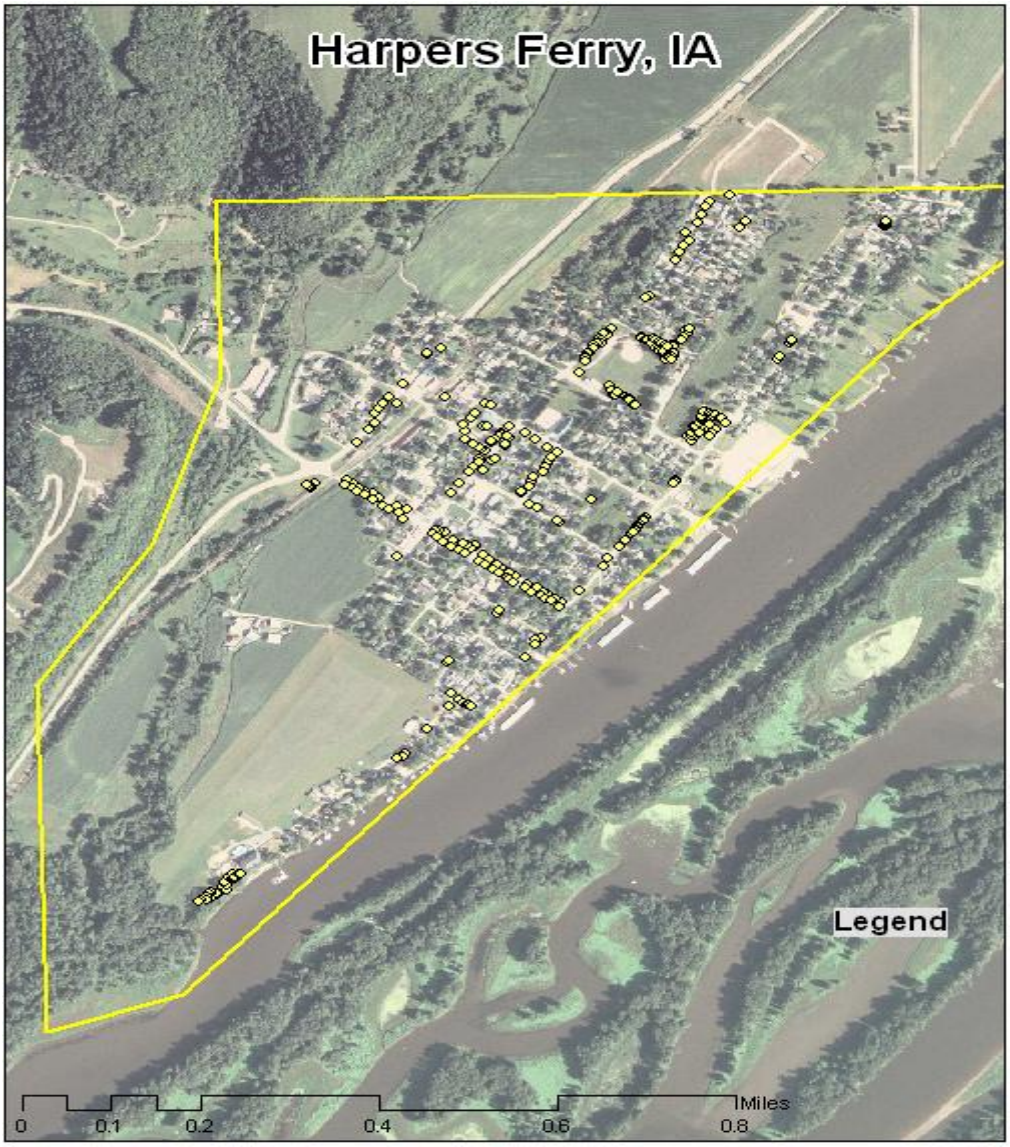
HARPERS FERRY, IA



2010 Management Plan

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Executive Summary

Overview

This plan was developed to assist the City of Harpers Ferry 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). There is a strong possibility that 18% of Harper Ferry's city owned trees (ash) will die once EAB becomes 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 2009, 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 104 trees inventoried.

- Harpers Ferry's trees provide $15,929 of benefits annually, an average of $153 a tree
- There are over 18 species of trees
- The top three genus are: Maple 46%, Ash 18%, and Basswood/Linden 14%
- 26% of trees are in need of some type of management
- 3 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 3 trees needing removal, 1 tree is over 30 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*
- 1 of the 19 ash trees is in need of follow up because it is displaying signs and symptoms associated with EAB
- 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

Introduction

This plan was developed to assist Harpers Ferry 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 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 and replacement planting. With proper planning and management of the current canopy in Harpers Ferry, these costs can be extended over years and public safety issues from dead and dying ash trees mitigated.

Trees are an important component of Harpers Ferry 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 Harpers Ferry 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 Harpers Ferry's urban forestry goals.

Inventory

In 2009, 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 ft, recommended maintenance, priority of that maintenance, leaf health, and wood condition. Additionally, signs and symptoms of 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 104 city trees was entered into the USDA Forest service program Street Tree Resource Analysis Tool for Urban forestry Management (STRATUM), part of the i-Tree suite. The following are results from the i-Tree STRATUM analysis.

Annual Benefits

Annual Energy Benefits

Trees conserve energy by shading buildings and blocking winds. Harpers Ferry's trees reduce energy related costs by approximately $4,511 annually (Appendix A, Table 1). These savings are both in Electricity (21.5 MWh) and in Natural Gas (2,935.1 Therms).

Annual Stormwater Benefits

Harpers Ferry's trees intercept about 205,884 gallons of rainfall or snow melt a year (Appendix A, Table 2). This interception provides $5,580 of 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 emitting volatile organic mater (ozone). In Harpers Ferry, it is estimated that trees remove 265.7 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 $743 (Appendix A, Table 3).

Annual Carbon Benefits

Carbon sequestration and storage reduce the amount of carbon in the atmosphere, mitigating climate change. In Harpers Ferry, trees sequester about 45,396 lbs of carbon a year with an associated value of $584 (Appendix A, Table 5). In addition, the trees store 766,043 lbs of carbon, with a yearly benefit of $5,745 (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. Harpers Ferry receives $4,511 in annual social benefits from trees (Appendix A, Table 6).

Financial Summary of all Benefits

According to the USDA Forest Service i-Tree STRATUM analysis, Harper Ferry's trees provide $15,929 of benefits annually. Benefits of individual trees vary based on size, species, health and location, but on average each of the 104 trees in Harper Ferry's provide approximately $153 annually (Appendix A, Table 7).

Forest Structure

Species Distribution

Harpers Ferry has over 18 different tree species along city streets and parks (Appendix A, Figure 1).
The distribution of trees by genus is as follows:

Species	# of Trees	% of Total
Maple	48	46
Ash	19	18
Basswood/Linden	15	14
Lilac	5	5
Apple	4	4
Evergreens	4	4
Black Walnut	2	2
Locust	2	2
Oak	2	2
Red Bud	1	1
Dogwood	1	1
Birch	1	1
Totals	104	100

Age Class

Most of Harper Ferry's trees (51%) are between 6 and 18 inches in diameter at 4.5 ft (Appendix A, Figure 2). For age, a Bell Curve is preferred and shows the highest amount of trees around 12 inches in diameter at 4.5 ft. Harper Ferry'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 Harper Ferry indicate that 89% of the trees are in good health, with only 2% of the foliage in poor health, dead or dying (Appendix A, Figure 3 & Appendix B, Figure 3). Similarly, 81% of Harpers Ferry's trees are in good health for wood condition (appendix A, Figure 4 & Appendix B, Figure 3). Wood condition that is in poor health, dead or dying is about 7% of the population. This 7% 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	23	22%
Crown Raising	1	1%
Tree Removal	3	3%

Canopy Cover

The canopy cover of Harpers Ferry is approximately 2 acres (Appendix A, Figure 4). According to the 2000 census, Harpers Ferry occupies 384 acres. Thus the canopy cover on city land is less than 1%.

Land Use and Location

The majority of Harpers Ferry'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	85%
Park/vacant/other	7%
Small commercial	7%
Multifamily residential	2%

Location	
Planting strip	99%
Cutout (surrounded by pavement)	1%

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.

Hazardous trees

Harpers Ferry has 3 critical concern trees that need immediate removal. These trees 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 is one tree over 30 inches in diameter at 4.5 ft that should be addressed immediately. Please refer to the

six year Proposed Work Schedule and Budget section of this plan. After all of the critical concern trees are addressed, there should be follow up on the trees marked as needing immediate maintenance. There are a total of 7 trees with these needs.

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 3 removals, none of these trees are ash trees. There are a total of 19 ash trees, and only one of these trees has signs and symptoms that have been associated with EAB. In addition, there are 4 trees that have major structural problems. *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 6 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 Harpers Ferry.

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 (46%) (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.

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 death 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 with dead, dying, hazardous trees to be removed first (Appendix B, Figure 4). Next will be all ash in poor condition and displaying 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*

EAB Quarantines

EAB is an extremely destructive plant pest and it is responsible for the death and decline of over 25 million 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 ash trees will be replaced. 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 genus other than ash will be prioritized by hazardous or emergency situations only.

Monitoring

It is recommended that ash trees be checked with a visual survey every year for tree death and for the following signs and symptoms: 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. Trees on private property are a vital component of Harpers Ferry's urban forest. It is strongly recommended that Harpers Ferry develop a city tree ordinance to guide species, location, and maintenance of trees planted in town.

PROPOSED WORK SCHEDULE AND ESTIMATED COSTS_

Year 1

Remove 3 critical concern trees	$2,100
Clean 7 trees of immediate concern	$1,400
Plant and maintain 3 trees in open locations	Booster Club
Visual survey for signs and symptoms of Emerald Ash Borer	

Year 2

Remove 4 ash trees	$2,800
Plant and maintain 4 trees in open locations	Booster Club
Prune 1/3 of city trees	$1,000
Visual survey for signs of EAB	

Year 3

Remove 4 ash trees	$2,800
Plant and maintain 4 trees in open locations	Booster Club
Visual survey for signs of EAB	

Year 4

Remove 4 ash trees	$2,800
Plant and maintain 4 trees in open locations	Booster Club
Prune 1/3 of city trees	$1,000
Visual survey for signs of EAB	

Year 5

Remove 4 ash trees	$2,800
Plant and maintain 4 trees in open locations	Booster Club
Visual survey for signs of EAB	

Year 6

Remove 3 ash trees	$2,100
Plant and maintain 3 trees in open locations	Booster Club
Prune 1/3 of city trees	$1,000
Visual survey for signs of EAB	

Purposed Budget Increase

EAB could potentially kill all ash trees in Harpers Ferry within 4 years of its arrival. To remove all ash trees, replant trees, and prune the trees in Harpers Ferry within 6 years the budget would need to be increased to $3,300 a year. Additionally, it is recommended that Harpers Ferry 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.

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Appendix A: i-Tree Data

Table 1: Annual Energy Benefits

Annual Energy Benefits of Public Trees by Species

5/21/2010

Species	Total Electricity (MWh)	Electricity ($)	Total Natural Gas (Therms)	Natural Gas ($)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Sugar maple	4.6	353	594.9	583	936	(N/A)	20.2	20.7	44.55
Green ash	3.9	295	495.5	486	780	(N/A)	16.4	17.3	45.90
Norway maple	3.2	243	475.4	466	709	(N/A)	12.5	15.7	54.55
Red maple	1.2	94	175.0	171	266	(N/A)	9.6	5.9	26.60
Littleleaf linden	1.2	94	157.1	154	248	(N/A)	7.7	5.5	31.03
American basswood	2.3	178	339.3	333	510	(N/A)	6.7	11.3	72.90
Silver maple	1.2	90	158.8	156	246	(N/A)	3.9	5.5	61.47
Apple	0.1	7	15.2	15	22	(N/A)	3.9	0.5	5.40
Lilac	0.8	61	126.5	124	185	(N/A)	3.9	4.1	46.14
Eastern red cedar	0.3	25	49.3	48	74	(N/A)	2.9	1.6	24.57
White ash	0.4	27	41.7	41	68	(N/A)	1.9	1.5	34.11
Honeylocust	0.6	47	84.6	83	130	(N/A)	1.9	2.9	64.79
Black walnut	0.5	38	65.1	64	102	(N/A)	1.9	2.3	50.77
Northern red oak	0.2	14	28.3	28	42	(N/A)	1.9	0.9	21.11
Other street trees	0.9	68	128.4	126	194	(N/A)	4.8	4.3	38.84
Citywide total	21.5	1,635	2,935.1	2,876	4,511	(N/A)	100.0	100.0	43.38

Table 2: Annual Stormwater Benefits

Annual Stormwater Benefits of Public Trees by Species

5/21/2010

Species	Total rainfall interception (Gal)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Sugar maple	44,112	1,196	(N/A)	20.2	21.4	56.93
Green ash	32,613	884	(N/A)	16.4	15.8	51.99
Norway maple	31,904	865	(N/A)	12.5	15.5	66.51
Red maple	8,371	227	(N/A)	9.6	4.1	22.69
Littleleaf linden	7,679	208	(N/A)	7.7	3.7	26.02
American basswood	30,446	825	(N/A)	6.7	14.8	117.88
Silver maple	17,291	469	(N/A)	3.9	8.4	117.15
Apple	275	7	(N/A)	3.9	0.1	1.86
Lilac	4,696	127	(N/A)	3.9	2.3	31.82
Eastern red cedar	4,903	133	(N/A)	2.9	2.4	44.30
White ash	2,276	62	(N/A)	1.9	1.1	30.84
Honeylocust	5,810	157	(N/A)	1.9	2.8	78.73
Black walnut	4,056	110	(N/A)	1.9	2.0	54.96
Northern red oak	1,057	29	(N/A)	1.9	0.5	14.33
Other street trees	10,395	282	(N/A)	4.8	5.1	56.34
Citywide total	205,884	5,580	(N/A)	100.0	100.0	53.65

Table 3: Annual Air Quality Benefits

Annual Air Quality Benefits of Public Trees by Species

5/21/2010

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
Sugar maple	5.9	1.0	3.0	0.3	32	21.8	3.2	3.1	21.0	137	-4.8	-18	54.6	151	(N/A)	20.2	7.20
Green ash	3.3	0.5	1.7	0.1	18	18.2	2.7	2.6	17.6	114	0.0	0	46.7	132	(N/A)	16.3	7.77
Norway maple	6.7	1.2	3.3	0.3	36	15.7	2.3	2.1	14.5	97	-1.6	-6	44.4	127	(N/A)	12.5	9.76
Red maple	1.5	0.3	0.8	0.1	8	6.0	0.9	0.8	5.6	37	-0.6	-2	15.4	43	(N/A)	9.6	4.34
Littleleaf linden	0.9	0.2	0.5	0.0	5	5.8	0.9	0.8	5.6	37	-0.5	-2	14.2	40	(N/A)	7.7	4.97
American basswood	4.5	0.8	2.2	0.2	24	11.4	1.6	1.6	10.6	70	-3.7	-14	29.1	81	(N/A)	6.7	11.51
Silver maple	2.9	0.5	1.4	0.1	16	5.6	0.8	0.8	5.4	35	-1.5	-6	16.0	45	(N/A)	3.8	11.28
Apple	0.0	0.0	0.0	0.0	0	0.4	0.1	0.1	0.4	3	0.0	0	1.0	3	(N/A)	3.8	0.71
Lilac	1.7	0.3	0.8	0.1	9	4.0	0.6	0.5	3.6	24	0.0	0	11.5	33	(N/A)	3.8	8.35
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)	2.9	2.19
White ash	0.1	0.0	0.1	0.0	1	1.7	0.2	0.2	1.6	10	0.0	0	4.0	11	(N/A)	1.9	5.61
Honeylocust	1.1	0.2	0.5	0.0	6	2.9	0.4	0.4	2.8	18	-0.8	-3	7.6	21	(N/A)	1.9	10.61
Black walnut	0.4	0.1	0.2	0.0	2	2.3	0.3	0.3	2.3	15	0.0	0	5.9	17	(N/A)	1.9	8.38
Northern red oak	0.1	0.0	0.1	0.0	1	0.9	0.1	0.1	0.9	6	-0.2	-1	2.1	6	(N/A)	1.9	2.89
Other street trees	1.7	0.3	1.0	0.1	10	4.3	0.6	0.6	4.1	27	-2.9	-11	9.9	26	(N/A)	4.8	5.18
Citywide total	32.0	5.4	16.3	1.5	175	102.7	15.0	14.3	97.6	640	-19.2	-72	265.7	743	(N/A)	100.0	7.14

Table 4: Annual Carbon Stored

Stored CO2 Benefits of Public Trees by Species

5/21/2010

Species	Total Stored CO2 (lbs)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Sugar maple	178,012	1,335	(N/A)	20.2	23.2	63.58
Green ash	109,239	819	(N/A)	16.4	14.3	48.19
Norway maple	110,108	826	(N/A)	12.5	14.4	63.52
Red maple	18,409	138	(N/A)	9.6	2.4	13.81
Littleleaf linden	21,049	158	(N/A)	7.7	2.8	19.73
American	169,474	1,271	(N/A)	6.7	22.1	181.58
Silver maple	63,335	475	(N/A)	3.9	8.3	118.75
Apple	711	5	(N/A)	3.9	0.1	1.33
Lilac	26,971	202	(N/A)	3.9	3.5	50.57
Eastern red cedar	3,306	25	(N/A)	2.9	0.4	8.27
White ash	4,706	35	(N/A)	1.9	0.6	17.65
Honeylocust	13,485	101	(N/A)	1.9	1.8	50.57
Black walnut	12,130	91	(N/A)	1.9	1.6	45.49
Northern red oak	2,049	15	(N/A)	1.9	0.3	7.68
Other street trees	14,994	248	(N/A)	4.8	4.3	49.59
Citywide total	766,043	5,745	(N/A)	100.0	100.0	55.24

Table 5: Annual Carbon Sequestered

Annual CO Benefits of Public Trees by Species

5/21/2010

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
Sugar maple	9,390	70	-854	-4	-6	7,791	58	16,321	122	(N/A)	20.2	21.0	5.83
Green ash	8,185	61	-524	-3	-4	6,512	49	14,170	106	(N/A)	16.4	18.2	6.25
Norway maple	3,678	28	-529	-3	-4	5,376	40	8,522	64	(N/A)	12.5	11.0	4.92
Red maple	1,516	11	-88	-2	-1	2,088	16	3,514	26	(N/A)	9.6	4.5	2.64
Littleleaf linden	3,241	24	-101	-2	-1	2,085	16	5,224	39	(N/A)	7.7	6.7	4.90
American basswood	9,304	70	-813	-1	-6	3,930	29	12,419	93	(N/A)	6.7	16.0	13.31
Silver maple	4,805	36	-304	-1	-2	1,994	15	6,495	49	(N/A)	3.9	8.4	12.18
Apple	152	1	-3	-1	0	149	1	296	2	(N/A)	3.9	0.4	0.56
Lilac	0	0	-129	-1	-1	1,339	10	1,209	9	(N/A)	3.9	1.6	2.27
Eastern red cedar	43	0	-16	-1	0	561	4	587	4	(N/A)	2.9	0.8	1.47
White ash	676	5	-23	0	0	604	5	1,257	9	(N/A)	1.9	1.6	4.71
Honeylocust	1,873	14	-65	0	0	1,030	8	2,838	21	(N/A)	1.9	3.7	10.64
Black walnut	1,105	8	-58	0	0	834	6	1,881	14	(N/A)	1.9	2.4	7.05
Northern red oak	295	2	-10	0	0	320	2	604	5	(N/A)	1.9	0.8	2.27
Other street trees	1,133	8	-159	-1	-1	1,512	11	2,486	19	(N/A)	4.8	3.2	3.73
Citywide total	45,396	340	-3,677	-20	-28	36,125	271	77,823	584	(N/A)	100.0	100.0	5.61

Table 6: Annual Social and Aesthetic Benefits

Annual Aesthetic/Other Benefits of Public Trees by Species

5/21/2010

Species	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Sugar maple	1,015	(N/A)	20.2	22.5	48.35
Green ash	787	(N/A)	16.4	17.5	46.32
Norway maple	353	(N/A)	12.5	7.8	27.15
Red maple	252	(N/A)	9.6	5.6	25.22
Littleleaf linden	369	(N/A)	7.7	8.2	46.13
American basswood	617	(N/A)	6.7	13.7	88.17
Silver maple	392	(N/A)	3.9	8.7	97.94
Apple	8	(N/A)	3.9	0.2	2.06
Lilac	0	(N/A)	3.9	0.0	0.00
Eastern red cedar	14	(N/A)	2.9	0.3	4.56
White ash	97	(N/A)	1.9	2.2	48.58
Honeylocust	389	(N/A)	1.9	8.6	194.60
Black walnut	104	(N/A)	1.9	2.3	51.77
Northern red oak	32	(N/A)	1.9	0.7	16.24
Other street trees	81	(N/A)	4.8	1.8	16.22
Citywide total	4,511	(N/A)	100.0	100.0	43.38

Table 7: Summary of Benefits in Dollars

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

5/21/2010

Species	Energy	CO_2	Air Quality	Stormwater	Aesthetic/Other	Total ($)	Standard Error
Sugar maple	44.55	5.83	7.20	56.93	48.35	162.86	(N/A)
Green ash	45.90	6.25	7.77	51.99	46.32	158.24	(N/A)
Norway maple	54.55	4.92	9.76	66.51	27.15	162.89	(N/A)
Red maple	26.60	2.64	4.34	22.69	25.22	81.48	(N/A)
Littleleaf linden	31.03	4.90	4.97	26.02	46.13	113.05	(N/A)
American basswood	72.90	13.31	11.51	117.88	88.17	303.77	(N/A)
Silver maple	61.47	12.18	11.28	117.15	97.94	300.02	(N/A)
Apple	5.40	0.56	0.71	1.86	2.06	10.59	(N/A)
Lilac	46.14	2.27	8.35	31.82	0.00	88.57	(N/A)
Eastern red cedar	24.57	1.47	2.19	44.30	4.56	77.08	(N/A)
White ash	34.11	4.71	5.61	30.84	48.58	123.86	(N/A)
Honeylocust	64.79	10.64	10.61	78.73	194.60	359.38	(N/A)
Black walnut	50.77	7.05	8.38	54.96	51.77	172.94	(N/A)
Northern red oak	21.11	2.27	2.89	14.33	16.24	56.84	(N/A)
Other street trees	38.84	3.73	5.18	56.34	16.22	120.32	(N/A)

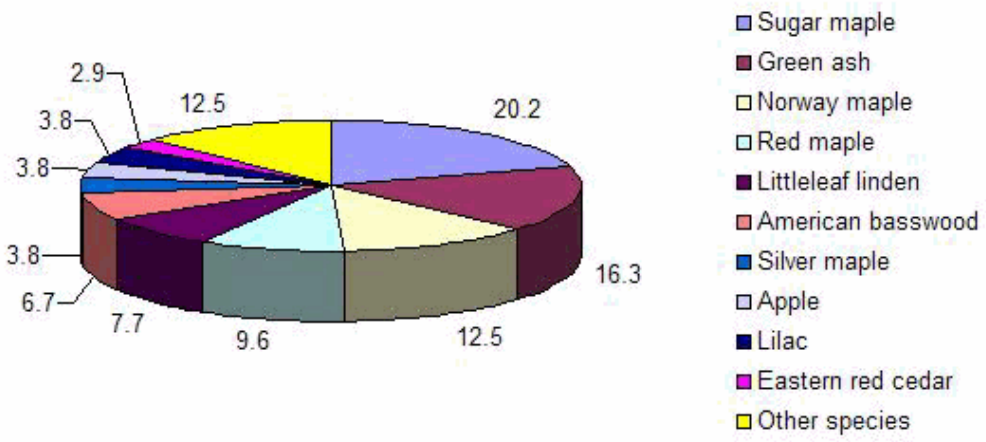
Total Annual Benefits of Public Trees by Species ($)

5/21/2010

Species	Energy	CO_2	Air Quality	Stormwater	Aesthetic/Other	Total ($)	Standard Error	% of Total $
Sugar maple	936	122	151	1,196	1,015	3,420	(±0)	21.5
Green ash	780	106	132	884	787	2,690	(±0)	16.9
Norway maple	709	64	127	865	353	2,118	(±0)	13.3
Red maple	266	26	43	227	252	815	(±0)	5.1
Littleleaf linden	248	39	40	208	369	904	(±0)	5.7
American basswood	510	93	81	825	617	2,126	(±0)	13.3
Silver maple	246	49	45	469	392	1,200	(±0)	7.5
Apple	22	2	3	7	8	42	(±0)	0.3
Lilac	185	9	33	127	0	354	(±0)	2.2
Eastern red cedar	74	4	7	133	14	231	(±0)	1.5
White ash	68	9	11	62	97	248	(±0)	1.6
Honeylocust	130	21	21	157	389	719	(±0)	4.5
Black walnut	102	14	17	110	104	346	(±0)	2.2
Northern red oak	42	5	6	29	32	114	(±0)	0.7
Other street trees	194	19	26	282	81	602	(±0)	3.8
Citywide Total	4,511	584	743	5,580	4,511	15,929	(±0)	100.0

Species Distribution of Public Trees (%)

5/21/2010

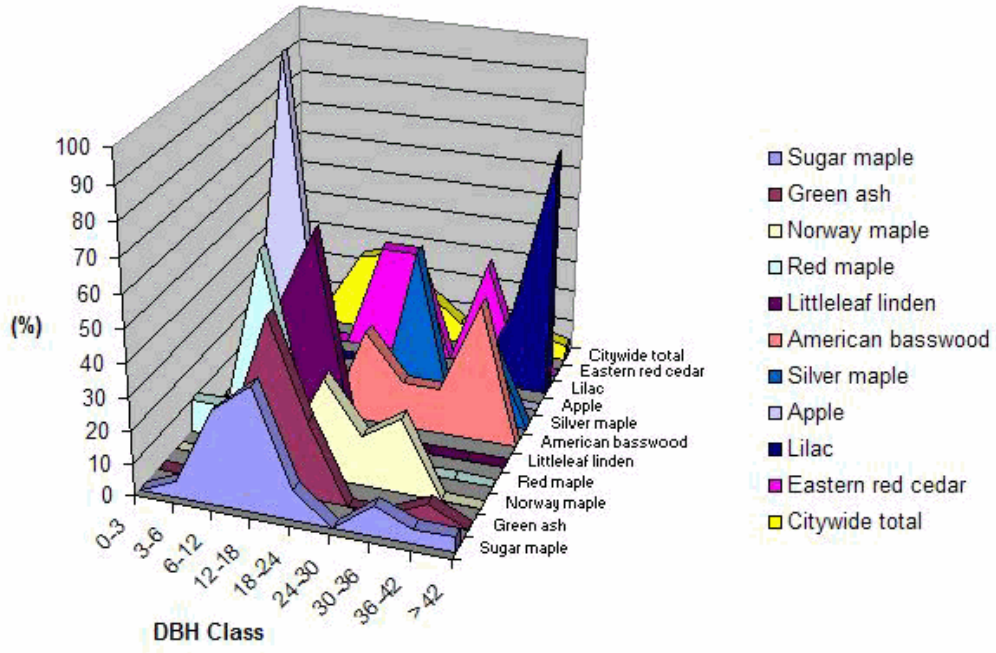


Species	Percent
Sugar maple	20.2
Green ash	16.3
Norway maple	12.5
Red maple	9.6
Littleleaf linden	7.7
American basswood	6.7
Silver maple	3.8
Apple	3.8
Lilac	3.8
Eastern red cedar	2.9
Other species	12.5
Total	100.0

Figure 1: Species Distribution

Relative Age Distribution of Top 10 Public Tree Species (%)

5/21/2010



	DBH class (in)								
Species	0-3	3-6	6-12	12-18	18-24	24-30	30-36	36-42	>42
Sugar maple	0.0	4.8	28.6	38.1	9.5	0.0	9.5	4.8	4.8
Green ash	0.0	0.0	17.6	52.9	23.5	0.0	0.0	5.9	0.0
Norway maple	0.0	0.0	23.1	7.7	30.8	15.4	23.1	0.0	0.0
Red maple	10.0	10.0	60.0	10.0	0.0	10.0	0.0	0.0	0.0
Littleleaf linden	0.0	0.0	37.5	62.5	0.0	0.0	0.0	0.0	0.0
American basswood	0.0	0.0	0.0	0.0	28.6	14.3	14.3	42.9	0.0
Silver maple	0.0	0.0	25.0	0.0	0.0	50.0	0.0	25.0	0.0
Apple	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lilac	0.0	0.0	0.0	0.0	0.0	0.0	0.0	25.0	75.0
Eastern red cedar	0.0	0.0	0.0	33.3	33.3	0.0	33.3	0.0	0.0
Citywide total	1.9	5.8	24.0	26.9	15.4	6.7	6.7	7.7	4.8

Figure 2: Relative Age Class

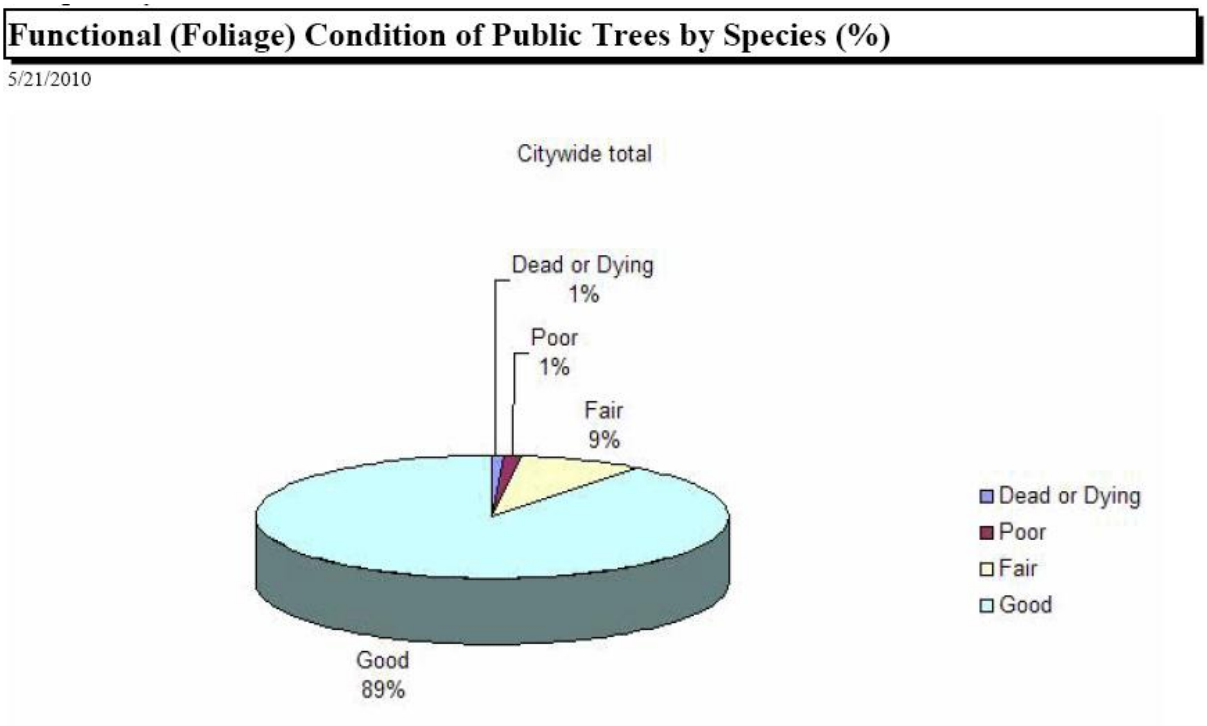


Figure 3: Foliage Condition

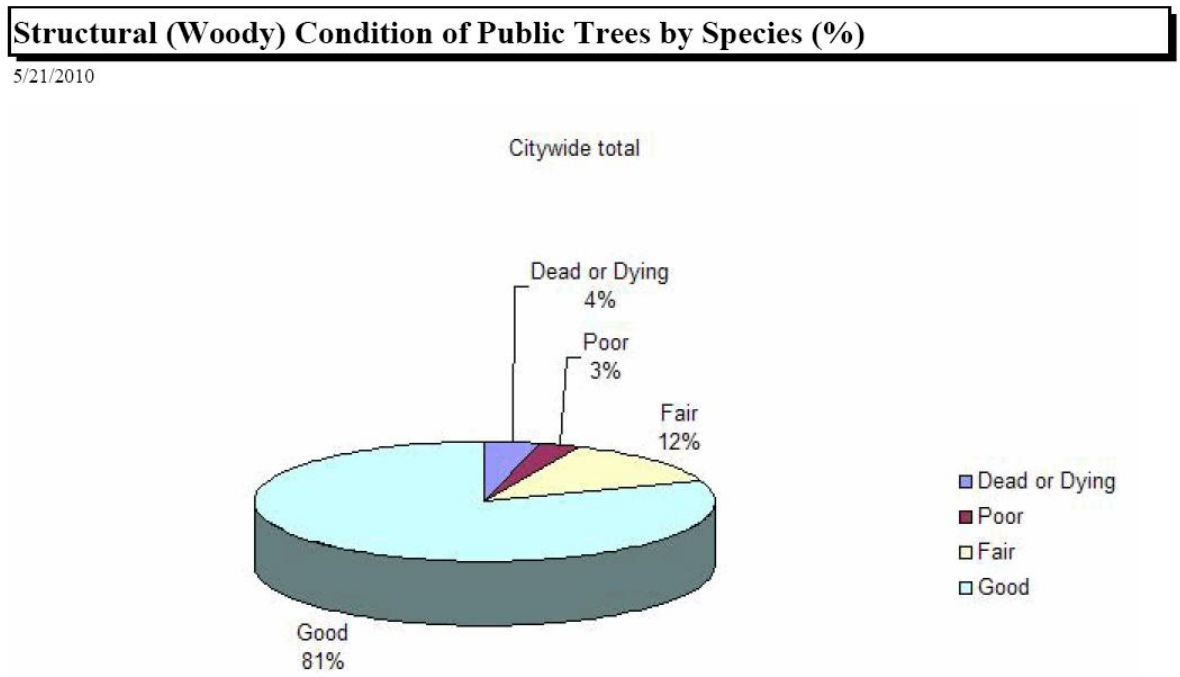
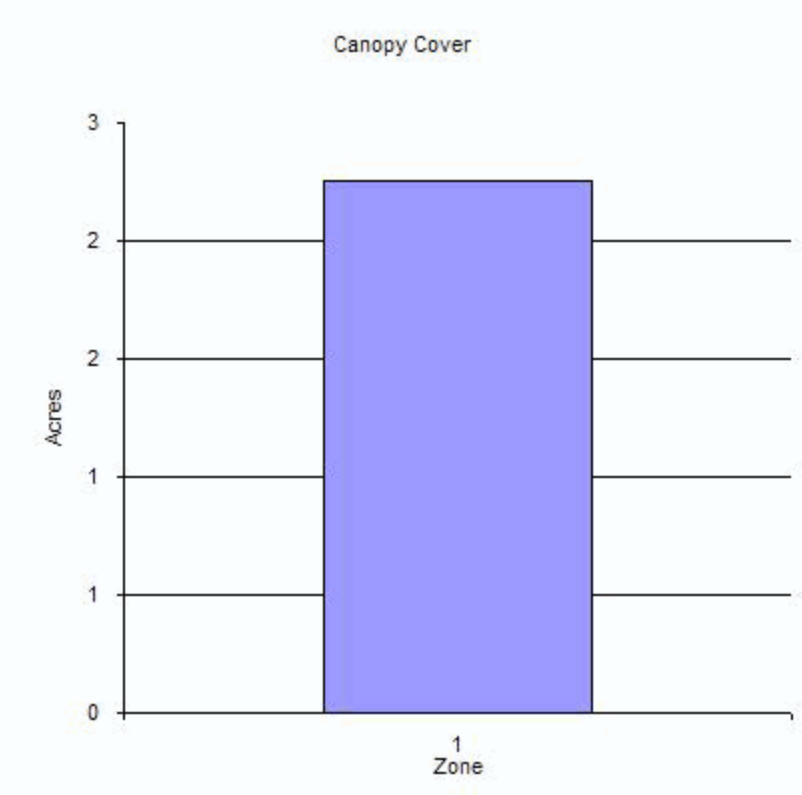


Figure 4: Wood Condition

Canopy Cover of Public Trees (Acres)

5/21/2010



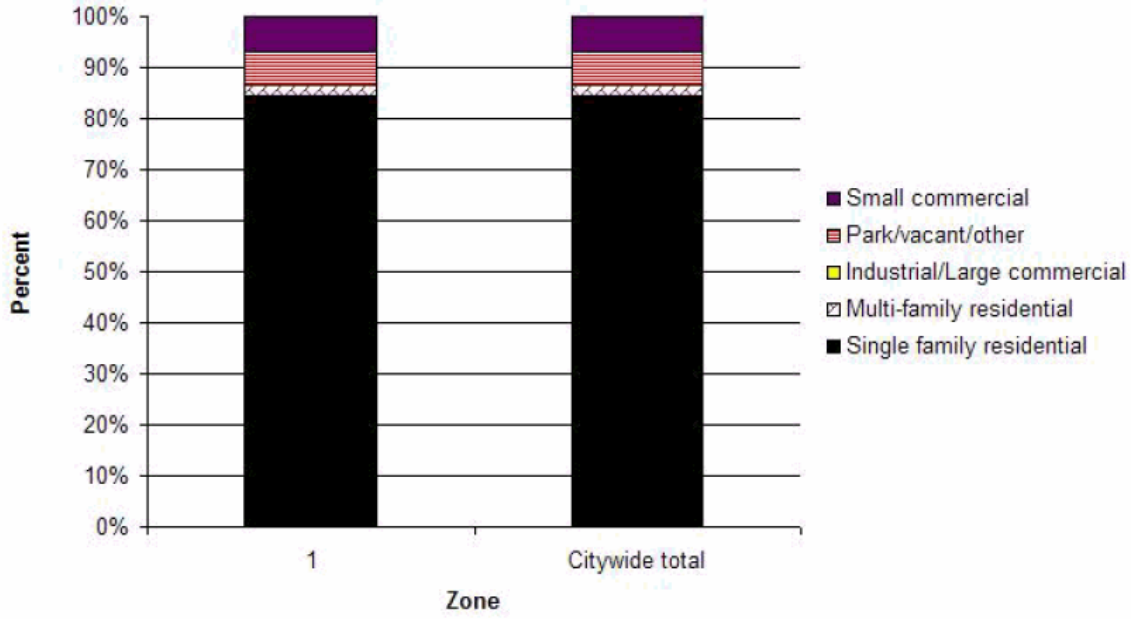
Zone	Acres	% of Total Canopy Cover
1	2	100.0
Citywide total	2	100.0

	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	0	0	2		

Figure 5: Canopy Cover in Acres

Land Use of Public Trees by Zone (%)

5/21/2010

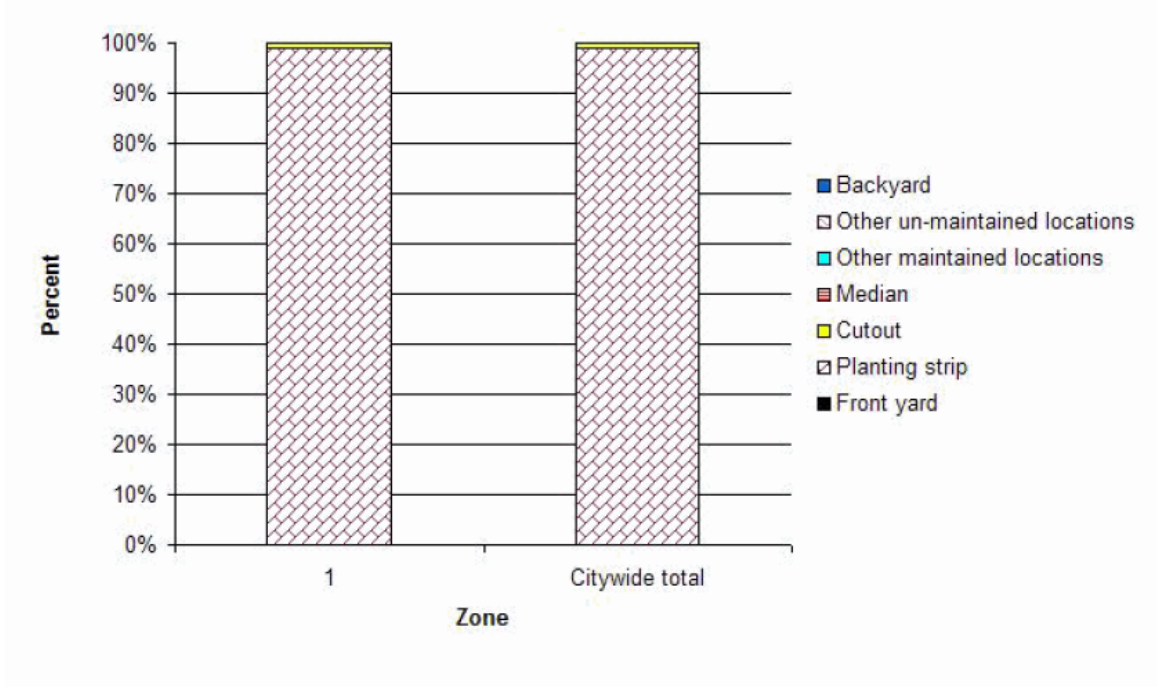


Zone	Single family residential	Multi-family residential	Industrial/ Large commercial	Park/vacant/ other	Small commercial
1	84.6	1.9	0.0	6.7	6.7
Citywide total	84.6	1.9	0.0	6.7	6.7

Figure 6: Land Use of city/park trees

Location of Public Trees by Zone (%)

5/21/2010



Zone	Front yard	Planting strip	Cutout	Median	Other maintained locations	Other un-maintained locations	Backyard
1	0.0	99.0	1.0	0.0	0.0	0.0	0.0
Citywide total	0.0	99.0	1.0	0.0	0.0	0.0	0.0

Figure 7: Location of city/park trees

Appendix B: ArcGIS Mapping

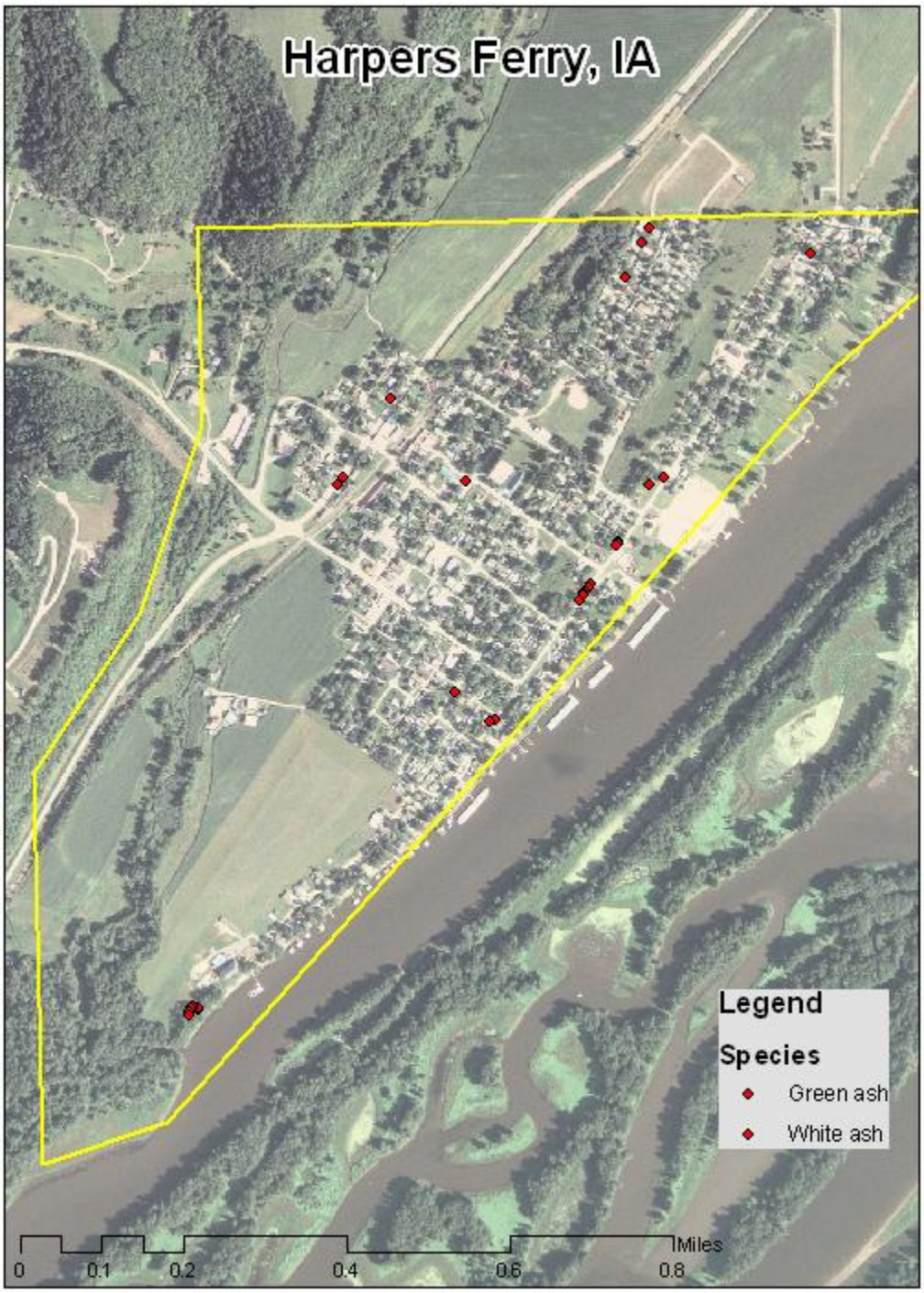


Figure 1: Location of Ash Trees

Figure 2: Location of EAB symptoms

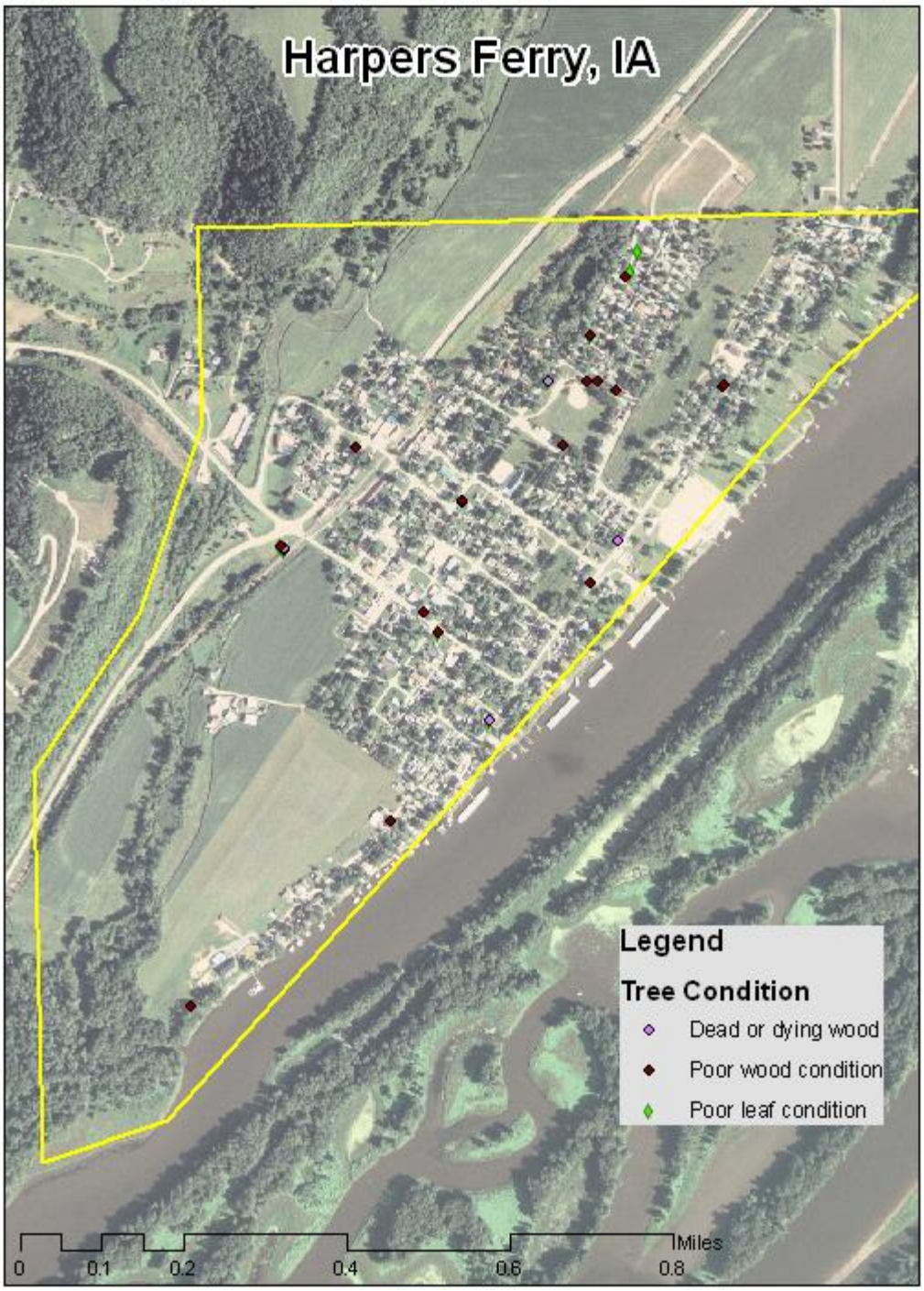


Figure 3: Location of Poor Condition Trees

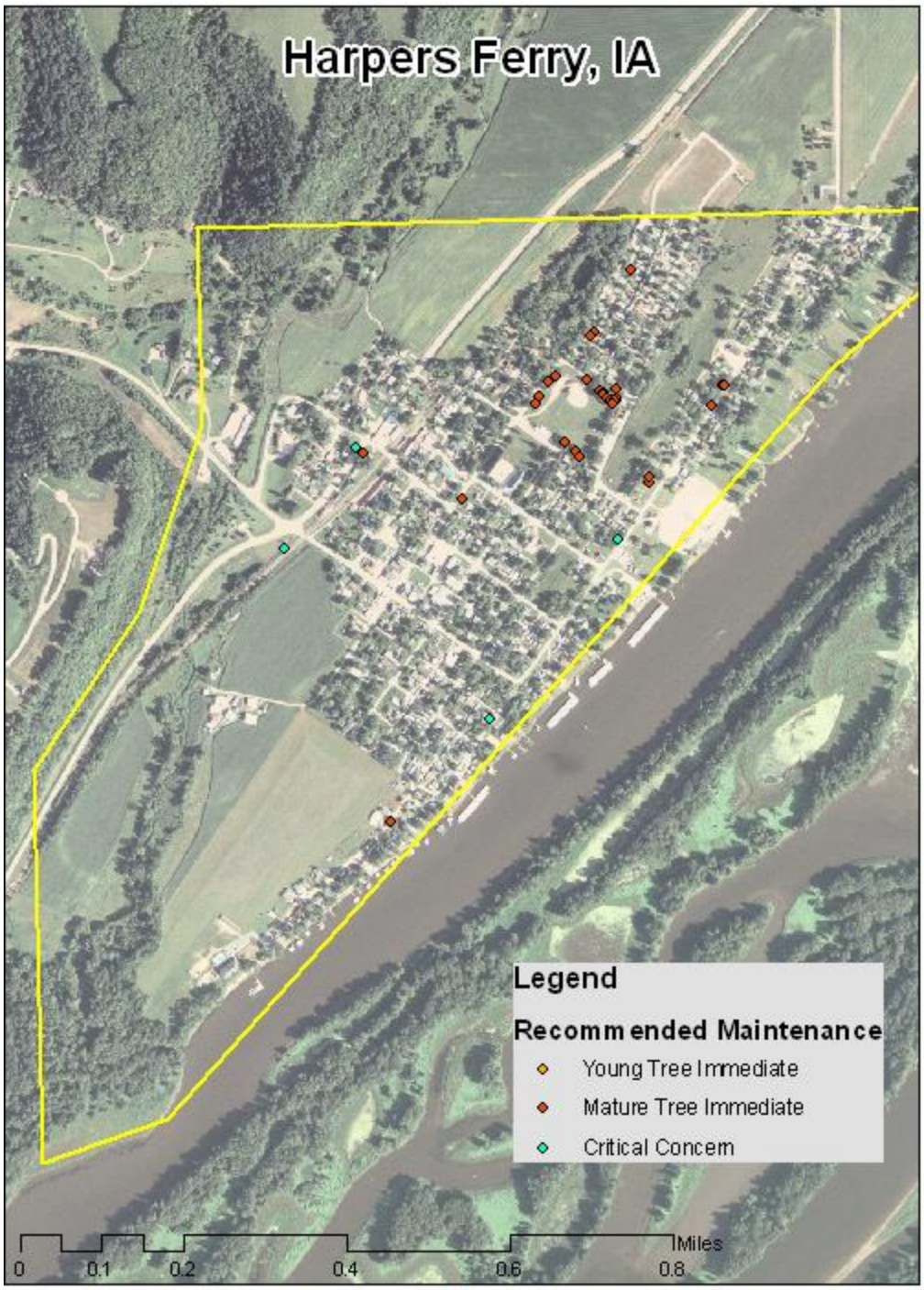


Figure 4: Location of Trees with Recommended Maintenance

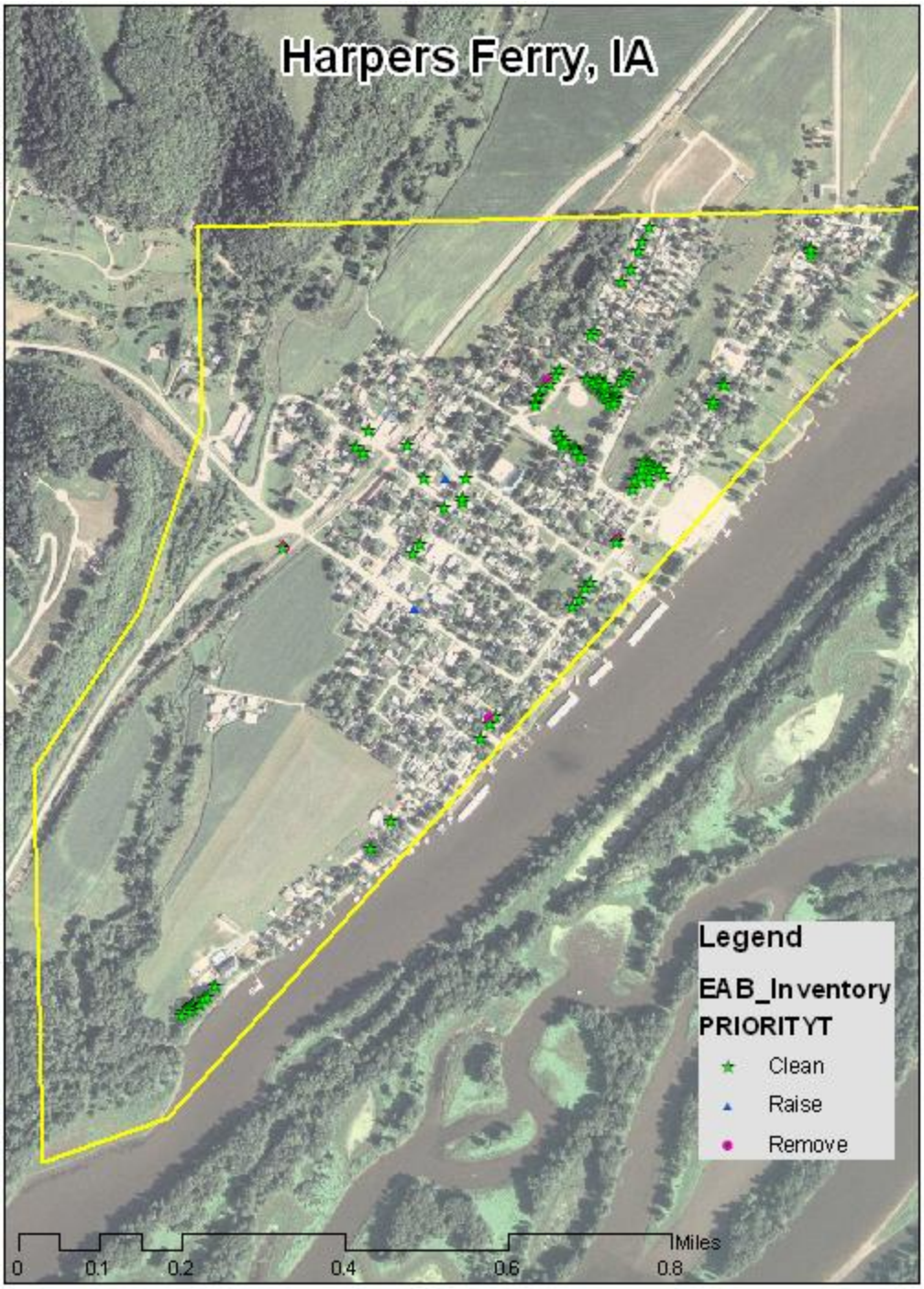


Figure 5: Maintenance Tasks *City ownership of the trees recommended for removal should be verified prior to any removal*

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