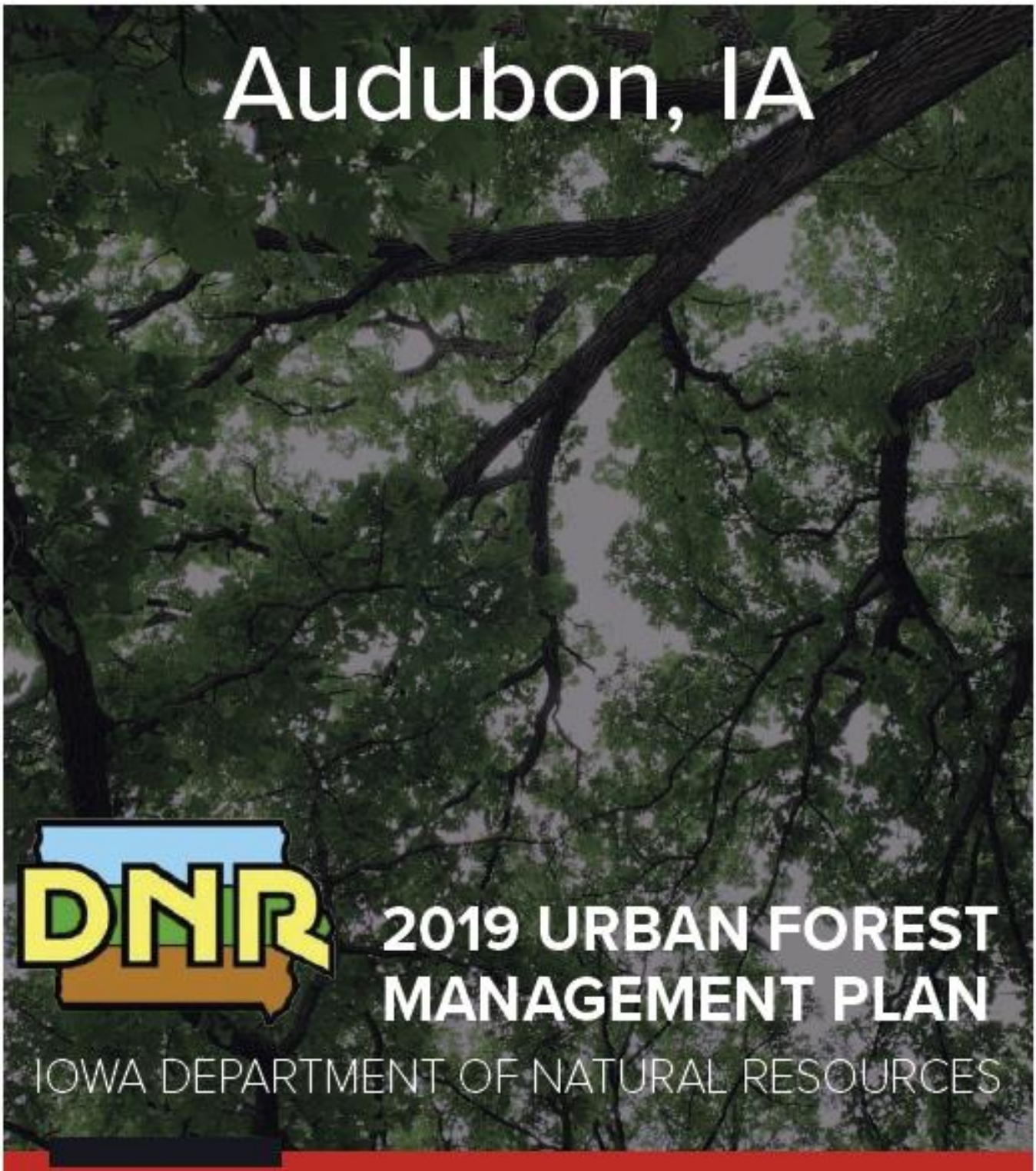

Audubon, IA

2019 URBAN FOREST MANAGEMENT PLAN

IOWA DEPARTMENT OF NATURAL RESOURCES

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Table of Contents

Executive Summary

Overview

This plan was developed to assist the City of Audubon in managing its urban forest, including budgeting and future planning. Trees bring numerous benefits to a community, and sound management helps leaders take advantage of these benefits. Management is especially important now considering the serious threats posed by forest pests like 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 except mountain ash. There is a strong possibility that 17% of Audubon's city owned trees (ash) will die once EAB becomes established in the community, unless local leaders begin preventative treatment. 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 2019, JEO conducted a tree inventory 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 1,144 trees inventoried.

- Audubon's trees provide $212,181 of benefits annually, an average of $185 a tree
- There are over 51 species of trees
- The top three genera are: Maple 37%, Ash 15%, and Oak 11%
- 15% of trees are in need of some type of management
- 20 trees are recommended for removal

Recommendations

We detail our core recommendations in the Recommendations Section. In the Emerald Ash Borer Plan, we also included management recommendations. Below are some key recommendations.

- Of the 20 trees needing removal, 3 trees are over 24 inches in diameter at 4.5 ft and must be addressed immediately *City ownership of the trees recommended for removal should be verified prior to any removal*
- Nine of the 168 ash trees should be carefully examined, as they have one or more symptoms that could be related to an EAB infestation
- 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: ash, maple, cottonwood, poplar, box elder, Chinese elm, evergreen, willow or black walnut
- Check ash trees with a visual survey yearly
- With the current tree care provided, it could take 24 years to remove all ash trees alone including both Emerald Ash borer infested and non-infested trees. Time is calculated only considering the removal of ash trees, and does not include replacement, trimming, or other care. We suggest that city officials request a budget increase to at least $12,000 annually and apply for grants to plant replacement trees

Introduction

This plan was developed to assist Audubon with managing, budgeting, and future planning of their urban forest. Across the state, forestry budgets continue to decrease as a higher percentage of the budgets are devoted to tree removal. With the anticipated arrival of Emerald Ash Borer (EAB), an invasive pest that kills native ash trees, it is time to prepare for the increased costs of tree removal, treatment, and replacement planting. With proper planning and management of the current canopy in Audubon, these costs can be spread out over the years and public safety issues from dead and dying ash trees can be mitigated.

Trees are an important part of Audubon's infrastructure and one of the city's greatest assets. The benefits of trees are immense. Trees improve air quality, intercept stormwater runoff, conserve energy, lower traffic speeds, increase property values, reduce crime, improve mental health, and create a desirable place to live, to name just a few. Good urban forestry management will maintain these important benefits for the people of Audubon and future generations.

Urban forestry management sets goals and develops management strategies to achieve them. To develop management strategies, a comprehensive public tree inventory must be conducted. The inventory informs maintenance, removal schedules, tree planting, and budgeting. Aligning management actions with the tree inventory results will help meet Audubon's urban forestry goals.

Inventory

In 2019, JEO conducted a tree inventory that included 100% of the city-owned trees on both streets and parks. The team collected tree data 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 data collectors' programming 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 ft, recommended maintenance, priority of that maintenance, leaf health, and wood condition. Additionally, for all ash trees, the team noted signs and symptoms associated with EAB including canopy dieback, epicormic shoots, bark splitting, D-shaped borer exit holes, and wood pecker damage.

Inventory Results

The data collected for the 1,144 city trees were 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. Audubon's trees reduce energy related costs by approximately $55,240 annually (Appendix A, Table 1). These savings are both in Electricity (260.4 MWh) and in Natural Gas (36,196.7 Therms).

Annual Stormwater Benefits

Audubon's trees intercept about 2,827,465 gallons of rainfall or snow melt a year (Appendix A, Table 2). This interception provides $76,624 in benefits to the city.

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 lessens emissions of volatile organic matter (ozone). In Audubon, it is estimated that trees remove 3,312.9 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 $9,294 (Appendix A, Table 3).

Annual Carbon Benefits

Carbon sequestration and storage reduce the amount of carbon in the atmosphere, mitigating climate change. In Audubon, trees sequester about 687,902 lbs of carbon a year with an associated value of $5,159 (Appendix A, Table 5). In addition, the trees store 10,341,083 lbs of carbon, with a yearly benefit of $77,558 (Appendix A, Table 4).

Annual Aesthetics Benefits

The social benefits of trees are hard to capture. The i-Tree 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. Audubon receives $62,980 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, Audubon's trees provide $212,181 of benefits annually. Benefits of individual trees vary based on size, species, health and location, but on average each of the 1,144 trees in Audubon provide approximately $185 annually (Appendix A, Table 7).

Forest Structure

Species Distribution

Audubon has over 51 different tree species along city streets and parks (Appendix A, Figure 1). The distribution of trees by genera is as follows:

Maple	445	39%
Ash	168	15%
Oak	123	11%
Apple	75	7%
Honeylocust	58	5%
Pear	31	3%
Linden/Basswood	29	<1%
Northern Catalpa	29	<1%
Walnut	28	<1%
Hackberry	28	<1%
Spruce	11	<1%
Plum	10	<1%
Redbud	9	<1%
American Sycamore	9	<1%
Elm	3	<1%
Birch	3	<1%
Buckeye	3	<1%
Ginkgo	2	<1%
Chokecherry	2	<1%
Japanese Tree Lilac	2	<1%
Kentucky Coffeetree	2	<1%
Mulberry	2	<1%
Other Deciduous	27	2%
Other Large Evergreen	15	<1%

Age Class

Most of Audubon's trees (46%) are between eighteen and 30 inches in diameter at 4.5 ft (Appendix A, Figure 2). To prepare for natural mortality and to maintain canopy cover, most trees should be in the smallest size category (a downward slope), indicating youth. Audubon's size curve is on the smaller side, indicating an average stand.

Condition: Wood and Foliage

Both wood condition and leaf condition are good indicators of the urban forest's overall health. The foliage condition results for Audubon indicate that 66% of the trees are in good health, with only 3% of the foliage in poor health, dead or dying (Appendix A, Figure 3 & Appendix B, Figure 3). Similarly, 64% of Audubon's trees are in good health for wood condition (appendix A, Figure 4 & Appendix B, Figure

3). Four percent of the tree population's wood condition is in poor health, dead or dying. This 4% is an estimate of trees that need management follow up.

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).

Crown Cleaning	157	14%
Tree Removal	20	2
Crown Raising	7	<1%
Tree Staking	4	<1%
Crown Reduction	3	<1%

Land Use and Location

The majority of Audubon'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	69%
Industrial/Large commercial	28%
Park/vacant/other	3%
Small commercial	0%
Multifamily residential	0%

Recommendations

Risk Management

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

Hazardous trees

Audubon has 20 trees suggested for immediate removal. These trees in addition to other trees needing maintenance can be seen on the Location of Trees with Recommended Maintenance map (Appendix B, Figure 4). It is recommended to start with the large-diameter critical concern trees first. There are 3 trees over 24 inches in diameter at 4.5 ft that should be addressed immediately. Please refer to the Proposed Work Schedule and Budget at the end of this section. After all these trees are addressed, there should be follow up on the trees marked as needing maintenance. There is a total of 171 trees with these needs, which can be seen on the Location of Trees with Recommended Maintenance (Appendix B, Figure 4).

Poor tree species

After the removal of the critical concern trees, ash trees in poor health should be assessed for removal (Appendix B, Figure 3 & Appendix B, Figure 4). Of the 20 removals, 6 are ash trees. There is a total of 168 ash trees, and 9 of those have signs and symptoms that have been associated with EAB. In addition, there are 9 trees that are in poor health. *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 removes lower branches that are two inches in diameter or larger to provide clearance for pedestrians or vehicles. Crown reduction removes individual limbs from structures or utility wires. We recommend that all trees be pruned on a routine schedule every five to seven years. Please refer to the Proposed Work Schedule and Budget for further information.

Planting

Most of the planting over the next five years will replace the trees that are removed. We recommend planting 1.2 trees for every tree removed, since survival rates will not be 100%. 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 Audubon.

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 (39%) (Appendix A, Figure 1). Maples should not be planted until this percentage can be lowered. Also, ash trees have not been recommended since 2002, due to the threat of EAB. Other species to avoid because they are public nuisances include: cottonwood, poplar, box elder, Chinese elm, evergreen, willow or black walnut, as outlined in section 151.03 of the city ordinance (Appendix C). All trees planted must meet the restrictions in city ordinance 151.03 (Appendix C).

Continual Monitoring

Due to the threat of EAB, it is important to continuously check the health of ash trees. We recommend that ash trees be checked with a visual survey annually 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.

Emerald Ash Borer Plan

Ash Tree Removal

Tree removal will be prioritized by first removing dead, dying, and hazardous trees (Appendix B, Figure 4). Next will be all ash in poor condition that display signs and symptoms of EAB (Appendix B, Figure 2 & Appendix B, Figure 3). *City ownership of the tree recommended for removal should be verified prior to any removal*

Treatment of Ash Trees

Chemical treatment can be an effective tool for communities to spread removal costs out over several years while allowing trees to continue to provide benefits. However, treatment is not recommended if EAB is more than 15 miles away from the community. For more information on the cost of treatment strategies visit http://extension.entm.purdue.edu/treecomputer/

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 ordinance 151.03 (Appendix C). The new plantings will be a diverse mix and will not include ash, maple, 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.

Monitoring
We recommend that ash trees be checked with a visual survey every year for tree death and EAB signs and symptoms including canopy dieback, epicormic shoots, bark splitting, D-shaped borer exit holes, and wood pecker damage.

Private Ash Trees
It is strongly recommended that private property owners start removing ash trees on their property upon arrival of EAB if preventative treatments are not being used. City Code 151.06 states “The Council shall inspect or cause to be inspected any trees or shrubs in the City reported or suspected to be dead, diseased or damaged, and such trees and shrubs shall be subject to the following:

1. City Property. If it is determined that any such condition exists on any public property, including the strip between the curb and the lot line of private property, the Council may cause such condition to be corrected by treatment or removal. The Council may also order the removal of any trees on the streets of the City which interfere with the making of improvements or with travel thereon.

2. Private Property. If it is determined with reasonable certainty that any such condition exists on private property and that danger to other trees or to adjoining property or passing motorists or pedestrians is imminent, the Council shall notify by certified mail the owner, occupant or person in charge of such property to correct such condition by treatment or removal within fourteen (14) days of said notification. If such owner, occupant, or person in charge of said property fails to comply within 14 days of receipt of notice, the Council may cause the condition to be corrected and the cost assessed against the property.”

Proposed Work Schedule and Budget

Budget Allowance of $3,940/Year – (Based off $2/Capita Calculation Due to no City Reporting)

YEAR 1	**ESTIMATED COSTS**
Remove 2 recommended trees plus 2 ash trees in poor condition	$2,800
Plant 7 trees in open locations	$1,050
Visual Survey of EAB Signs/Symptoms	
YEAR 2	
Remove 3 recommended trees plus 2 ash trees in poor condition	$3,500
Plant 3 trees in open locations	$450
Visual Survey of EAB Signs/Symptoms	
YEAR 3	
Remove 2 recommended trees plus 2 ash trees in poor condition	$2,800
Plant 7 trees in open locations	$1,050
Visual Survey of EAB Signs/Symptoms	
YEAR 4	
Remove 3 recommended trees plus 2 ash trees in poor condition	$3,500
Plant 3 trees in open locations	$450
Visual Survey of EAB Signs/Symptoms	
YEAR 5	
Remove 2 recommended trees plus 2 ash trees in poor condition	$2,800
Plant 7 trees in open locations	$1,050
Visual Survey of EAB Signs/Symptoms	
YEAR 6	
Remove 3 recommended trees plus 2 ash trees in poor condition	$3,500
Plant 3 trees in open locations	$450
Visual Survey of EAB Signs/Symptoms	

Estimated costs based on statewide average costs of $700/tree for removal, $150/tree for planting and maintenance, and $15/tree for pruning.

**To remove all ash trees alone within 6 years, the budget would need to be increased to $19,600 a year. If the budget were increased to $12,000 per year, all ash could be removed in 10 years.

Proposed Work Schedule with Increased Budget

Budget Allowance of $12,000/Year – (Budget Increase Suggested to Best Manage City Trees)

YEAR 1	**ESTIMATED COSTS**
Remove 7 trees recommended for immediate removal	$4,900
Remove 6 ash trees in poor condition	$4,200
Plant 19 trees in open locations	$2,850
Visual Survey of EAB Signs/Symptoms	
YEAR 2	
Remove 7 trees recommended for immediate removal	$4,900
Plant 9 trees in open locations	$1,350
Prune 1/3 of city-owned trees	$5,730
Visual Survey of EAB Signs/Symptoms	
YEAR 3	
Remove 15 ash trees in declining health	$10,500
Plant 10 trees in open locations	$1,500
Visual Survey of EAB Signs/Symptoms	
YEAR 4	
Remove 7 ash trees in declining health	$4,900
Plant 9 trees in open locations	$1,350
Prune 1/3 of city-owned trees	$5,730
Visual Survey of EAB Signs/Symptoms	
YEAR 5	
Remove 15 ash trees in declining health	$10,500
Plant 10 trees in open locations	$1,500
Visual Survey of EAB Signs/Symptoms	
YEAR 6	
Remove 5 ash trees in declining health	$3,500
Plant 18 trees in open locations	$2,700
Prune 1/3 of city-owned trees	$5,730
Visual Survey of EAB Signs/Symptoms	

Proposed Budget Increase

EAB could potentially kill all ash trees in Audubon within 4 years of its arrival. To remove all ash trees within 6 years the budget would need to be increased to $19,600 a year. If the budget were increased to $10,000 a year all ash could be removed within 12 years. Additionally, it is recommended that Audubon apply for grants to fund replacement trees. Utility Company grants are usually between $500 and $10,000 for community-based, tree-planting projects that include parks, gateways, cemeteries, nature trails, libraries, nursing homes, and schools.

Another option being considered by many communities is treating a number of selected trees, either to maintain those trees in the landscape or to delay their removal – to spread out the costs and number of trees needing removed all at once. Trunk injection is administered every two years for the life of the tree. If treatment is discontinued, the tree dies. For instance, in this treatment scenario, the average ash diameter is 20 inches and at $15 per inch, about 4 trees could be treated per year (every other year treatment). This would be 8 trees selected for treatment, and Audubon would still need to find $8,000 for removal. Alternatively, if there are 15 treatable trees, it would cost approximately $2,250 a year for treatment and leave $1,800 for removal. These are alternatives to straight removal of ash trees. However, whether or not the treatment option is selected, there will be an increased cost of dealing with ash trees if EAB is found in Audubon. It is suggested to consider increasing the budget to plan for this.

Works Cited

Census Bureau. 2010. http://censtats.census.gov/data/IA/1601964290.pdf (April, 2013)

USDA Forest Service, et al. 2006. i-Tree Software Suite v1.0 User's Manual. Pp. 27-40.

McPherson EG, Simpson JR, Peper PJ, Gardner SL, Vargas KE, Ho J, Maco S, Xiao Q. 2005b. City of Charleston, South Carolina, municipal forest resource analysis. Internal Tech Rep. Davis, CA: U.S. Department of Agriculture, Center for Urban Forest Research. p. 57

Nowak, DJ and JF Dwyer. 2007. Understanding the benefits and costs of urban forest ecosystems. In: Kuser, J. (ed.) Urban and Community Forestry in the Northeast. New York: Springer. Pp. 25-46.

Peper, Paula J; McPherson, E Gregory; Simpson, James R; Vargas, Kelaine E; Xiao, Qingfu 2009. Lower Midwest community tree guide: benefits, costs, and strategic planting. Gen. Tech. Rep. PSW-GTR-219. Albany, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station. p.115

Appendix A: i-Tree Data

Table 1: Annual Energy Benefits

Annual Energy Benefits of Public Trees

3/10/2020

Species	Total Electricity (MWh)	Electricity ($)	Total Natural Gas (Therms)	Natural Gas ($)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Norway maple	44.8	3,401	6,489.1	6,359	9,761	(N/A)	15.1	17.7	56.42
Green ash	45.9	3,483	6,353.3	6,226	9,709	(N/A)	14.3	17.6	59.20
Silver maple	49.2	3,735	6,474.5	6,345	10,080	(N/A)	13.5	18.2	65.03
Pin oak	26.3	1,994	3,583.3	3,512	5,506	(N/A)	7.0	10.0	68.82
Apple	7.4	559	1,108.8	1,087	1,645	(N/A)	6.6	3.0	21.94
Honeylocust	11.5	874	1,564.1	1,533	2,407	(N/A)	5.1	4.4	41.50
Sugar maple	13.1	996	1,780.9	1,745	2,741	(N/A)	4.0	5.0	59.59
Northern catalpa	8.9	674	1,238.3	1,214	1,888	(N/A)	2.5	3.4	65.09
Northern hackberry	9.6	726	1,387.8	1,360	2,086	(N/A)	2.4	3.8	74.51
Black walnut	6.7	511	930.9	912	1,423	(N/A)	2.4	2.6	50.82
Pear	0.5	38	87.1	85	124	(N/A)	2.2	0.2	4.94
Maple	1.5	111	212.2	208	319	(N/A)	2.0	0.6	13.87
Red maple	3.2	240	420.8	412	653	(N/A)	1.9	1.2	29.67
Northern red oak	3.2	245	448.5	440	684	(N/A)	1.8	1.2	32.59
Broadleaf Deciduous Sma	0.5	37	83.4	82	118	(N/A)	1.7	0.2	6.23
Blue spruce	1.5	115	218.7	214	330	(N/A)	1.7	0.6	17.35
Amur maple	1.1	86	175.1	172	257	(N/A)	1.3	0.5	17.15
American basswood	3.7	278	537.1	526	805	(N/A)	1.3	1.5	53.63
Littleleaf linden	3.3	252	485.6	476	728	(N/A)	1.2	1.3	51.98
Spruce	0.8	64	108.1	106	170	(N/A)	1.0	0.3	15.48
Cherry plum	0.6	43	91.8	90	133	(N/A)	0.9	0.2	13.34
American sycamore	3.5	268	477.6	468	736	(N/A)	0.8	1.3	81.82
Bur oak	1.2	93	161.4	158	251	(N/A)	0.8	0.5	27.89
Eastern redbud	0.8	58	123.5	121	179	(N/A)	0.8	0.3	19.90
Black maple	0.8	58	108.2	106	164	(N/A)	0.6	0.3	23.39
Siberian elm	1.7	126	224.3	220	346	(N/A)	0.6	0.6	49.45
Callery pear	0.2	15	31.7	31	46	(N/A)	0.5	0.1	7.67
Northern white cedar	0.5	39	67.6	66	105	(N/A)	0.5	0.2	17.49
Northern pin oak	0.7	50	97.2	95	145	(N/A)	0.4	0.3	29.00
Broadleaf Deciduous Med	0.3	24	51.3	50	75	(N/A)	0.3	0.1	18.63
Conifer Evergreen Large	0.5	36	63.6	62	99	(N/A)	0.3	0.2	24.66
Eastern white pine	0.4	28	52.9	52	80	(N/A)	0.3	0.1	20.03
Mountain ash	0.4	31	60.1	59	90	(N/A)	0.3	0.2	29.89
Ohio buckeye	0.3	23	46.5	46	69	(N/A)	0.3	0.1	22.92
Elm	1.0	79	147.4	144	224	(N/A)	0.3	0.4	74.61
Oak	0.4	32	61.1	60	92	(N/A)	0.3	0.2	30.73
Swamp white oak	0.3	21	36.5	36	57	(N/A)	0.3	0.1	18.95
Norway spruce	0.4	28	49.2	48	76	(N/A)	0.2	0.1	38.17
Mulberry	0.0	3	7.6	7	11	(N/A)	0.2	0.0	5.40
Ginkgo	0.2	15	26.9	26	41	(N/A)	0.2	0.1	20.49
River birch	0.2	16	33.7	33	49	(N/A)	0.2	0.1	24.47
Japanese tree lilac	0.1	7	16.6	16	24	(N/A)	0.2	0.0	11.80
White ash	0.5	39	67.8	66	105	(N/A)	0.2	0.2	52.69
Ash	0.6	49	94.8	93	142	(N/A)	0.2	0.3	70.84
White oak	0.6	47	80.7	79	126	(N/A)	0.2	0.2	63.12
Kentucky coffeetree	0.4	32	60.6	59	92	(N/A)	0.2	0.2	45.77
Common chokecherry	0.1	11	25.7	25	36	(N/A)	0.2	0.1	18.19
Conifer Evergreen Small	0.0	1	2.5	2	4	(N/A)	0.1	0.0	3.62
Eastern cottonwood	0.4	33	59.0	58	91	(N/A)	0.1	0.2	91.02
Black cherry	0.1	6	12.8	13	18	(N/A)	0.1	0.0	18.19
Conifer Evergreen Mediu	0.1	5	10.2	10	15	(N/A)	0.1	0.0	14.80
Boxelder	0.2	17	30.8	30	47	(N/A)	0.1	0.1	46.76
Black spruce	0.0	2	4.9	5	7	(N/A)	0.1	0.0	6.94
Birch	0.0	3	6.2	6	9	(N/A)	0.1	0.0	8.99
Sumac	0.0	2	3.8	4	5	(N/A)	0.1	0.0	5.40
Broadleaf Evergreen Medi	0.1	6	12.7	12	19	(N/A)	0.1	0.0	18.82
Total	260.4	19,768	36,196.7	35,473	55,240	(N/A)	100.0	100.0	48.29

Table 2: Annual Stormwater Benefits

Annual Stormwater Benefits of Public Trees

3/10/2020

Species	Total rainfall interception (Gal)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Norway maple	422,424	11,448	(N/A)	15.1	14.9	66.17
Green ash	489,018	13,252	(N/A)	14.3	17.3	80.81
Silver maple	685,789	18,585	(N/A)	13.5	24.3	119.90
Pin oak	278,879	7,558	(N/A)	7.0	9.9	94.47
Apple	28,592	775	(N/A)	6.6	1.0	10.33
Honeylocust	110,057	2,983	(N/A)	5.1	3.9	51.42
Sugar maple	148,507	4,025	(N/A)	4.0	5.3	87.49
Northern catalpa	121,632	3,296	(N/A)	2.5	4.3	113.66
Northern hackberry	90,195	2,444	(N/A)	2.4	3.2	87.30
Black walnut	67,383	1,826	(N/A)	2.4	2.4	65.22
Pear	1,631	44	(N/A)	2.2	0.1	1.77
Maple	9,941	269	(N/A)	2.0	0.4	11.71
Red maple	23,335	632	(N/A)	1.9	0.8	28.74
Northern red oak	28,532	773	(N/A)	1.8	1.0	36.82
Broadleaf Deciduous Small	1,586	43	(N/A)	1.7	0.1	2.26
Blue spruce	18,298	496	(N/A)	1.7	0.6	26.10
Amur maple	4,901	133	(N/A)	1.3	0.2	8.86
American basswood	44,060	1,194	(N/A)	1.3	1.6	79.60
Littleleaf linden	39,231	1,063	(N/A)	1.2	1.4	75.94
Spruce	9,735	264	(N/A)	1.0	0.3	23.98
Cherry plum	2,007	54	(N/A)	0.9	0.1	5.44
American sycamore	52,383	1,420	(N/A)	0.8	1.9	157.73
Bur oak	11,692	317	(N/A)	0.8	0.4	35.21
Eastern redbud	4,069	110	(N/A)	0.8	0.1	12.25
Black maple	6,657	180	(N/A)	0.6	0.2	25.77
Siberian elm	18,857	511	(N/A)	0.6	0.7	73.00
Callery pear	826	22	(N/A)	0.5	0.0	3.73
Northern white cedar	9,587	260	(N/A)	0.5	0.3	43.30
Northern pin oak	7,565	205	(N/A)	0.4	0.3	41.00
Broadleaf Deciduous Medi	1,770	48	(N/A)	0.3	0.1	11.99
Conifer Evergreen Large	8,073	219	(N/A)	0.3	0.3	54.69
Eastern white pine	6,747	183	(N/A)	0.3	0.2	45.71
Mountain ash	1,909	52	(N/A)	0.3	0.1	17.25
Ohio buckeye	2,654	72	(N/A)	0.3	0.1	23.98
Elm	13,376	363	(N/A)	0.3	0.5	120.83
Oak	4,569	124	(N/A)	0.3	0.2	41.27
Swamp white oak	1,584	43	(N/A)	0.3	0.1	14.31
Norway spruce	9,209	250	(N/A)	0.2	0.3	124.79
Mulberry	137	4	(N/A)	0.2	0.0	1.86
Ginkgo	1,247	34	(N/A)	0.2	0.0	16.89
River birch	1,172	32	(N/A)	0.2	0.0	15.88
Japanese tree lilac	333	9	(N/A)	0.2	0.0	4.51
White ash	5,913	160	(N/A)	0.2	0.2	80.12
Ash	7,529	204	(N/A)	0.2	0.3	102.01
White oak	6,956	189	(N/A)	0.2	0.2	94.25
Kentucky coffeetree	4,551	123	(N/A)	0.2	0.2	61.66
Common chokecherry	529	14	(N/A)	0.2	0.0	7.17
Conifer Evergreen Small	183	5	(N/A)	0.1	0.0	4.97
Eastern cottonwood	7,239	196	(N/A)	0.1	0.3	196.17
Black cherry	264	7	(N/A)	0.1	0.0	7.17
Conifer Evergreen Medium	755	20	(N/A)	0.1	0.0	20.47
Boxelder	2,233	61	(N/A)	0.1	0.1	60.52
Black spruce	256	7	(N/A)	0.1	0.0	6.95
Birch	163	4	(N/A)	0.1	0.0	4.41
Sumac	69	2	(N/A)	0.1	0.0	1.86
Broadleaf Evergreen Mediu	677	18	(N/A)	0.1	0.0	18.34
Citywide total	2,827,465	76,624	(N/A)	100.0	100.0	66.98

Table 3: Annual Air Quality Benefits

Annual Air Quality Benefits of Public Trees

3/10/2020

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
Norway maple	86.4	14.9	42.4	3.8	467	217.5	31.4	29.9	205.3	1,347	-20.2	-76	609.5	1,737	(N/A)	15.1	10.04
Green ash	57.2	9.2	27.9	2.6	306	219.8	31.9	30.5	208.0	1,367	0.0	0	587.0	1,673	(N/A)	14.3	10.20
Silver maple	115.3	19.5	56.9	5.1	622	232.0	34.0	32.4	222.6	1,451	-59.8	-224	658.0	1,850	(N/A)	13.5	11.93
Pin oak	47.0	8.2	24.3	2.1	258	125.2	18.2	17.4	119.0	780	-87.8	-329	273.7	709	(N/A)	7.0	8.86
Apple	7.9	1.3	3.8	0.4	42	36.0	5.2	4.9	33.4	222	0.0	0	92.8	264	(N/A)	6.6	3.53
Honeylocust	20.4	3.4	9.5	0.9	108	54.7	8.0	7.6	52.1	341	-15.5	-58	141.1	391	(N/A)	5.1	6.75
Sugar maple	19.7	3.4	9.8	0.9	106	62.4	9.1	8.7	59.4	389	-15.4	-58	157.9	438	(N/A)	4.0	9.52
Northern catalpa	17.1	2.7	7.8	0.8	90	42.6	6.2	5.9	40.2	265	0.0	0	123.4	355	(N/A)	2.5	12.25
Northern hackberry	13.6	2.3	7.0	0.6	74	46.5	6.7	6.4	43.4	288	0.0	0	126.5	362	(N/A)	2.4	12.92
Black walnut	7.4	1.2	3.7	0.3	40	32.2	4.7	4.5	30.5	200	0.0	0	84.5	241	(N/A)	2.4	8.59
Pear	0.2	0.0	0.1	0.0	1	2.6	0.4	0.3	2.3	16	0.0	0	5.9	17	(N/A)	2.2	0.67
Maple	1.9	0.3	1.0	0.1	10	7.1	1.0	1.0	6.6	44	-0.7	-2	18.3	52	(N/A)	2.0	2.25
Red maple	5.0	0.9	2.4	0.2	27	15.0	2.2	2.1	14.3	94	-1.8	-7	40.4	114	(N/A)	1.9	5.19
Northern red oak	5.7	1.0	2.8	0.3	31	15.4	2.2	2.1	14.6	96	-8.1	-30	36.0	96	(N/A)	1.8	4.59
Broadleaf Deciduous Smal	0.2	0.0	0.1	0.0	1	2.5	0.3	0.3	2.2	15	0.0	0	5.7	16	(N/A)	1.7	0.84
Blue spruce	1.9	0.4	1.8	0.2	13	7.3	1.1	1.0	6.9	45	-6.1	-23	14.5	36	(N/A)	1.7	1.89
Amur maple	1.4	0.2	0.7	0.1	8	5.6	0.8	0.8	5.1	34	0.0	0	14.7	42	(N/A)	1.3	2.79
American basswood	6.2	1.1	3.0	0.3	33	17.8	2.6	2.4	16.6	110	-5.2	-20	44.8	124	(N/A)	1.3	8.28
Littleleaf linden	7.2	1.2	3.5	0.3	39	16.1	2.3	2.2	15.1	100	-3.4	-13	44.6	126	(N/A)	1.2	8.99
Spruce	1.0	0.2	0.9	0.1	7	4.0	0.6	0.6	3.8	25	-3.3	-12	7.8	19	(N/A)	1.0	1.75
Cherry plum	0.4	0.1	0.2	0.0	2	2.8	0.4	0.4	2.6	17	0.0	0	6.9	20	(N/A)	0.9	1.97
American sycamore	7.9	1.3	3.5	0.4	41	16.8	2.5	2.3	16.0	105	0.0	0	50.7	146	(N/A)	0.8	16.27
Bur oak	1.3	0.2	0.7	0.1	7	5.8	0.8	0.8	5.5	36	0.0	0	15.2	43	(N/A)	0.8	4.80
Eastern redbud	1.4	0.2	0.6	0.1	7	3.8	0.5	0.5	3.5	23	0.0	0	10.6	31	(N/A)	0.8	3.39
Black maple	1.6	0.3	0.7	0.1	8	3.7	0.5	0.5	3.4	23	-0.5	-2	10.3	29	(N/A)	0.6	4.17
Siberian elm	3.3	0.6	1.6	0.1	18	7.9	1.2	1.1	7.5	49	0.0	0	23.4	67	(N/A)	0.6	9.61
Callery pear	0.0	0.0	0.0	0.0	0	1.0	0.1	0.1	0.9	6	0.0	0	2.2	6	(N/A)	0.5	1.03
Northern white cedar	1.1	0.2	0.9	0.1	7	2.4	0.4	0.3	2.3	15	-4.9	-18	2.8	4	(N/A)	0.5	0.64
Northern pin oak	1.7	0.3	0.8	0.1	9	3.2	0.5	0.4	3.0	20	-0.4	-1	9.6	28	(N/A)	0.4	5.51
Broadleaf Deciduous Medi	0.2	0.0	0.1	0.0	1	1.6	0.2	0.2	1.4	10	-0.1	0	3.7	11	(N/A)	0.3	2.63
Conifer Evergreen Large	0.9	0.2	0.8	0.1	6	2.3	0.3	0.3	2.2	14	-3.5	-13	3.6	7	(N/A)	0.3	1.80
Eastern white pine	0.7	0.1	0.6	0.1	5	1.8	0.3	0.2	1.7	11	-3.0	-11	2.6	5	(N/A)	0.3	1.23
Mountain ash	0.6	0.1	0.3	0.0	3	2.0	0.3	0.3	1.8	12	0.0	0	5.4	16	(N/A)	0.3	5.20
Ohio buckeye	0.5	0.1	0.3	0.0	3	1.5	0.2	0.2	1.4	9	-0.1	0	4.0	12	(N/A)	0.3	3.84
Elm	1.8	0.3	0.8	0.1	9	5.0	0.7	0.7	4.7	31	0.0	0	14.2	41	(N/A)	0.3	13.55
Oak	0.5	0.1	0.3	0.0	3	2.1	0.3	0.3	1.9	13	0.0	0	5.5	16	(N/A)	0.3	5.18
Swamp white oak	0.2	0.0	0.1	0.0	1	1.3	0.2	0.2	1.3	8	-0.1	0	3.3	9	(N/A)	0.3	5.09
Norway spruce	1.1	0.2	0.9	0.1	7	1.8	0.3	0.2	1.7	11	-5.7	-21	0.6	-3	(N/A)	0.2	-1.58
Mulberry	0.0	0.0	0.0	0.0	0	0.2	0.0	0.0	0.2	1	0.0	0	0.5	1	(N/A)	0.2	0.71
Ginkgo	0.3	0.1	0.1	0.0	2	0.9	0.1	0.1	0.9	6	-0.1	0	2.5	7	(N/A)	0.2	3.49
River birch	0.1	0.0	0.1	0.0	1	1.0	0.1	0.1	1.0	6	0.0	0	2.5	7	(N/A)	0.2	3.47
Japanese tree lilac	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)	0.2	1.63
White ash	0.9	0.2	0.4	0.0	5	2.4	0.4	0.3	2.3	15	0.0	0	7.0	20	(N/A)	0.2	10.05
Ash	1.7	0.3	0.8	0.1	9	3.1	0.5	0.4	2.9	19	-0.4	-1	9.5	27	(N/A)	0.2	13.58
White oak	0.9	0.1	0.4	0.0	5	2.9	0.4	0.4	2.8	18	0.0	0	8.1	23	(N/A)	0.2	11.57
Kentucky coffeetree	0.5	0.1	0.3	0.0	3	2.0	0.3	0.3	1.9	13	0.0	0	5.4	15	(N/A)	0.2	7.73
Common chokecherry	0.1	0.0	0.1	0.0	1	0.8	0.1	0.1	0.7	5	0.0	0	1.8	5	(N/A)	0.2	2.55
Conifer Evergreen Small	0.0	0.0	0.0	0.0	0	0.1	0.0	0.0	0.1	0	-0.1	0	0.1	0	(N/A)	0.1	0.20
Eastern cottonwood	1.2	0.2	0.5	0.1	6	2.1	0.3	0.3	2.0	13	0.0	0	6.6	19	(N/A)	0.1	19.04
Black cherry	0.0	0.0	0.0	0.0	0	0.4	0.1	0.1	0.3	2	0.0	0	0.9	3	(N/A)	0.1	2.55
Conifer Evergreen Medium	0.1	0.0	0.1	0.0	0	0.3	0.0	0.0	0.3	2	-0.2	-1	0.6	2	(N/A)	0.1	1.53
Boxelder	0.3	0.0	0.1	0.0	1	1.0	0.2	0.1	1.0	7	-0.1	0	2.7	8	(N/A)	0.1	7.54
Black spruce	0.0	0.0	0.0	0.0	0	0.1	0.0	0.0	0.1	1	-0.1	0	0.3	1	(N/A)	0.1	0.75
Birch	0.0	0.0	0.0	0.0	0	0.2	0.0	0.0	0.2	1	0.0	0	0.4	1	(N/A)	0.1	1.21
Sumac	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)	0.1	0.71
Broadleaf Evergreen Medi	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)	0.1	2.10
Citywide total	454.4	76.8	225.8	20.8	2,458	1,247.7	181.3	172.8	1,180.0	7,761	-246.8	-925	3,312.9	9,294	(N/A)	100.0	8.12

Table 4: Annual Carbon Stored

Stored CO2 Benefits of Public Trees

3/10/2020

Species	Total Stored CO2 (lbs)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Norway maple	1,419,575	10,647	(N/A)	15.1	13.7	61.54
Green ash	1,843,259	13,824	(N/A)	14.3	17.8	84.30
Silver maple	2,545,409	19,091	(N/A)	13.5	24.6	123.16
Pin oak	1,191,210	8,934	(N/A)	7.0	11.5	111.68
Apple	126,321	947	(N/A)	6.6	1.2	12.63
Honeylocust	262,473	1,969	(N/A)	5.1	2.5	33.94
Sugar maple	561,783	4,213	(N/A)	4.0	5.4	91.60
Northern catalpa	560,939	4,207	(N/A)	2.5	5.4	145.07
Northern hackberry	198,768	1,491	(N/A)	2.4	1.9	53.24
Black walnut	241,275	1,810	(N/A)	2.4	2.3	64.63
Pear	4,831	36	(N/A)	2.2	0.0	1.45
Maple	22,999	172	(N/A)	2.0	0.2	7.50
Red maple	56,548	424	(N/A)	1.9	0.5	19.28
Northern red oak	119,194	894	(N/A)	1.8	1.2	42.57
Broadleaf Deciduou	4,748	36	(N/A)	1.7	0.0	1.87
Blue spruce	9,570	72	(N/A)	1.7	0.1	3.78
Amur maple	23,378	175	(N/A)	1.3	0.2	11.69
American basswood	231,671	1,738	(N/A)	1.3	2.2	115.84
Littleleaf linden	152,210	1,142	(N/A)	1.2	1.5	81.54
Spruce	6,517	49	(N/A)	1.0	0.1	4.44
Cherry plum	7,394	55	(N/A)	0.9	0.1	5.55
American sycamore	264,479	1,984	(N/A)	0.8	2.6	220.40
Bur oak	42,828	321	(N/A)	0.8	0.4	35.69
Eastern redbud	21,861	164	(N/A)	0.8	0.2	18.22
Black maple	17,462	131	(N/A)	0.6	0.2	18.71
Siberian elm	82,066	615	(N/A)	0.6	0.8	87.93
Callery pear	1,109	8	(N/A)	0.5	0.0	1.39
Northern white ceda	12,082	91	(N/A)	0.5	0.1	15.10
Northern pin oak	28,611	215	(N/A)	0.4	0.3	42.92
Broadleaf Deciduou	3,319	25	(N/A)	0.3	0.0	6.22
Conifer Evergreen I	8,112	61	(N/A)	0.3	0.1	15.21
Eastern white pine	6,980	52	(N/A)	0.3	0.1	13.09
Mountain ash	9,958	75	(N/A)	0.3	0.1	24.89
Ohio buckeye	8,181	61	(N/A)	0.3	0.1	20.45
Elm	57,489	431	(N/A)	0.3	0.6	143.72
Oak	16,819	126	(N/A)	0.3	0.2	42.05
Swamp white oak	3,859	29	(N/A)	0.3	0.0	9.65
Norway spruce	14,981	112	(N/A)	0.2	0.1	56.18
Mulberry	356	3	(N/A)	0.2	0.0	1.33
Ginkgo	4,208	32	(N/A)	0.2	0.0	15.78
River birch	2,201	17	(N/A)	0.2	0.0	8.26
Japanese tree lilac	1,086	8	(N/A)	0.2	0.0	4.07
White ash	16,807	126	(N/A)	0.2	0.2	63.03
Ash	28,560	214	(N/A)	0.2	0.3	107.10
White oak	29,615	222	(N/A)	0.2	0.3	111.06
Kentucky coffeetree	16,807	126	(N/A)	0.2	0.2	63.03
Common chokecher	1,816	14	(N/A)	0.2	0.0	6.81
Conifer Evergreen S	43	0	(N/A)	0.1	0.0	0.32
Eastern cottonwood	39,259	294	(N/A)	0.1	0.4	294.44
Black cherry	908	7	(N/A)	0.1	0.0	6.81
Conifer Evergreen N	284	2	(N/A)	0.1	0.0	2.13
Boxelder	7,945	60	(N/A)	0.1	0.1	59.59
Black spruce	43	0	(N/A)	0.1	0.0	0.32
Birch	218	2	(N/A)	0.1	0.0	1.64
Sumac	178	1	(N/A)	0.1	0.0	1.33
Broadleaf Evergreen	484	4	(N/A)	0.1	0.0	3.63
Citywide total	10,341,083	77,558	(N/A)	100.0	100.0	67.80

Table 5: Annual Carbon Sequestered

Annual CO_2 Benefits of Public Trees

3/10/2020

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
Norway maple	67,512	506	-6,814	-460	-55	75,168	564	135,406	1,016	(N/A)	15.1	12.6	5.87
Green ash	111,998	840	-8,848	-474	-70	76,977	577	179,654	1,347	(N/A)	14.3	16.8	8.22
Silver maple	195,732	1,468	-12,219	-532	-96	82,550	619	265,531	1,991	(N/A)	13.5	24.8	12.85
Pin oak	115,774	868	-5,718	-274	-45	44,065	330	153,847	1,154	(N/A)	7.0	14.3	14.42
Apple	11,939	90	-606	-99	-5	12,346	93	23,580	177	(N/A)	6.6	2.2	2.36
Honeylocust	28,849	216	-1,270	-95	-10	19,315	145	46,799	351	(N/A)	5.1	4.4	6.05
Sugar maple	29,711	223	-2,697	-142	-21	22,007	165	48,879	367	(N/A)	4.0	4.6	7.97
Northern catalpa	21,874	164	-2,693	-98	-21	14,898	112	33,980	255	(N/A)	2.5	3.2	8.79
Northern hackberry	12,200	92	-954	-90	-8	16,049	120	27,206	204	(N/A)	2.4	2.5	7.29
Black walnut	16,043	120	-1,158	-69	-9	11,286	85	26,101	196	(N/A)	2.4	2.4	6.99
Pear	854	6	-24	-12	0	843	6	1,662	12	(N/A)	2.2	0.2	0.50
Maple	2,063	15	-111	-18	-1	2,455	18	4,389	33	(N/A)	2.0	0.4	1.43
Red maple	7,138	54	-272	-30	-2	5,312	40	12,148	91	(N/A)	1.9	1.1	4.14
Northern red oak	4,050	30	-572	-41	-5	5,411	41	8,848	66	(N/A)	1.8	0.8	3.16
Broadleaf Deciduous Sn	802	6	-23	-11	0	810	6	1,578	12	(N/A)	1.7	0.1	0.62
Blue spruce	994	7	-46	-26	-1	2,551	19	3,473	26	(N/A)	1.7	0.3	1.37
Amur maple	1,600	12	-112	-18	-1	1,893	14	3,364	25	(N/A)	1.3	0.3	1.68
American basswood	13,082	98	-1,112	-45	-9	6,147	46	18,072	136	(N/A)	1.3	1.7	9.04
Littleleaf linden	11,156	84	-731	-41	-6	5,566	42	15,950	120	(N/A)	1.2	1.5	8.54
Spruce	755	6	-31	-14	0	1,423	11	2,132	16	(N/A)	1.0	0.2	1.45
Cherry plum	884	7	-36	-9	0	959	7	1,798	13	(N/A)	0.9	0.2	1.35
American sycamore	7,932	59	-1,269	-39	-10	5,930	44	12,554	94	(N/A)	0.8	1.2	10.46
Bur oak	2,729	20	-206	-13	-2	2,053	15	4,564	34	(N/A)	0.8	0.4	3.80
Eastern redbud	753	6	-105	-13	-1	1,283	10	1,917	14	(N/A)	0.8	0.2	1.60
Black maple	1,172	9	-84	-8	-1	1,274	10	2,353	18	(N/A)	0.6	0.2	2.52
Siberian elm	3,263	24	-394	-19	-3	2,791	21	5,641	42	(N/A)	0.6	0.5	6.04
Callery pear	483	4	-9	-3	0	330	2	801	6	(N/A)	0.5	0.1	1.00
Northern white cedar	599	4	-58	-10	-1	856	6	1,386	10	(N/A)	0.5	0.1	1.73
Northern pin oak	756	6	-137	-8	-1	1,099	8	1,710	13	(N/A)	0.4	0.2	2.56
Broadleaf Deciduous Me	677	5	-16	-4	0	535	4	1,192	9	(N/A)	0.3	0.1	2.24
Conifer Evergreen Large	543	4	-39	-9	0	804	6	1,299	10	(N/A)	0.3	0.1	2.44
Eastern white pine	445	3	-34	-7	0	625	5	1,030	8	(N/A)	0.3	0.1	1.93
Mountain ash	784	6	-48	-5	0	680	5	1,411	11	(N/A)	0.3	0.1	3.53
Ohio buckeye	571	4	-40	-4	0	512	4	1,039	8	(N/A)	0.3	0.1	2.60
Elm	2,673	20	-276	-11	-2	1,755	13	4,141	31	(N/A)	0.3	0.4	10.35
Oak	1,068	8	-81	-5	-1	715	5	1,698	13	(N/A)	0.3	0.2	4.25
Swamp white oak	487	4	-19	-3	0	467	4	932	7	(N/A)	0.3	0.1	2.33
Norway spruce	512	4	-72	-7	-1	622	5	1,055	8	(N/A)	0.2	0.1	3.96
Mulberry	76	1	-2	-1	0	74	1	147	1	(N/A)	0.2	0.0	0.55
Ginkgo	228	2	-20	-3	0	322	2	527	4	(N/A)	0.2	0.0	1.98
River birch	448	3	-11	-2	0	352	3	787	6	(N/A)	0.2	0.1	2.95
Japanese tree lilac	152	1	-5	-2	0	161	1	306	2	(N/A)	0.2	0.0	1.15
White ash	1,497	11	-81	-5	-1	860	6	2,272	17	(N/A)	0.2	0.2	8.52
Ash	370	3	-137	-8	-1	1,077	8	1,302	10	(N/A)	0.2	0.1	4.88
White oak	1,405	11	-142	-6	-1	1,043	8	2,299	17	(N/A)	0.2	0.2	8.62
Kentucky coffeetree	1,066	8	-81	-5	-1	711	5	1,691	13	(N/A)	0.2	0.2	6.34
Common chokecherry	228	2	-9	-2	0	248	2	465	3	(N/A)	0.2	0.0	1.74
Conifer Evergreen Small	13	0	0	-1	0	26	0	39	0	(N/A)	0.1	0.0	0.29
Eastern cottonwood	912	7	-188	-5	-1	734	6	1,453	11	(N/A)	0.1	0.1	10.90
Black cherry	114	1	-4	-1	0	124	1	232	2	(N/A)	0.1	0.0	1.74
Conifer Evergreen Medi	39	0	-1	-1	0	106	1	142	1	(N/A)	0.1	0.0	1.07
Boxelder	694	5	-38	-3	0	366	3	1,020	8	(N/A)	0.1	0.1	7.65
Black spruce	12	0	0	-1	0	48	0	60	0	(N/A)	0.1	0.0	0.45
Birch	96	1	-2	-1	0	65	0	158	1	(N/A)	0.1	0.0	1.18
Sumac	38	0	-1	-1	0	37	0	74	1	(N/A)	0.1	0.0	0.55
Broadleaf Evergreen Me	56	0	-2	-1	0	141	1	194	1	(N/A)	0.1	0.0	1.45
Citywide total	687,902	5,159	-49,656	-2,813	-394	436,859	3,276	1,072,291	8,042	(N/A)	100.0	100.0	7.03

Table 6: Annual Social and Aesthetic Benefits

Annual Aesthetic/Other Benefits of Public Trees

3/10/2020

Species	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Norway maple	6,310	(N/A)	15.1	10.0	36.47
Green ash	9,325	(N/A)	14.3	14.8	56.86
Silver maple	15,608	(N/A)	13.5	24.8	100.70
Pin oak	9,060	(N/A)	7.0	14.4	113.25
Apple	688	(N/A)	6.6	1.1	9.17
Honeylocust	6,714	(N/A)	5.1	10.7	115.75
Sugar maple	3,078	(N/A)	4.0	4.9	66.91
Northern catalpa	1,590	(N/A)	2.5	2.5	54.82
Northern hackberry	1,631	(N/A)	2.4	2.6	58.25
Black walnut	1,413	(N/A)	2.4	2.2	50.48
Pear	42	(N/A)	2.2	0.1	1.69
Maple	316	(N/A)	2.0	0.5	13.74
Red maple	951	(N/A)	1.9	1.5	43.25
Northern red oak	347	(N/A)	1.8	0.6	16.51
Broadleaf Deciduous Small	42	(N/A)	1.7	0.1	2.21
Blue spruce	421	(N/A)	1.7	0.7	22.17
Amur maple	91	(N/A)	1.3	0.1	6.09
American basswood	920	(N/A)	1.3	1.5	61.31
Littleleaf linden	1,104	(N/A)	1.2	1.8	78.87
Spruce	220	(N/A)	1.0	0.3	19.98
Cherry plum	49	(N/A)	0.9	0.1	4.94
American sycamore	546	(N/A)	0.8	0.9	60.62
Bur oak	266	(N/A)	0.8	0.4	29.51
Eastern redbud	43	(N/A)	0.8	0.1	4.83
Black maple	154	(N/A)	0.6	0.2	21.94
Siberian elm	246	(N/A)	0.6	0.4	35.13
Callery pear	67	(N/A)	0.5	0.1	11.19
Northern white cedar	125	(N/A)	0.5	0.2	20.85
Northern pin oak	71	(N/A)	0.4	0.1	14.23
Broadleaf Deciduous Mediu	81	(N/A)	0.3	0.1	20.35
Conifer Evergreen Large	142	(N/A)	0.3	0.2	35.48
Eastern white pine	116	(N/A)	0.3	0.2	29.10
Mountain ash	46	(N/A)	0.3	0.1	15.45
Ohio buckeye	59	(N/A)	0.3	0.1	19.56
Elm	198	(N/A)	0.3	0.3	65.93
Oak	99	(N/A)	0.3	0.2	33.14
Swamp white oak	55	(N/A)	0.3	0.1	18.26
Norway spruce	53	(N/A)	0.2	0.1	26.25
Mulberry	4	(N/A)	0.2	0.0	2.06
Ginkgo	18	(N/A)	0.2	0.0	8.92
River birch	52	(N/A)	0.2	0.1	26.22
Japanese tree lilac	8	(N/A)	0.2	0.0	4.23
White ash	160	(N/A)	0.2	0.3	79.89
Ash	31	(N/A)	0.2	0.0	15.73
White oak	112	(N/A)	0.2	0.2	56.23
Kentucky coffeetree	94	(N/A)	0.2	0.1	47.07
Common chokecherry	13	(N/A)	0.2	0.0	6.40
Conifer Evergreen Small	13	(N/A)	0.1	0.0	13.37
Eastern cottonwood	58	(N/A)	0.1	0.1	58.34
Black cherry	6	(N/A)	0.1	0.0	6.40
Conifer Evergreen Medium	21	(N/A)	0.1	0.0	21.08
Boxelder	52	(N/A)	0.1	0.1	51.63
Black spruce	12	(N/A)	0.1	0.0	12.31
Birch	13	(N/A)	0.1	0.0	12.89
Sumac	2	(N/A)	0.1	0.0	2.06
Broadleaf Evergreen Mediu	22	(N/A)	0.1	0.0	21.93
Citywide total	62,980	(N/A)	100.0	100.0	55.05

Table 7: Summary of Benefits in Dollars

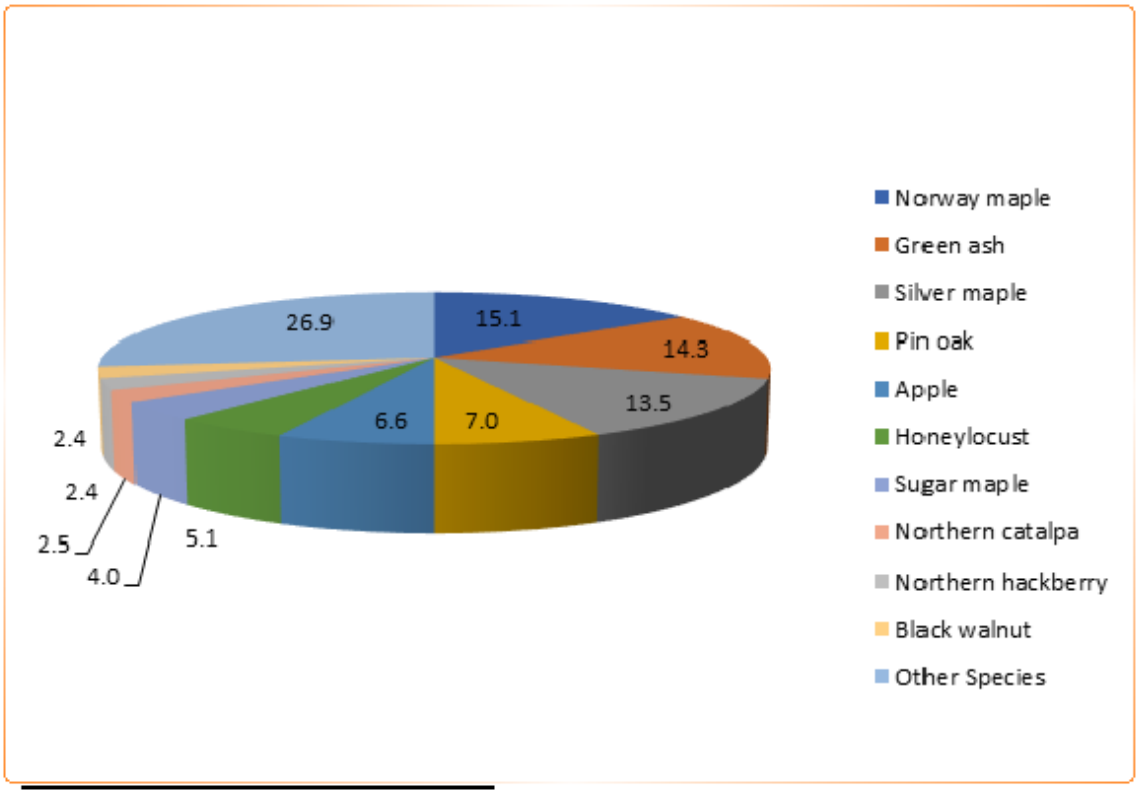
Annual Benefits of Public Trees by Species ($/tree)

3/10/2020

Species	Energy	CO_2	Air Quality	Stormwater	Aesthetic/Other	Total ($)	Standard Error
Norway maple	56.42	5.87	10.04	66.17	36.47	174.98	(N/A)
Green ash	59.20	8.22	10.20	80.81	56.86	215.29	(N/A)
Silver maple	65.03	12.85	11.93	119.90	100.70	310.42	(N/A)
Pin oak	68.82	14.42	8.86	94.47	113.25	299.82	(N/A)
Apple	21.94	2.36	3.53	10.33	9.17	47.32	(N/A)
Honeylocust	41.50	6.05	6.75	51.42	115.75	221.47	(N/A)
Sugar maple	59.59	7.97	9.52	87.49	66.91	231.48	(N/A)
Northern catalpa	65.09	8.79	12.25	113.66	54.82	254.61	(N/A)
Northern hackberry	74.51	7.29	12.92	87.30	58.25	240.26	(N/A)
Black walnut	50.82	6.99	8.59	65.22	50.48	182.10	(N/A)
Pear	4.94	0.50	0.67	1.77	1.69	9.56	(N/A)
Maple	13.87	1.43	2.25	11.71	13.74	43.00	(N/A)
Red maple	29.67	4.14	5.19	28.74	43.25	110.99	(N/A)
Northern red oak	32.59	3.16	4.59	36.82	16.51	93.67	(N/A)
Broadleaf Deciduous	6.23	0.62	0.84	2.26	2.21	12.17	(N/A)
Blue spruce	17.35	1.37	1.89	26.10	22.17	68.89	(N/A)
Amur maple	17.15	1.68	2.79	8.86	6.09	36.58	(N/A)
American basswood	53.63	9.04	8.28	79.60	61.31	211.86	(N/A)
Littleleaf linden	51.98	8.54	8.99	75.94	78.87	224.32	(N/A)
Spruce	15.48	1.45	1.75	23.98	19.98	62.65	(N/A)
Cherry plum	13.34	1.35	1.97	5.44	4.94	27.03	(N/A)
American sycamore	81.82	10.46	16.27	157.73	60.62	326.91	(N/A)
Bur oak	27.89	3.80	4.80	35.21	29.51	101.22	(N/A)
Eastern redbud	19.90	1.60	3.39	12.25	4.83	41.97	(N/A)
Black maple	23.39	2.52	4.17	25.77	21.94	77.79	(N/A)
Siberian elm	49.45	6.04	9.61	73.00	35.13	173.24	(N/A)
Callery pear	7.67	1.00	1.03	3.73	11.19	24.63	(N/A)
Northern white cedar	17.49	1.73	0.64	43.30	20.85	84.01	(N/A)
Northern pin oak	29.00	2.56	5.51	41.00	14.23	92.31	(N/A)
Broadleaf Deciduous	18.63	2.24	2.63	11.99	20.35	55.84	(N/A)
Conifer Evergreen L	24.66	2.44	1.80	54.69	35.48	119.06	(N/A)
Eastern white pine	20.03	1.93	1.23	45.71	29.10	98.01	(N/A)
Mountain ash	29.89	3.53	5.20	17.25	15.45	71.32	(N/A)
Ohio buckeye	22.92	2.60	3.84	23.98	19.56	72.89	(N/A)
Elm	74.61	10.35	13.55	120.83	65.93	285.28	(N/A)
Oak	30.73	4.25	5.18	41.27	33.14	114.57	(N/A)
Swamp white oak	18.95	2.33	3.09	14.31	18.26	56.94	(N/A)
Norway spruce	38.17	3.96	-1.58	124.79	26.25	191.60	(N/A)
Mulberry	5.40	0.55	0.71	1.86	2.06	10.58	(N/A)
Ginkgo	20.49	1.98	3.49	16.89	8.92	51.77	(N/A)
River birch	24.47	2.95	3.47	15.88	26.22	72.99	(N/A)
Japanese tree lilac	11.80	1.15	1.63	4.51	4.23	23.32	(N/A)
White ash	52.69	8.52	10.05	80.12	79.89	231.27	(N/A)
Ash	70.84	4.88	13.58	102.01	15.73	207.05	(N/A)
White oak	63.12	8.62	11.57	94.25	56.23	233.80	(N/A)
Kentucky coffeetree	45.77	6.34	7.73	61.66	47.07	168.59	(N/A)
Common chokecherr	18.19	1.74	2.55	7.17	6.40	36.05	(N/A)
Conifer Evergreen S	3.62	0.29	0.20	4.97	13.37	22.45	(N/A)
Eastern cottonwood	91.02	10.90	19.04	196.17	58.34	375.47	(N/A)
Black cherry	18.19	1.74	2.55	7.17	6.40	36.05	(N/A)
Conifer Evergreen M	14.80	1.07	1.53	20.47	21.08	58.96	(N/A)
Boxelder	46.76	7.65	7.54	60.52	51.63	174.10	(N/A)
Black spruce	6.94	0.45	0.75	6.95	12.31	27.41	(N/A)
Birch	8.99	1.18	1.21	4.41	12.89	28.68	(N/A)
Sumac	5.40	0.55	0.71	1.86	2.06	10.58	(N/A)
Broadleaf Evergreen	18.82	1.45	2.10	18.34	21.93	62.64	(N/A)
Citywide Total	48.29	7.03	8.12	66.98	55.05	185.47	(N/A)

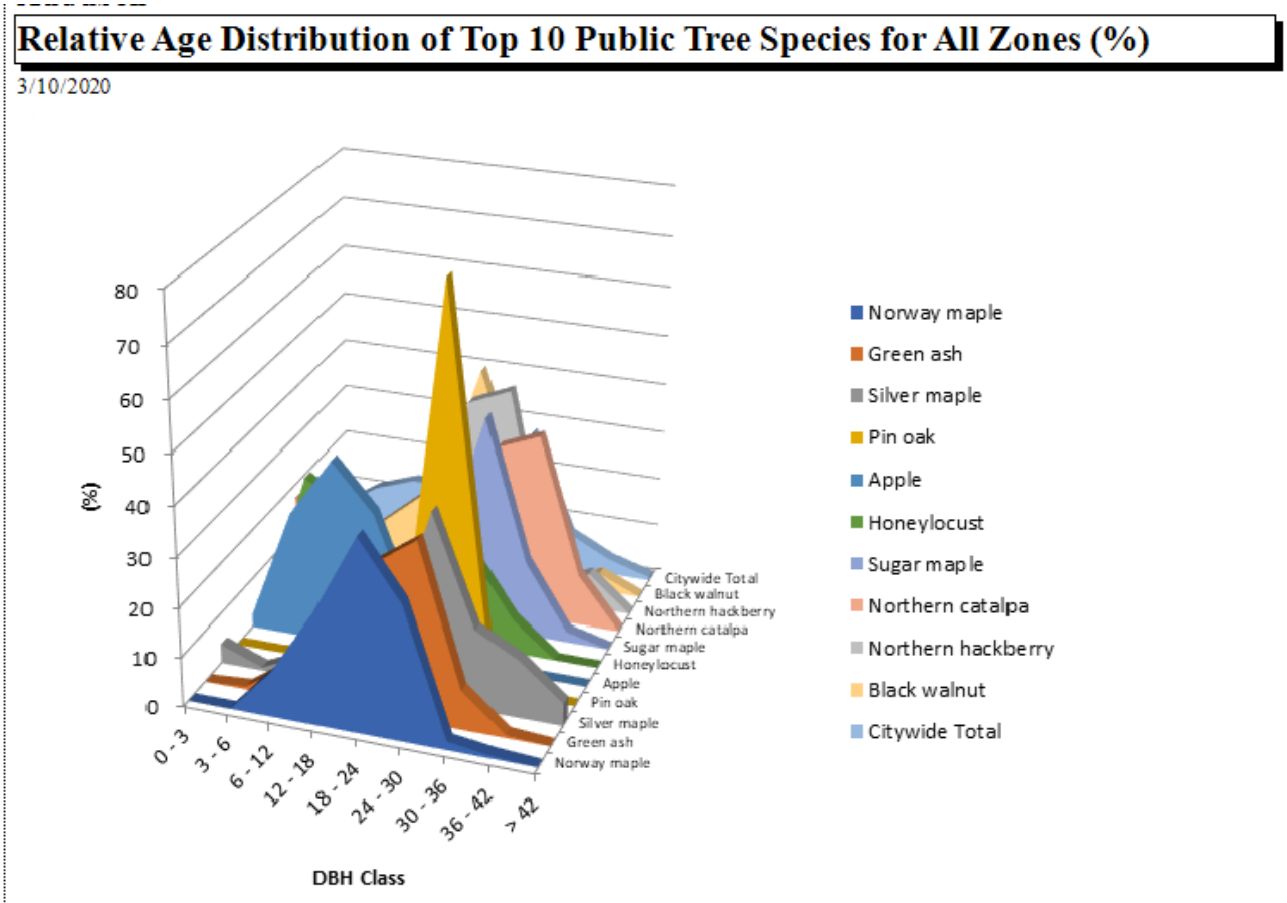
Species Distribution of Public Trees

3/10/2020



Species	Percent
Norway maple	15.1
Green ash	14.3
Silver maple	13.5
Pin oak	7.0
Apple	6.6
Honeylocust	5.1
Sugar maple	4.0
Northern catalpa	2.5
Northern hackberry	2.4
Black walnut	2.4
Other Species	26.9
Total	100.0

Figure 1: Species Distribution



	DBH class (in)								
Species	0-3	3-6	6-12	12-18	18-24	24-30	30-36	36-42	> 42
Norway maple	0.00	0.00	9.25	22.54	38.73	27.17	1.73	0.58	0.00
Green ash	0.00	0.61	6.71	18.29	29.88	35.98	7.93	0.61	0.00
Silver maple	3.87	0.65	4.52	9.68	10.97	38.06	16.13	11.61	4.52
Pin oak	0.00	0.00	1.25	5.00	6.25	78.75	8.75	0.00	0.00
Apple	2.67	25.33	37.33	28.00	6.67	0.00	0.00	0.00	0.00
Honeylocust	1.72	29.31	24.14	5.17	13.79	18.97	6.90	0.00	0.00
Sugar maple	0.00	0.00	10.87	13.04	15.22	43.48	15.22	2.17	0.00
Northern catalpa	17.24	0.00	0.00	0.00	0.00	34.48	37.93	10.34	0.00
Northern hackberry	0.00	0.00	3.57	3.57	39.29	42.86	3.57	7.14	0.00
Black walnut	3.57	3.57	10.71	17.86	42.86	17.86	0.00	3.57	0.00
Citywide Total	5.16	10.75	13.72	13.46	17.83	27.88	7.34	3.15	0.70

Figure 2: Relative Age Class

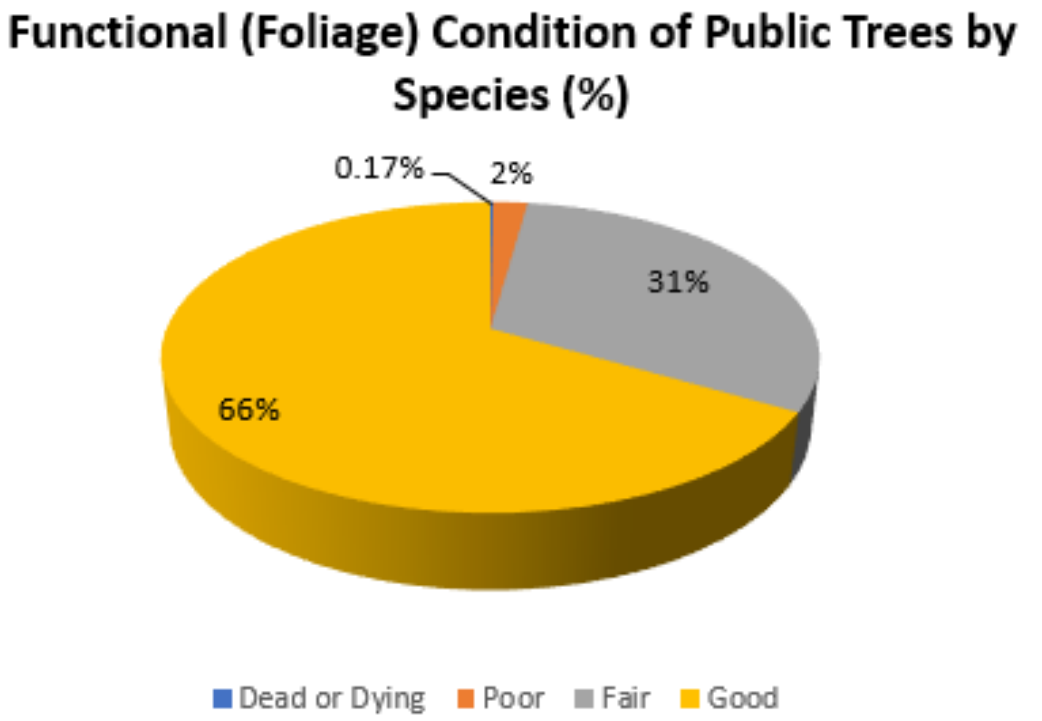


Figure 3: Foliage Condition

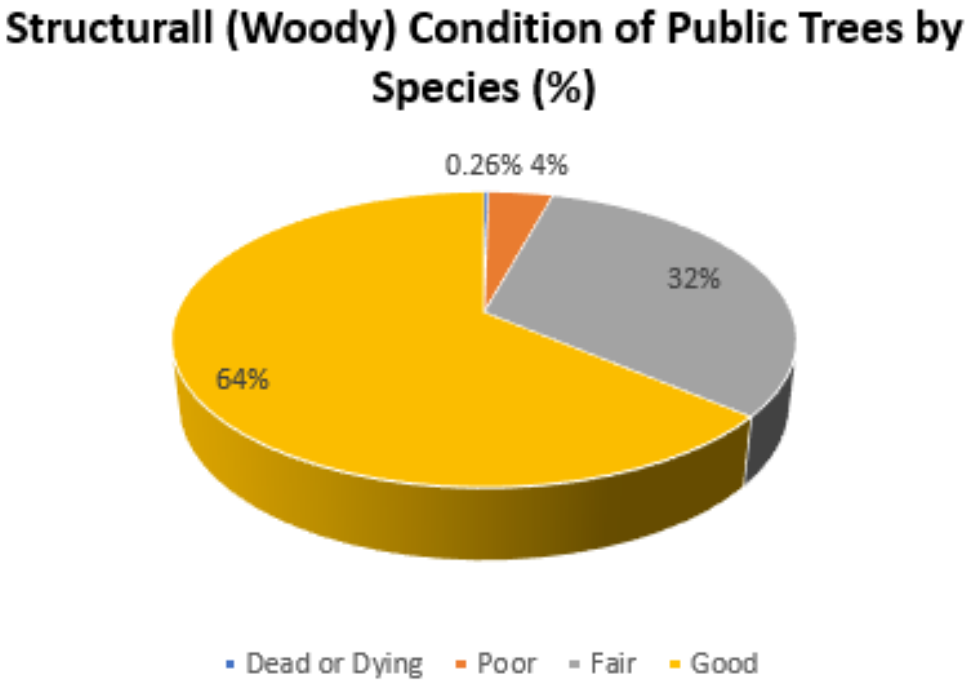
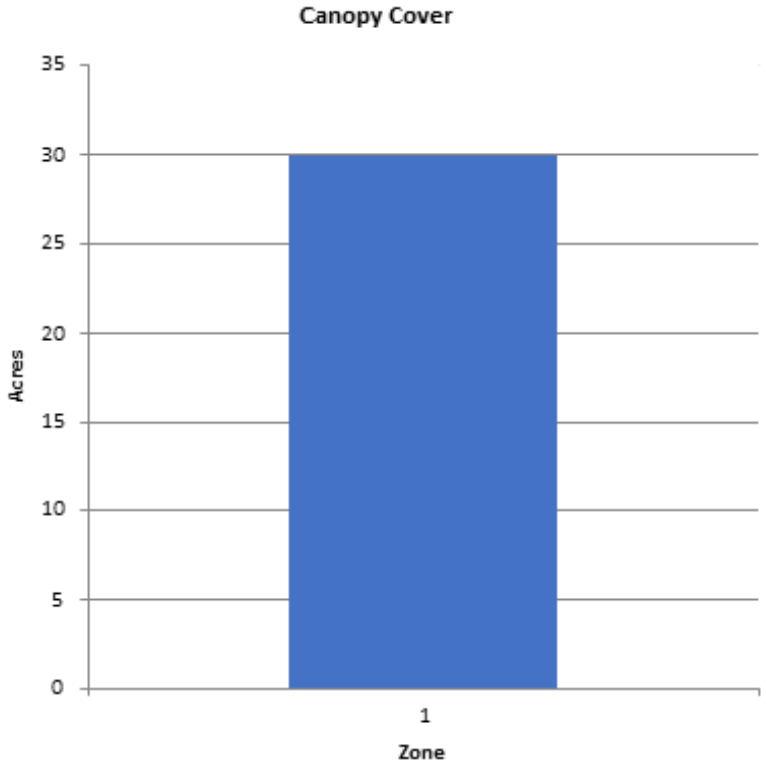


Figure 4: Wood Condition

Audubon

Canopy Cover of Public Trees (Acres)

3/10/2020



Zone	Acres	% of Total Canopy Cover
1	30	100.0
Citywide total	30	100.0

	Total Land Area	Total Street and Sidewalk Area	Total Canopy Cover	Canopy Cover as % of Total Land Area	Canopy Cover as % of Total Streets and Sidewalks
Citywide Total	0	0	30	0.00	0.00

Figure 5: Canopy Cover in Acres

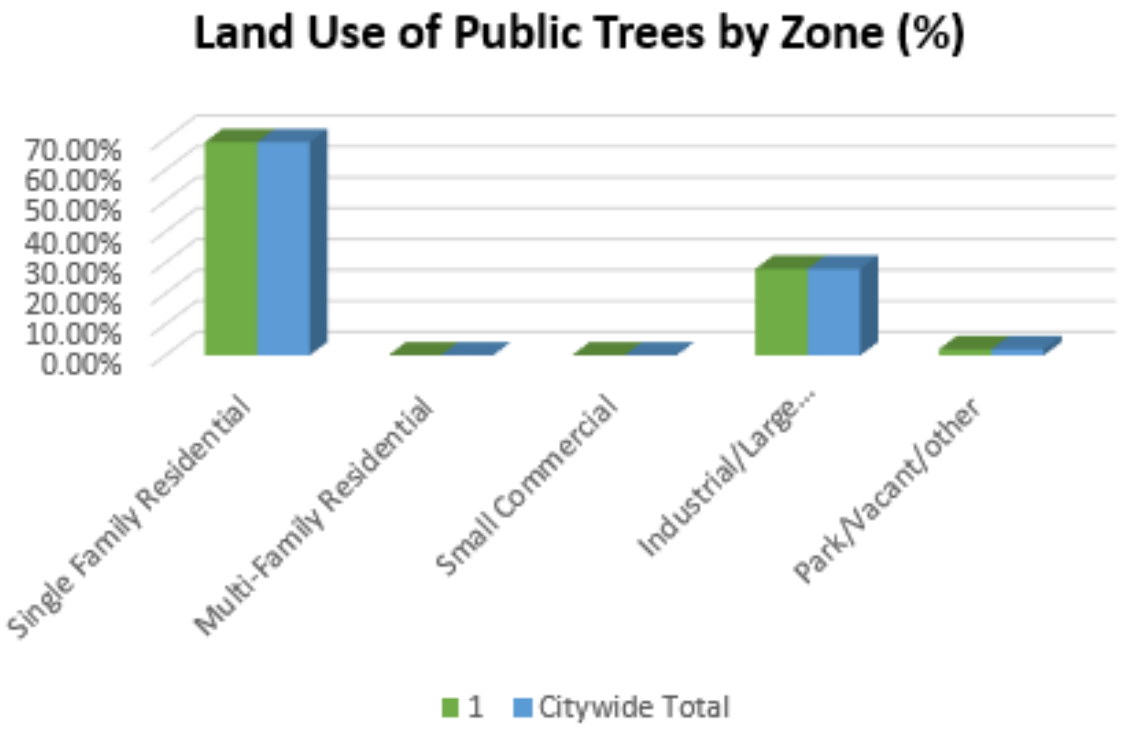


Figure 6: Land Use of city/park trees

Appendix B: ArcGIS Mapping

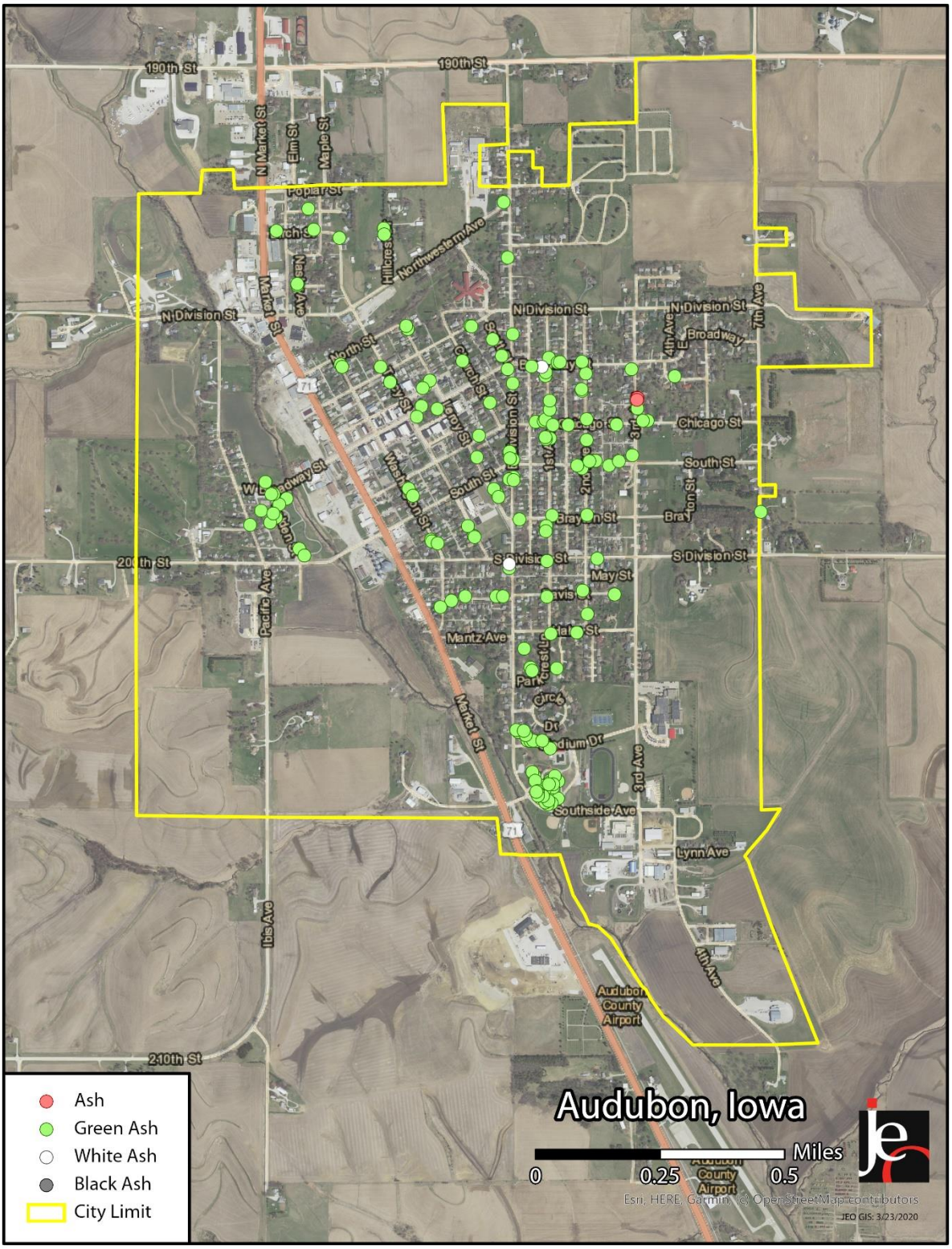


Figure 1: Location of Ash Trees

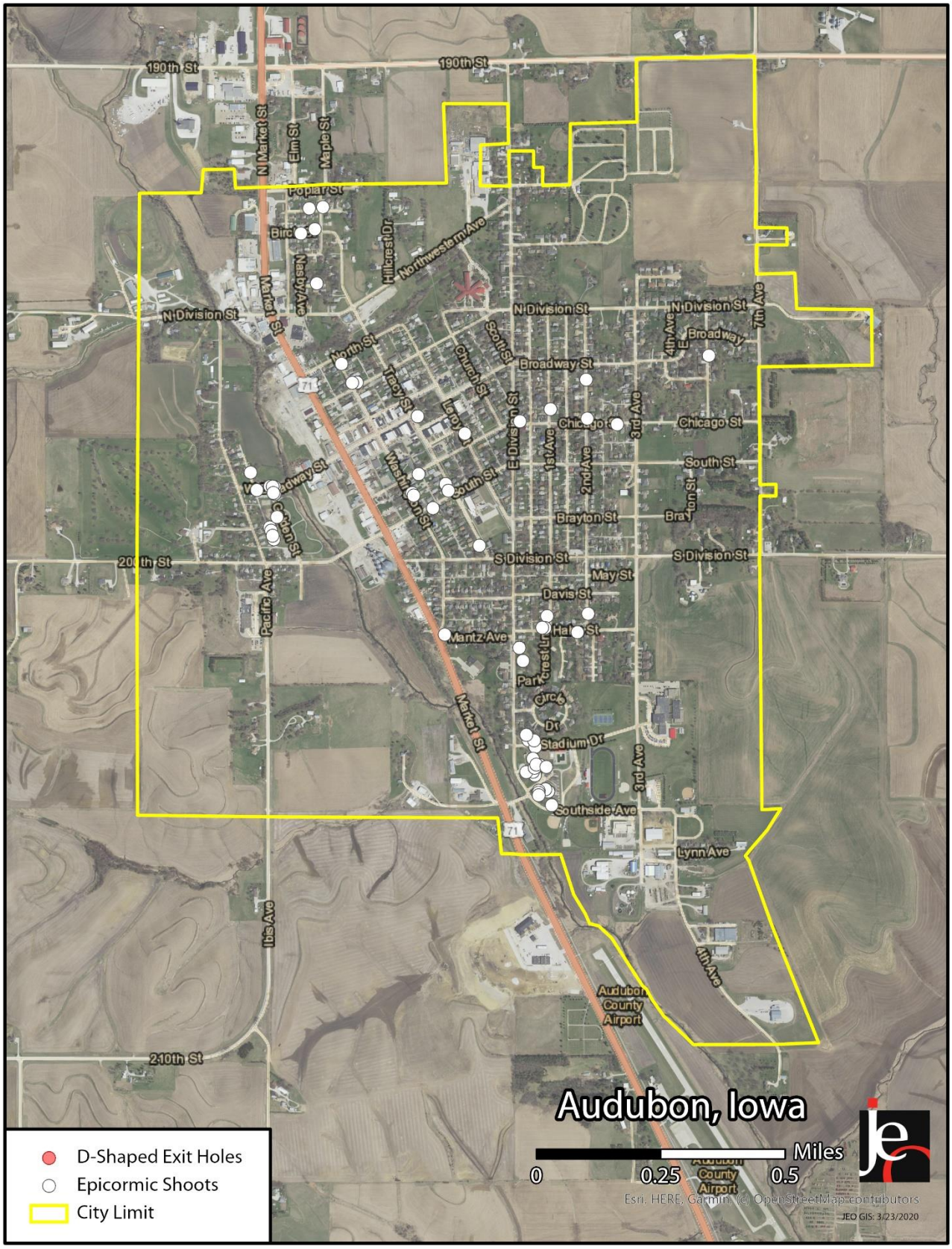


Figure 2: Location of EAB symptoms

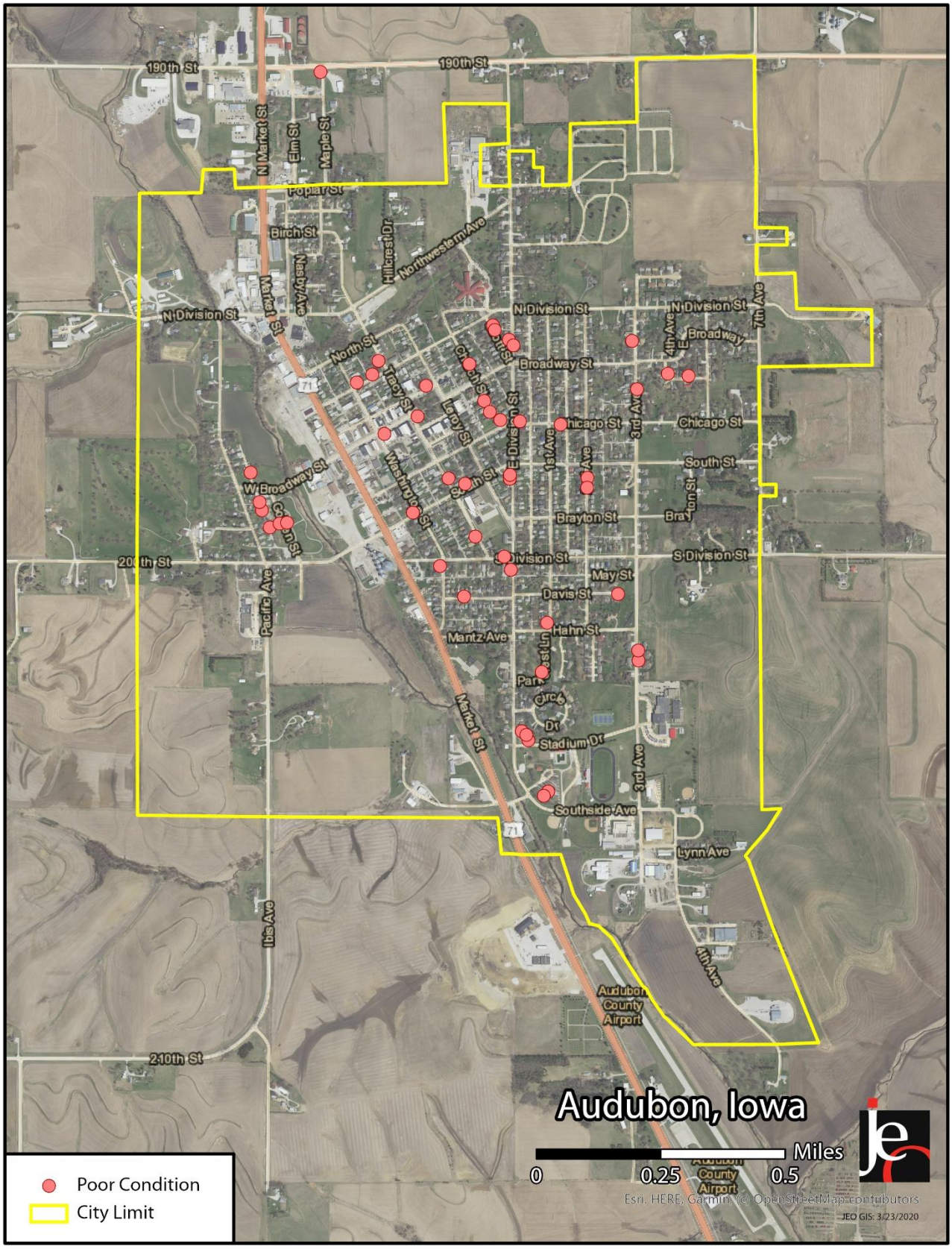


Figure 3: Location of Poor Condition Trees

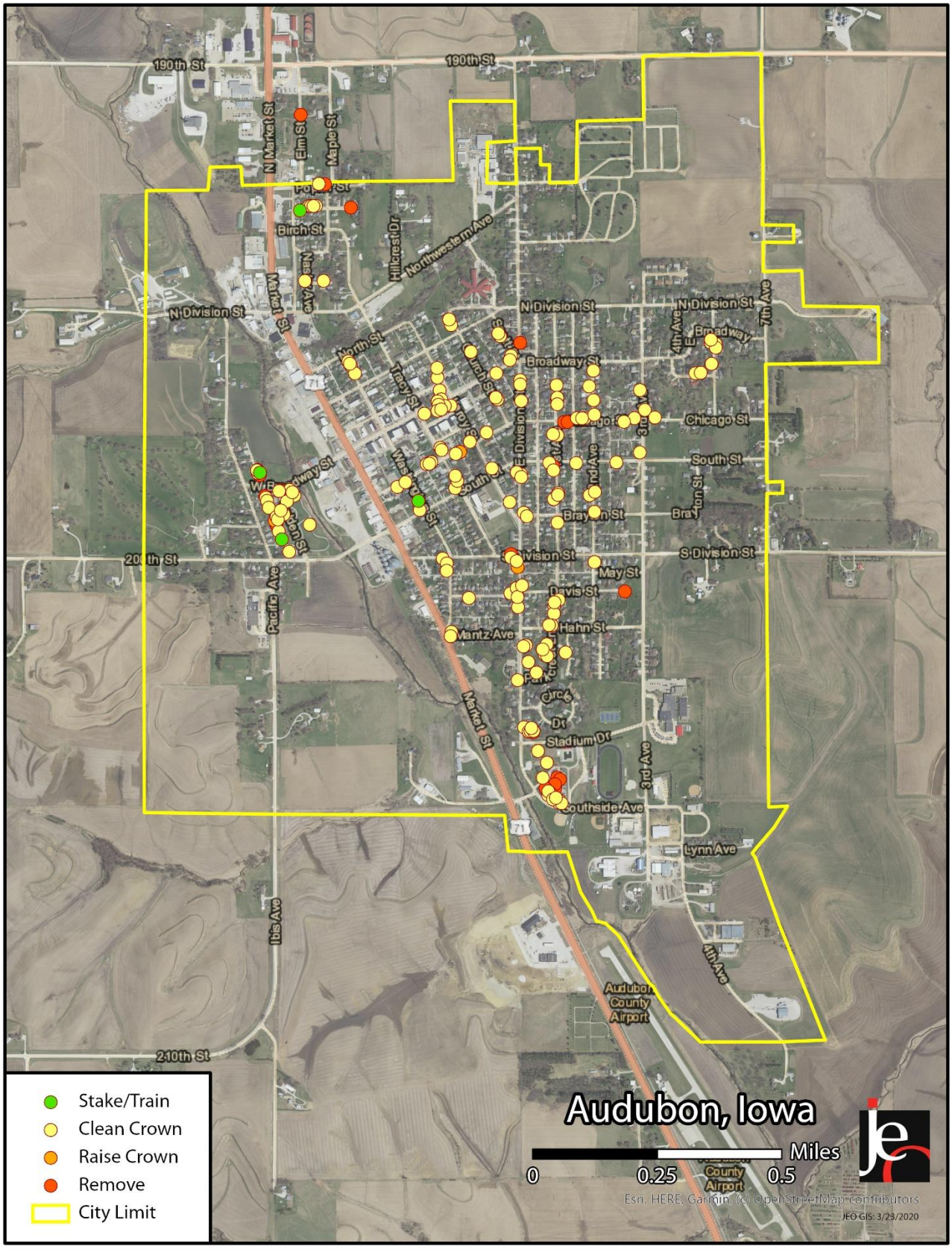


Figure 4: Location of Trees with Recommended Maintenance

Appendix C: Audubon Tree Ordinances

Trees

151.01 DEFINITION. For use in this chapter, "parking" means that part of the street, avenue, or highway in the City not covered by sidewalk and lying between the lot line and the curb line or, on unpaved streets, that part of the street, avenue, or highway lying between the lot line and that portion of the street usually traveled by vehicular traffic.

151.02 PLANTING RESTRICTIONS. No tree shall be planted in any parking or street except in accordance with the following: 1. Alignment. All trees planted in any street shall be planted in the parking midway between the outer line of the sidewalk and the curb. In the event a curb line is not established, trees shall be planted on a line ten (10) feet from the property line. 2. Spacing. Trees shall not be planted on any parking that is less than nine (9) feet in width, or contains less than eighty-one (81) square feet of exposed soil surface per tree. Trees shall not be planted closer than twenty (20) feet from street intersections (property lines extended) and ten (10) feet from driveways. If it is at all possible, trees should be planted inside the property lines and not between the sidewalk and the curb. 3. Prohibited Trees. No person shall plant in any street any fruit-bearing tree or any tree of the kinds commonly known as cottonwood, poplar, box elder, Chinese elm, evergreen, willow, or black walnut.

151.03 DUTY TO TRIM TREES. The owner or agent of the abutting property shall keep the trees on, or overhanging the street, trimmed so that all branches will be at least fifteen (15) feet above the surface of the street and eight (8) feet above the sidewalks. If the abutting property owner fails to trim the trees, the City may serve notice on the abutting property owner requiring that such action be taken within five (5) days. If such action is not taken within that time, the City may perform the required action and assess the costs against the abutting property for collection in the same manner as a property tax. (Code of Iowa, Sec. 364.12[2c, d & e])

151.04 TRIMMING TREES TO BE SUPERVISED. Except as allowed in Section 151.03, it is unlawful for any person to trim or cut any tree in a street or public place unless the work is done under the supervision of the City.

151.05 DISEASE CONTROL. Any dead, diseased, or damaged tree or shrub that may harbor serious insect or disease pests or disease injurious to other trees is hereby declared to be a nuisance.

151.06 INSPECTION AND REMOVAL. The Council shall inspect or cause to be inspected any trees or shrubs in the City reported or suspected to be dead, diseased or damaged, and such trees and shrubs shall be subject to the following:

1. City Property. If it is determined that any such condition exists on any public property, including the strip between the curb and the lot line of private property, the Council may cause such condition to be corrected by treatment or removal. The Council may also order the removal of any trees on the streets of the City which interfere with the making of improvements or with travel thereon.

2. Private Property. If it is determined with reasonable certainty that any such condition exists on private property and that danger to other trees or to adjoining property or passing motorists or pedestrians is imminent, the Council shall notify by certified mail the owner, occupant or person in charge of such property to correct such condition by treatment or removal within fourteen (14) days of said notification. If such owner, occupant, or person in charge of said property fails to comply within 14 days of receipt of notice, the Council may cause the condition to be corrected and the cost assessed against the property.

The State of Iowa is an Equal Opportunity Employer and provider of ADA services.

Federal law prohibits employment discrimination on the basis of race, color, age, religion, national origin, sex or disability. State law prohibits employment discrimination on the basis of race, color, creed, age, sex, sexual orientation, gender identity, national origin, religion, pregnancy, or disability. State law also prohibits public accommodation (such as access to services or physical facilities) discrimination on the basis of race, color, creed, religion, sex, sexual orientation, gender identity, religion, national origin, or disability. If you believe you have been discriminated against in any program, activity or facility as described above, or if you desire further information, please contact the Iowa Civil Rights Commission, 1-800-457-4416, or write to the Iowa Department of Natural Resources, Wallace State Office Bldg., 502 E 9th St, Des Moines IA 50319.

If you need accommodations because of disability to access the services of this Agency, please contact the Director at 515-725-8200.