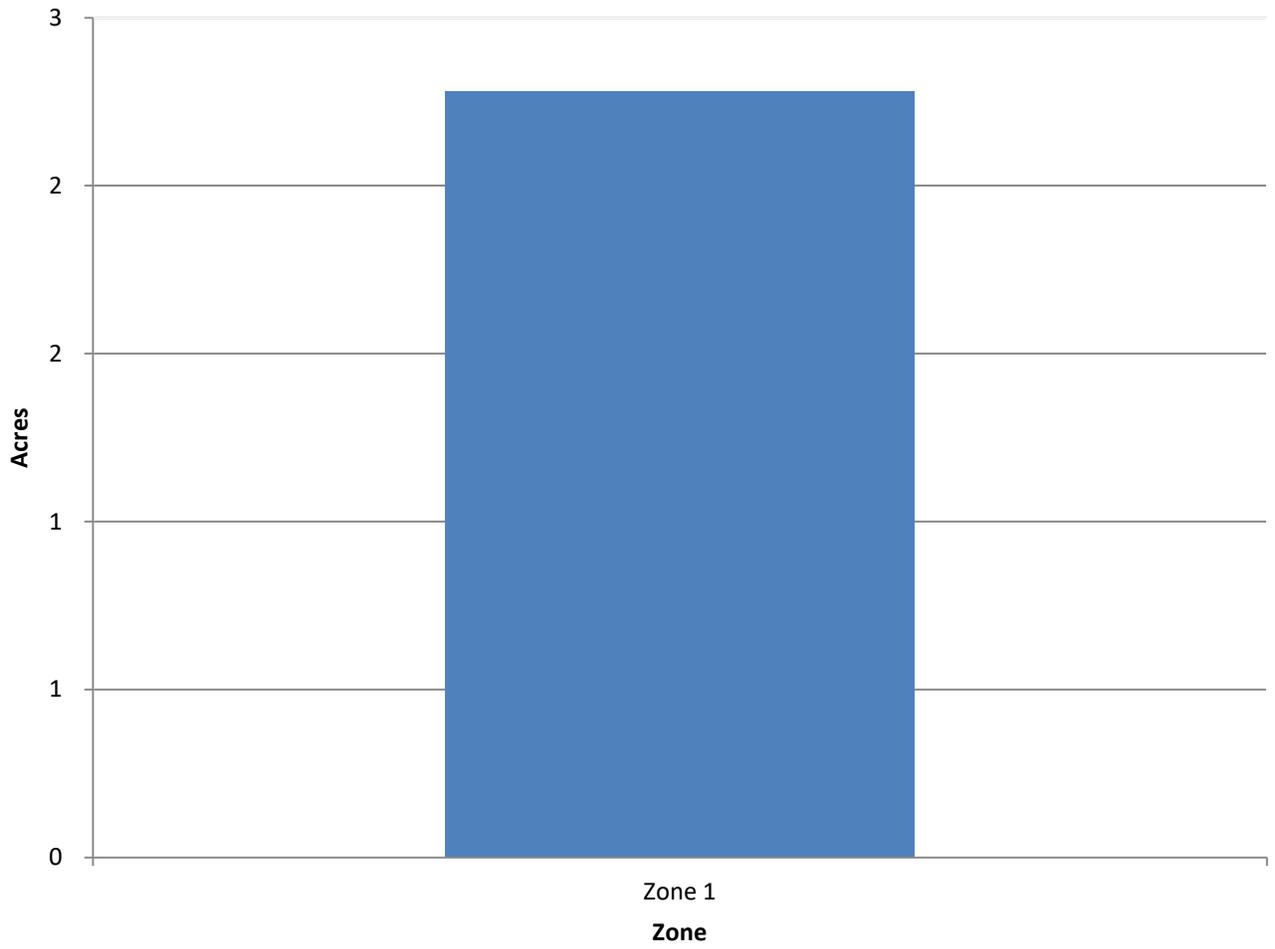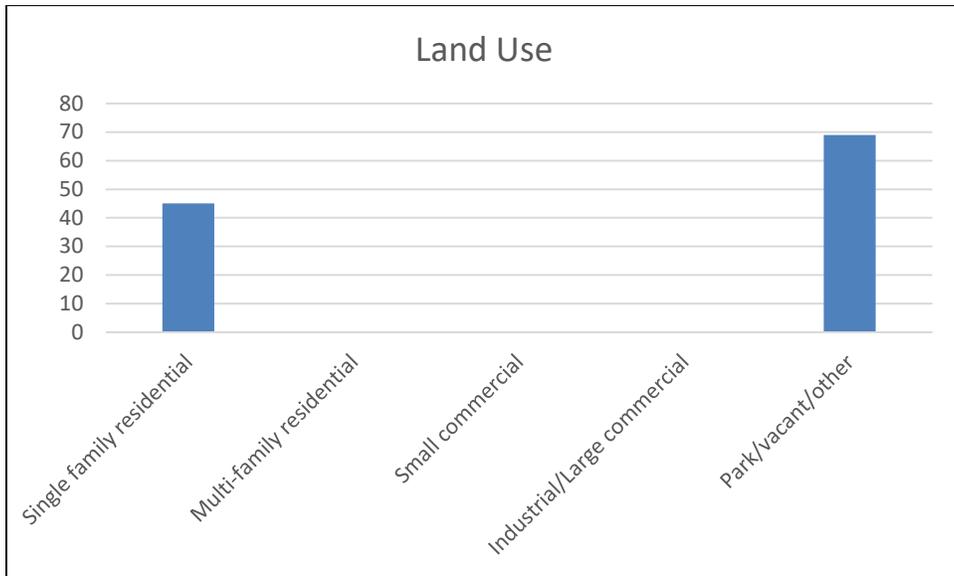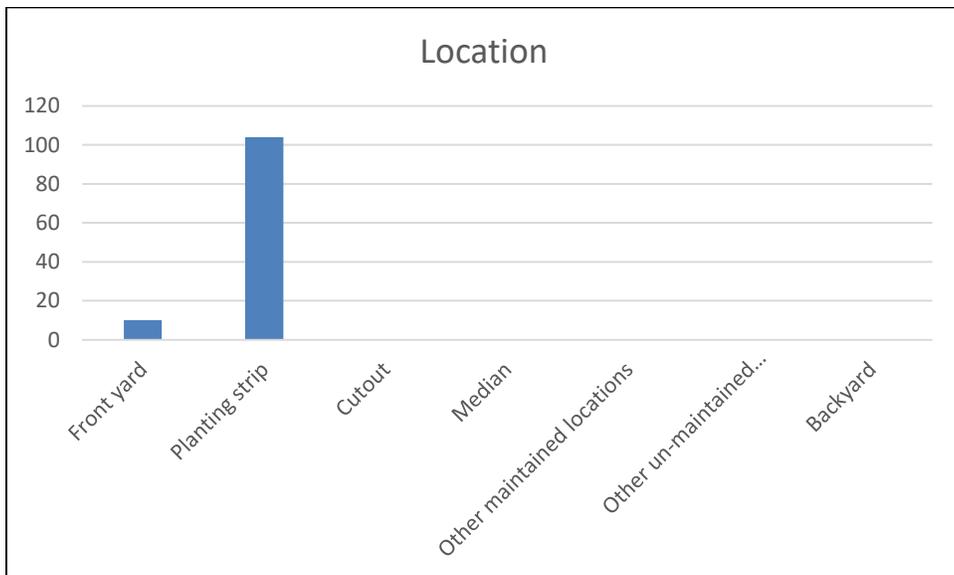**Figure 5: Canopy Cover in Acres**

Figure 6: Land Use of city/park trees
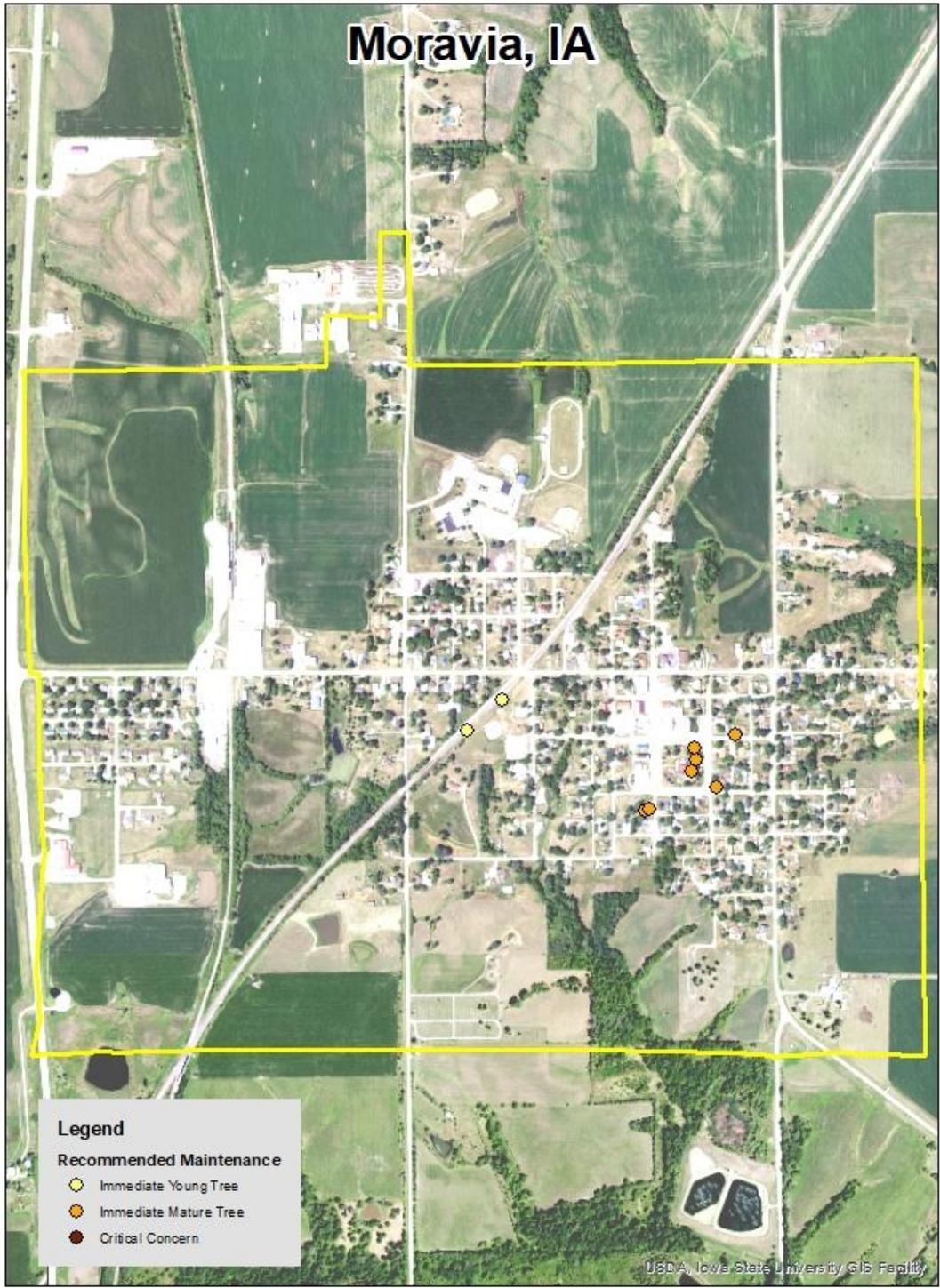

Figure 7: Location of city/park trees
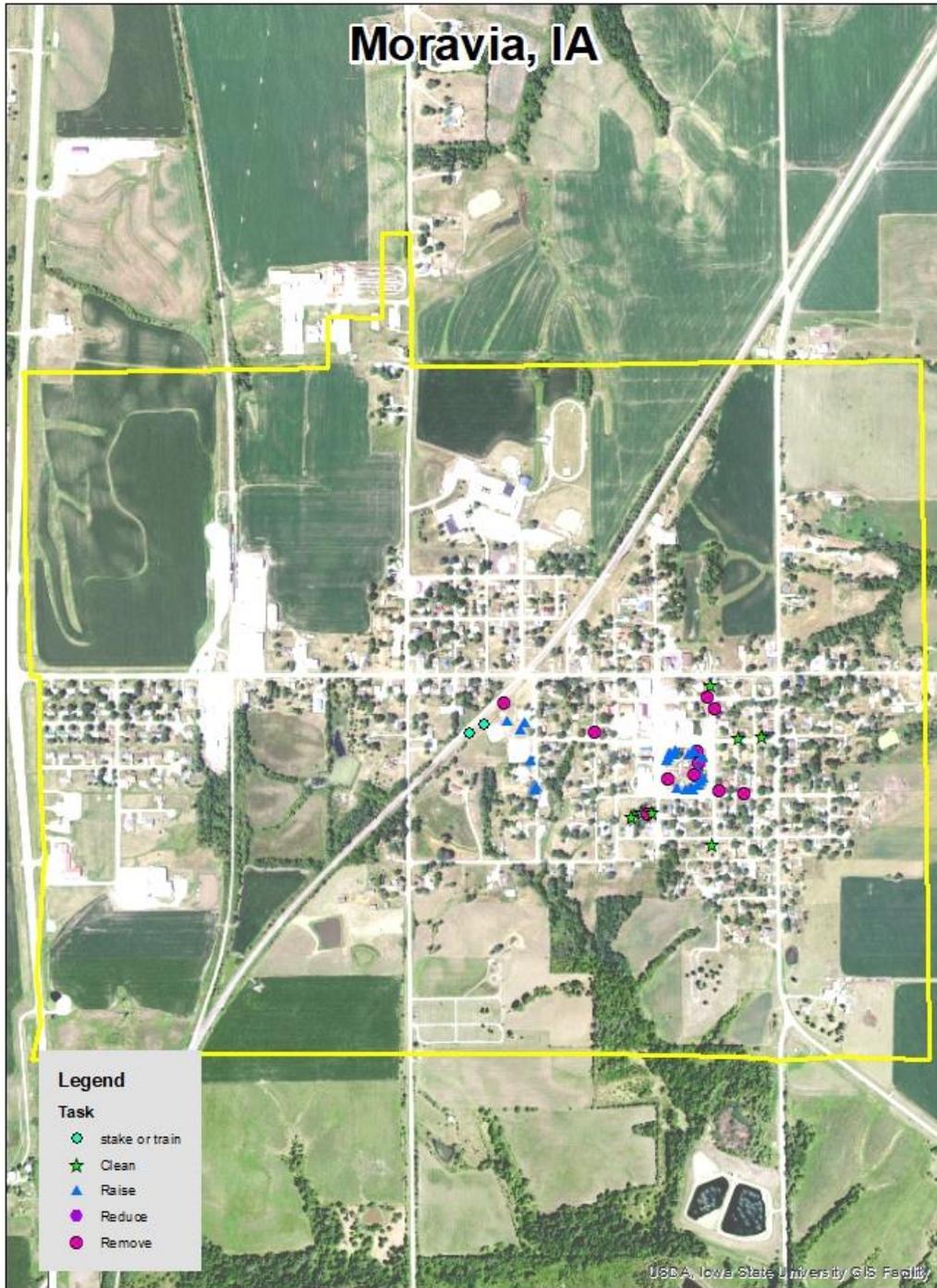
Figure 1: Location of Ash Trees

None
Figure 2: Location of EAB symptoms

Figure 3: Location of Poor Condition Trees

Figure 4: Location of Trees with Recommended Maintenance

Figure 5: Maintenance Tasks

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