Danville, IA
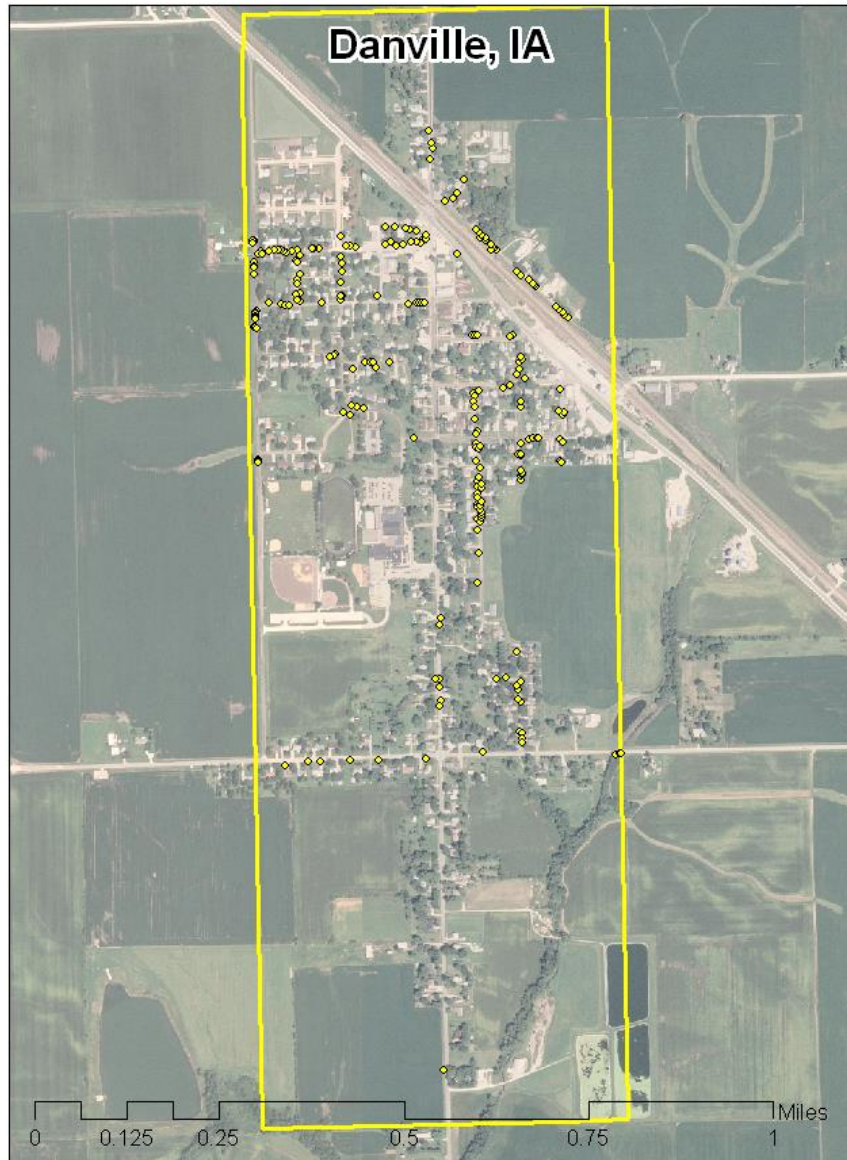

Danville, IA

2010 Management Plan
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Executive Summary_____

Overview

This plan was developed to assist the City of Danville 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 15% of Danville'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 2010, 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 230 street trees inventoried.
- Danville's trees provide $27,954 of benefits annually, an average of $121 a tree
- There are over 37 species of trees
- The top three genus are: Maple 30%, Ash 14%, and Spruce 11%
- 36% of trees are in need of some type of management
- 15 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 15 trees needing removal, 5 trees are over 18 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*
- 2 of the 35 ash trees are in need of follow up because they are 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
- With the current budget it could take 18 years to remove ash – Suggestion: request a budget increase to $1,000 annually and apply for grants to plant replacement trees

Introduction

This plan was developed to assist Danville 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 Danville, these costs can be extended over years and public safety issues from dead and dying ash trees mitigated.

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

Inventory

In 2010, a tree inventory was conducted that included 100% of the city owned streets trees. 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 230 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. Findings

Annual Benefits

Annual Energy Benefits

Trees conserve energy by shading buildings and blocking winds. Danville's trees reduce energy related costs by approximately $7,644 annually (Appendix A, Table 1). These savings are both in Electricity (36.5 MWh) and in Natural Gas (4, 972.9 Therms).

Annual Stormwater Benefits

Danville's trees intercept about 356,508 gallons of rainfall or snow melt a year (Appendix A, Table 2). This interception provides $9,662 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 Danville, it is estimated that trees remove 437.8 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 $1,220 (Appendix A, Table 3).

Annual Carbon Benefits

Carbon sequestration and storage reduce the amount of carbon in the atmosphere, mitigating climate change. In Danville, trees sequester about 134,071 lbs of carbon a year with an associated value of $1,066 (Appendix A, Table 4). In addition, the trees store 1,703,799 lbs of carbon, with a yearly benefit of $8,053 (Appendix A, Table 5).

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. Danville receives $8,423 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, Danville's trees provide $27,954 of benefits annually. Benefits of individual trees vary based on size, species, health and location, but on average each of the 230 trees in Danville provide approximately $121 annually (Appendix A, Table 7).

Forest Structure

Species Distribution

Danville has over 37 different tree species along city streets and parks (Appendix A, Figure 1). The distribution of trees by genus is as follows:

Maple	73	30%
Ash	35	14%
Spruce	26	11%
Pine	14	6%
Arborvitae (White Cedar)	12	5%
Walnut	10	5%
Oak	11	5%
Redbud	6	3%
Mulberry	6	3%
Apple (Crab)	5	2%
Plum	5	2%
Hackberry	2	< 1%
Basswood	2	<1%
Locust	2	<1%
Cherry	2	<1%
Elm	2	<1%
Other large/small deciduous	17	8%

Age Class

Most of Danville's trees (42%) are between 12 and 24 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 18 inches in diameter at 4.5 ft. Danville's size curve is right on track with medium age, and also has a large (28%) young stand from 0-6", indicating an overall 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 Danville indicate that 71% of the trees are in good health, with only 4% of the foliage in poor health (Appendix A, Figure 3 & Appendix B, Figure 3). Similarly, 58% of Danville'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 8% 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	38	16%
Crown Raising	9	4%
Tree Staking	1	<1%
Tree Removal	15	7%
Crown Reduction	20	9%

Canopy Cover

The canopy cover of Danville is approximately 4 acres (Appendix A, Figure 4).   According to the 2000 census, Danville occupies 486 acres. Thus the canopy cover on city land is less than 1%.

Land Use and Location

The majority of Danville'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	91.3%
Park/vacant/other	6.5%
Small commercial	2.2%
Multifamily residential	0%

Location
Backyard	7.4%
Other maintained locations	6.5 %
Front yard	86.1%

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
Danville has 1 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 are 4 trees over 18 inches in diameter at 4.5 ft that should be addressed immediately. Please refer to the six year maintenance plan at the end of this section. After all of the critical concern trees are

addressed, there should be follow up on the trees marked as needing maintenance that do not include trimming. There are a total of 30 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 15 removals, 0 are ash trees. There are a total of 35 ash trees, and 2 of those have signs and symptoms that have been associated with EAB. In addition, there are other trees that are in need of attention and maintenance. *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 Danville.

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 (30%) and Ash (14%) (Appendix A, Figure 1). Maples and Ash 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, suggested to be outlined in a section of the city ordinance (Appendix C). All trees planted must meet the restrictions in current city ordinance 12.16.020, 12.16.050 (Appendix C).

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.

Six Year Maintenance Plan with <u>No Additional Funding</u>

Year 1
> Removal: critical concern tree, 1 large immediate concern
> Planting and Replacement: 3-4 trees to be planted in open locations
> Visual Survey for signs and symptoms of EAB

Year 2
> Removal: 1-2 largest trees with immediate concern, poor health
> Planting and Replacement: 1-2 trees in open locations from year one removals
> Routine trimming: encourage landowner trimming, stay current with line trimming
> Visual Survey for signs and symptoms of EAB

Year 3
> Removal: 1-2 largest immediate concern, any new critical concern trees
> Planting and Replacement: 3-4 trees to be planted in open locations and locations from previous removals
> Visual Survey for signs and symptoms of EAB

Year 4
> Removal: 1-2 trees - removal of any new critical concern trees and ash in poor health
> Planting and Replacement: 1-2 trees in open locations from previous removals
> Routine trimming: encourage landowner trimming, line trimming
> Visual Survey for signs and symptoms of EAB

Year 5
> Removal: removal of any new critical concern trees and ash in poor health
> Planting and Replacement: 3-4 trees to be planted in open locations and locations from previous removals
> Visual Survey for signs and symptoms of EAB

Year 6
> Removal: removal of any new critical concern trees and ash in poor health
> Planting and Replacement: 1-2 trees in open locations from previous removals
> Routine trimming: encourage landowner trimming, line trimming
> Visual Survey for signs and symptoms of EAB

*Reduction of ash over 6 years: Approximately 2 ash trees removed (approximately 5% of ash). It will take approximately 18 years to remove all ash with the current budget. EAB could potentially kill all ash within 4 years of its arrival.
** To remove all ash trees within 6 years, the budget would need to be increased to $4,300 a year. If the budget were increased to $2,000 a year all ash could be removed in 13 years.

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. All trees will meet any restrictions in city ordinance (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 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 upon arrival of EAB. City code 12.16.020 Maintenance by owner states "All abutting and adjoining property owners shall maintain all property outside the lot and property lines and inside the curb lines upon the public streets, except that the property owner shall not be required to remove diseased or dead wood on the publicly owned property or right-of-way. Such maintenance shall include, but not limited to, the pruning and care of all trees, shrubs, and bushes upon the public streets or right-of-way."

Budget

Current Budget
Total $12,000 over 6 years ($2,000/year)

FY 2011 Budget
> Removal: $2,000
> Planting: possible grant funded
> Watering & Maintenance: $500

FY 2012 Budget
> Removal: $1,500
> Planting: possible grant funded
> Watering & Maintenance: $500

FY 2013 Budget
> Removal: $1,000
> Planting: $600
> Watering & Maintenance: $400

FY 2014 Budget
> Removal: $2,000
> Planting: possible grant funded
> Watering & Maintenance: $

FY 2015 Budget
> Removal: $2,000
> Planting: possible grant funding
> Watering & Maintenance: $

FY 2016 Budget
> Removal: $1,000
> Planting: $500
> Watering & Maintenance: $500

*Reduction of ash over 6 years: approximately 2 ash trees removed (approximately 5% of ash).
It will take approximately 18 years to remove all ash with the current budget.

Purposed Budget Increase
EAB could potentially kill all ash trees in Danville within 4 years of its arrival. To remove all ash trees within 6 years the budget would need to be increased to $4,300 a year. If the budget were increased to $2,000 a year all ash could be removed within 13 years. Additionally, it is recommended that Danville 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

11/22/2010

Species	Total Electricity (MWh)	Electricity ($)	Total Natural Gas (Therms)	Natural Gas ($)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Green ash	7.6	579	1,038.0	1,017	1,597	(N/A)	14.8	20.9	46.96
Sugar maple	7.8	589	1,026.9	1,006	1,595	(N/A)	13.9	20.9	49.85
Silver maple	5.2	397	687.4	674	1,071	(N/A)	9.1	14.0	50.99
Norway spruce	1.5	117	211.3	207	324	(N/A)	7.8	4.2	18.02
Northern white cedar	0.1	8	17.9	18	25	(N/A)	5.2	0.3	2.10
Black walnut	2.3	174	308.2	302	476	(N/A)	4.8	6.2	43.30
Norway maple	1.3	101	171.3	168	268	(N/A)	3.5	3.5	33.56
Red maple	1.2	91	160.0	157	248	(N/A)	3.5	3.2	31.00
Blue spruce	0.6	45	86.2	84	130	(N/A)	3.5	1.7	16.25
Eastern white pine	0.4	29	54.2	53	83	(N/A)	3.0	1.1	11.80
Eastern redbud	0.6	43	82.6	81	123	(N/A)	2.6	1.6	20.58
White mulberry	0.0	2	3.7	4	5	(N/A)	2.6	0.1	0.87
Eastern red cedar	0.2	16	34.2	33	50	(N/A)	2.2	0.7	9.90
Apple	0.2	16	37.1	36	53	(N/A)	2.2	0.7	10.52
Plum	0.1	9	21.7	21	31	(N/A)	2.2	0.4	6.15
Northern pin oak	1.2	93	182.6	179	272	(N/A)	2.2	3.6	54.46
Red pine	0.2	17	32.1	31	49	(N/A)	1.7	0.6	12.23
Broadleaf Deciduous	0.1	5	11.4	11	16	(N/A)	1.3	0.2	5.40
Oak	0.9	70	131.8	129	199	(N/A)	1.3	2.6	66.38
Swamp white oak	0.1	9	18.6	18	27	(N/A)	1.3	0.4	8.99
Lilac	0.0	4	8.2	8	12	(N/A)	1.3	0.2	3.89
Other street trees	4.7	355	647.6	635	989	(N/A)	10.0	12.9	43.01
Citywide total	36.5	2,770	4,972.9	4,873	7,644	(N/A)	100.0	100.0	33.23

Table 2: Annual Stormwater Benefits

Annual Stormwater Benefits of Public Trees by Species

11/22/2010

Species	Total rainfall interception (Gal)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Green ash	68,804	1,865	(N/A)	14.8	19.3	54.85
Sugar maple	71,830	1,947	(N/A)	13.9	20.2	60.84
Silver maple	55,947	1,516	(N/A)	9.1	15.7	72.20
Norway spruce	20,003	542	(N/A)	7.8	5.6	30.12
Northern white cedar	1,077	29	(N/A)	5.2	0.3	2.43
Black walnut	21,200	575	(N/A)	4.8	6.0	52.23
Norway maple	7,806	212	(N/A)	3.5	2.2	26.44
Red maple	8,225	223	(N/A)	3.5	2.3	27.86
Blue spruce	7,122	193	(N/A)	3.5	2.0	24.13
Eastern white pine	5,571	151	(N/A)	3.0	1.6	21.57
Eastern redbud	1,999	54	(N/A)	2.6	0.6	9.03
White mulberry	45	1	(N/A)	2.6	0.0	0.20
Eastern red cedar	2,820	76	(N/A)	2.2	0.8	15.29
Apple	735	20	(N/A)	2.2	0.2	3.98
Plum	417	11	(N/A)	2.2	0.1	2.26
Northern pin oak	13,784	374	(N/A)	2.2	3.9	74.71
Red pine	2,559	69	(N/A)	1.7	0.7	17.34
Broadleaf Deciduous	206	6	(N/A)	1.3	0.1	1.86
Oak	10,476	284	(N/A)	1.3	2.9	94.64
Swamp white oak	488	13	(N/A)	1.3	0.1	4.41
Lilac	145	4	(N/A)	1.3	0.0	1.31
Other street trees	55,250	1,497	(N/A)	10.0	15.5	65.10
Citywide total	356,508	9,662	(N/A)	100.0	100.0	42.01

Annual Air Quality Benefits of Public Trees by Species

11/22/2010

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
Green ash	6.9	1.1	3.6	0.3	37	36.4	5.3	5.1	34.6	227	0.0	0	93.2	264 (N/A)	14.8	7.77
Sugar maple	8.6	1.5	4.5	0.4	47	36.7	5.4	5.1	35.2	229	-7.0	-26	90.4	251 (N/A)	13.9	7.84
Silver maple	7.4	1.2	3.9	0.3	41	24.7	3.6	3.4	23.7	154	-4.4	-16	63.9	178 (N/A)	9.1	8.50
Norway spruce	2.1	0.4	1.9	0.3	14	7.4	1.1	1.0	7.0	46	-7.9	-29	13.2	31 (N/A)	7.8	1.70
Northern white cedar	0.0	0.0	0.0	0.0	0	0.5	0.1	0.1	0.5	3	-0.3	-1	0.9	2 (N/A)	5.2	0.18
Black walnut	2.2	0.4	1.1	0.1	12	10.9	1.6	1.5	10.4	68	0.0	0	28.2	80 (N/A)	4.8	7.28
Norway maple	1.2	0.2	0.6	0.1	6	6.3	0.9	0.9	6.0	39	-0.3	-1	15.8	44 (N/A)	3.5	5.55
Red maple	1.6	0.3	0.8	0.1	9	5.7	0.8	0.8	5.4	36	-0.6	-2	15.0	42 (N/A)	3.5	5.28
Blue spruce	0.7	0.1	0.7	0.1	5	2.9	0.4	0.4	2.7	18	-2.4	-9	5.7	14 (N/A)	3.5	1.78
Eastern white pine	0.6	0.1	0.5	0.1	4	1.9	0.3	0.3	1.8	12	-2.2	-8	3.2	7 (N/A)	3.0	1.01
Eastern redbud	0.5	0.1	0.3	0.0	3	2.7	0.4	0.4	2.5	17	0.0	0	6.9	20 (N/A)	2.6	3.27
White mulberry	0.0	0.0	0.0	0.0	0	0.1	0.0	0.0	0.1	1	0.0	0	0.2	1 (N/A)	2.6	0.11
Eastern red cedar	0.3	0.1	0.2	0.0	2	1.1	0.1	0.1	1.0	6	-1.5	-6	1.4	3 (N/A)	2.2	0.53
Apple	0.1	0.0	0.1	0.0	1	1.1	0.2	0.1	1.0	7	0.0	0	2.6	7 (N/A)	2.2	1.44
Plum	0.1	0.0	0.0	0.0	0	0.6	0.1	0.1	0.6	4	0.0	0	1.5	4 (N/A)	2.2	0.84
Northern pin oak	3.1	0.5	1.5	0.1	17	6.0	0.9	0.8	5.6	37	-0.7	-3	17.8	51 (N/A)	2.2	10.21
Red pine	0.2	0.0	0.2	0.0	2	1.1	0.2	0.2	1.0	7	-0.8	-3	2.2	5 (N/A)	1.7	1.35
Broadleaf Deciduous	0.0	0.0	0.0	0.0	0	0.3	0.0	0.0	0.3	2	0.0	0	0.8	2 (N/A)	1.3	0.71
Oak	1.3	0.2	0.6	0.1	7	4.5	0.6	0.6	4.2	28	0.0	0	12.0	34 (N/A)	1.3	11.43
Swamp white oak	0.0	0.0	0.0	0.0	0	0.6	0.1	0.1	0.5	4	0.0	0	1.3	4 (N/A)	1.3	1.21
Lilac	0.0	0.0	0.0	0.0	0	0.2	0.0	0.0	0.2	1	0.0	0	0.5	2 (N/A)	1.3	0.51
Other street trees	8.2	1.3	4.0	0.4	44	22.4	3.3	3.1	21.2	139	-2.7	-10	61.2	173 (N/A)	10.0	7.53
Citywide total	45.0	7.6	24.7	2.4	251	173.9	25.3	24.2	165.4	1,084	-30.7	-115	437.8	1,220 (N/A)	100.0	5.30

Stored CO2 Benefits of Public Trees by Species

11/22/2010

Species	Total Stored CO2 (lbs)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Green ash	222,944	1,672	(N/A)	14.8	20.8	49.18
Sugar maple	245,854	1,844	(N/A)	13.9	22.9	57.62
Silver maple	159,003	1,193	(N/A)	9.1	14.8	56.79
Norway spruce	17,117	128	(N/A)	7.8	1.6	7.13
Northern white	137	1	(N/A)	5.2	0.0	0.09
Black walnut	72,195	541	(N/A)	4.8	6.7	49.22
Norway maple	19,457	146	(N/A)	3.5	1.8	18.24
Red maple	18,933	142	(N/A)	3.5	1.8	17.75
Blue spruce	3,700	28	(N/A)	3.5	0.3	3.47
Eastern white pine	4,704	35	(N/A)	3.0	0.4	5.04
Eastern redbud	8,246	62	(N/A)	2.6	0.8	10.31
White mulberry	83	1	(N/A)	2.6	0.0	0.10
Eastern red cedar	1,151	9	(N/A)	2.2	0.1	1.73
Apple	2,349	18	(N/A)	2.2	0.2	3.52
Plum	1,291	10	(N/A)	2.2	0.1	1.94
Northern pin oak	50,803	381	(N/A)	2.2	4.7	76.20
Red pine	1,503	11	(N/A)	1.7	0.1	2.82
Broadleaf	533	4	(N/A)	1.3	0.1	1.33
Oak	40,003	300	(N/A)	1.3	3.7	100.01
Swamp white oak	655	5	(N/A)	1.3	0.1	1.64
Lilac	369	3	(N/A)	1.3	0.0	0.92
Other street trees	91,966	1,521	(N/A)	10.0	18.9	66.11
Citywide total	1,073,779	8,053	(N/A)	100.0	100.0	35.01

Table 5: Annual Carbon Sequestered

Annual CO$_2$ Benefits of Public Trees by Species

11/22/2010

Species	Sequestered (lb)	Sequestered ($)	Decomposition Release (lb)	Maintenance Release (lb)	Total Released ($)	Avoided (lb)	Avoided ($)	Net Total (lb)	Total Standard ($) d Error	% of Total Trees	% of Total $	Avg. $/tree
Green ash	17,769	133	-1,070	-7	-8	12,802	96	29,494	221 (N/A)	14.8	22.0	6.51
Sugar maple	15,080	113	-1,180	-6	-9	13,016	98	26,910	202 (N/A)	13.9	20.1	6.31
Silver maple	16,467	123	-763	-4	-6	8,777	66	24,476	184 (N/A)	9.1	18.3	8.74
Norway spruce	1,494	11	-82	-4	-1	2,592	19	4,000	30 (N/A)	7.8	3.0	1.67
Northern white cedar	86	1	-1	-2	0	168	1	251	2 (N/A)	5.2	0.2	0.16
Black walnut	5,292	40	-347	-2	-3	3,850	29	8,793	66 (N/A)	4.8	6.6	6.00
Norway maple	2,255	17	-93	-2	-1	2,223	17	4,382	33 (N/A)	3.5	3.3	4.11
Red maple	2,463	18	-91	-2	-1	2,016	15	4,387	33 (N/A)	3.5	3.3	4.11
Blue spruce	387	3	-18	-2	0	1,005	8	1,372	10 (N/A)	3.5	1.0	1.29
Eastern white pine	393	3	-23	-1	0	652	5	1,021	8 (N/A)	3.0	0.8	1.09
Eastern redbud	839	6	-40	-1	0	940	7	1,738	13 (N/A)	2.6	1.3	2.17
White mulberry	52	0	0	-1	0	34	0	84	1 (N/A)	2.6	0.1	0.11
Eastern red cedar	173	1	-6	-1	0	354	3	520	4 (N/A)	2.2	0.4	0.78
Apple	342	3	-11	-1	0	360	3	689	5 (N/A)	2.2	0.5	1.03
Plum	207	2	-6	-1	0	210	2	410	3 (N/A)	2.2	0.3	0.61
Northern pin oak	845	6	-244	-1	-2	2,063	15	2,664	20 (N/A)	2.2	2.0	4.00
Red pine	204	2	-7	-1	0	387	3	583	4 (N/A)	1.7	0.4	1.09
Broadleaf Deciduous	114	1	-3	-1	0	112	1	222	2 (N/A)	1.3	0.2	0.56
Oak	2,373	18	-192	-1	-1	1,546	12	3,727	28 (N/A)	1.3	2.8	9.32
Swamp white oak	287	2	-3	-1	0	194	1	477	4 (N/A)	1.3	0.4	1.19
Lilac	85	1	-2	-1	0	80	1	162	1 (N/A)	1.3	0.1	0.41
Other street trees	10,848	81	-973	-4	-7	7,838	59	17,708	133 (N/A)	10.0	13.2	5.77
Citywide total	78,053	585	-5,154	-45	-39	61,217	459	134,071	1,006 (N/A)	100.0	100.0	4.37

Table 6: Annual Social and Aesthetic Benefits

Annual Aesthetic/Other Benefits of Public Trees by Species

11/22/2010

| Species	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Green ash	1,648	(N/A)	14.8	19.6	48.47
Sugar maple	1,671	(N/A)	13.9	19.8	52.21
Silver maple	1,500	(N/A)	9.1	17.8	71.41
Norway spruce	381	(N/A)	7.8	4.5	21.18
Northern white cedar	72	(N/A)	5.2	0.9	6.03
Black walnut	493	(N/A)	4.8	5.9	44.81
Norway maple	238	(N/A)	3.5	2.8	29.70
Red maple	345	(N/A)	3.5	4.1	43.12
Blue spruce	168	(N/A)	3.5	2.0	21.02
Eastern white pine	114	(N/A)	3.0	1.4	16.22
Eastern redbud	48	(N/A)	2.6	0.6	7.98
White mulberry	0	(N/A)	2.6	0.0	0.03
Eastern red cedar	99	(N/A)	2.2	1.2	19.75
Apple	19	(N/A)	2.2	0.2	3.80
Plum	11	(N/A)	2.2	0.1	2.12
Northern pin oak	77	(N/A)	2.2	0.9	15.45
Red pine	61	(N/A)	1.7	0.7	15.35
Broadleaf Deciduous	6	(N/A)	1.3	0.1	2.06
Oak	189	(N/A)	1.3	2.2	62.96
Swamp white oak	39	(N/A)	1.3	0.5	12.89
Lilac	4	(N/A)	1.3	0.1	1.38
Other street trees	1,241	(N/A)	10.0	14.7	53.95
Citywide total	8,423	(N/A)	100.0	100.0	36.62

Table 7: Summary of Benefits in Dollars

Total Annual Benefits of Public Trees by Species ($)

11/22/20

Species	Energy	CO_2	Air Quality	Stormwater	Aesthetic/Other	Total ($)	Standard Error	% of Total $
Green ash	1,597	221	264	1,865	1,648	5,595	(±0)	20.0
Sugar maple	1,595	202	251	1,947	1,671	5,665	(±0)	20.3
Silver maple	1,071	184	178	1,516	1,500	4,449	(±0)	15.9
Norway spruce	324	30	31	542	381	1,308	(±0)	4.7
Northern white cedar	25	2	2	29	72	131	(±0)	0.5
Black walnut	476	66	80	575	493	1,690	(±0)	6.0
Norway maple	268	33	44	212	238	795	(±0)	2.8
Red maple	248	33	42	223	345	891	(±0)	3.2
Blue spruce	130	10	14	193	168	516	(±0)	1.8
Eastern white pine	83	8	7	151	114	362	(±0)	1.3
Eastern redbud	123	13	20	54	48	258	(±0)	0.9
White mulberry	5	1	1	1	0	8	(±0)	0.0
Eastern red cedar	50	4	3	76	99	231	(±0)	0.8
Apple	53	5	7	20	19	104	(±0)	0.4
Plum	31	3	4	11	11	60	(±0)	0.2
Northern pin oak	272	20	51	374	77	794	(±0)	2.8
Red pine	49	4	5	69	61	189	(±0)	0.7
Broadleaf Deciduous	16	2	2	6	6	32	(±0)	0.1
Oak	199	28	34	284	189	734	(±0)	2.6
Swamp white oak	27	4	4	13	39	86	(±0)	0.3
Lilac	12	1	2	4	4	22	(±0)	0.1
Other street trees	989	133	173	1,497	1,241	4,034	(±0)	14.4
Citywide Total	7,644	1,006	1,220	9,662	8,423	27,954	(±0)	100.0

Species Distribution of Public Trees (%)

11/22/2010
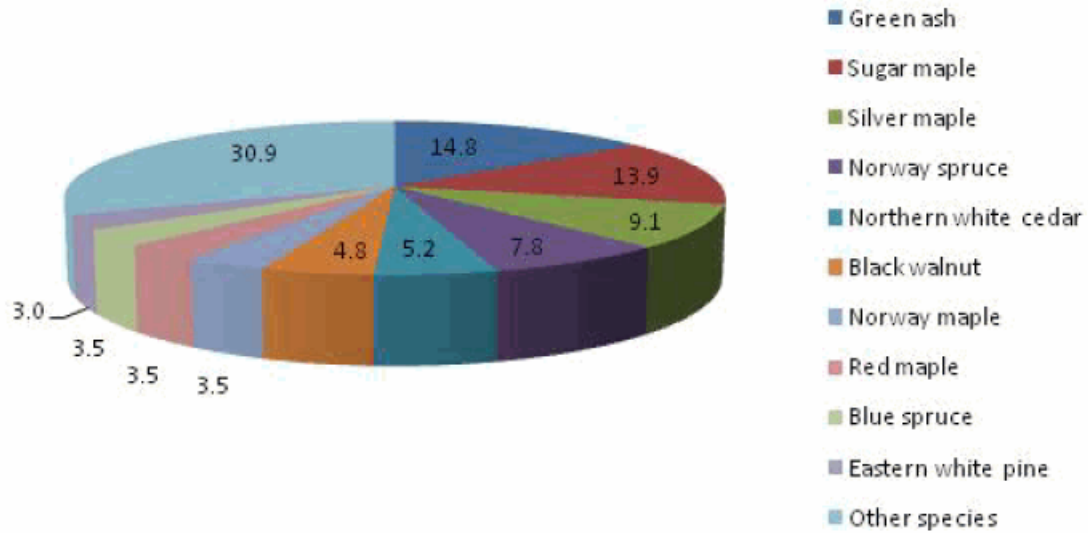
Species	Percent
Green ash	14.8
Sugar maple	13.9
Silver maple	9.1
Norway spruce	7.8
Northern white cedar	5.2
Black walnut	4.8
Norway maple	3.5
Red maple	3.5
Blue spruce	3.5
Eastern white pine	3.0
Other species	30.9
Total	100.0

Figure 1: Species Distribution

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

11/22/2010
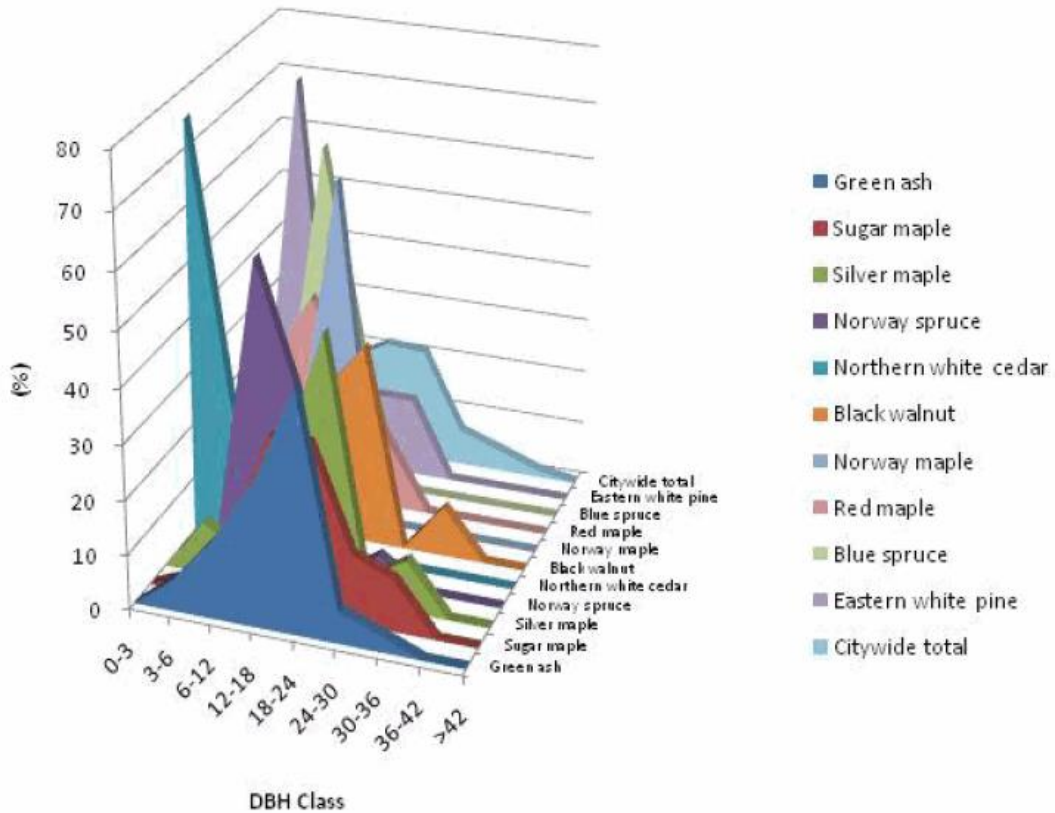
	DBH class (in)								
Species	0-3	3-6	6-12	12-18	18-24	24-30	30-36	36-42	>42
Green ash	0.0	5.9	14.7	26.5	44.1	5.9	2.9	0.0	0.0
Sugar maple	0.0	3.1	12.5	31.3	31.3	12.5	9.4	0.0	0.0
Silver maple	0.0	9.5	4.8	23.8	47.6	4.8	9.5	0.0	0.0
Norway spruce	0.0	5.6	55.6	33.3	0.0	5.6	0.0	0.0	0.0
Northern white cedar	75.0	25.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Black walnut	0.0	18.2	9.1	27.3	36.4	0.0	9.1	0.0	0.0
Norway maple	12.5	12.5	12.5	62.5	0.0	0.0	0.0	0.0	0.0
Red maple	0.0	25.0	37.5	25.0	12.5	0.0	0.0	0.0	0.0
Blue spruce	0.0	12.5	62.5	25.0	0.0	0.0	0.0	0.0	0.0
Eastern white pine	0.0	71.4	0.0	14.3	14.3	0.0	0.0	0.0	0.0
Citywide total	9.6	19.1	17.4	21.3	20.9	6.5	3.9	1.3	0.0

Figure 2: Relative Age Class

Functional (Foliage) Condition of Public Trees by Species (%)

11/22/2010

Citywide total

Dead or Dying 0%
Poor 4%
Fair 25%
Good 71%

- Dead or Dying
- Poor
- Fair
- Good
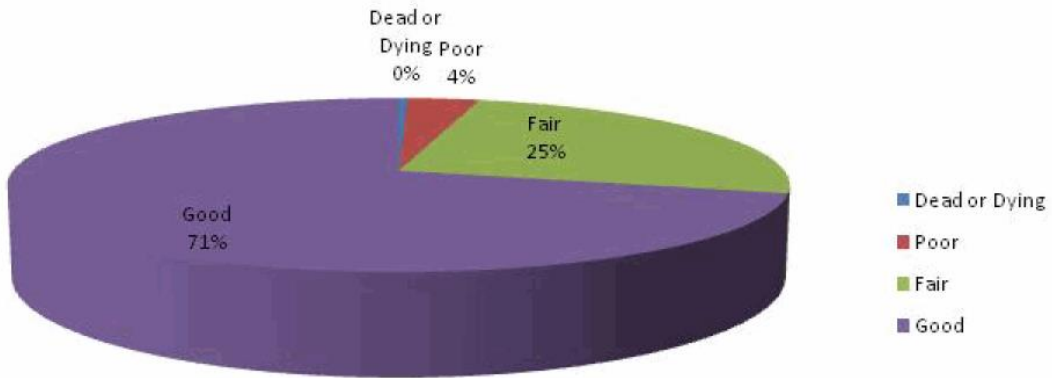
Figure 3: Foliage Condition

Structural (Woody) Condition of Public Trees by Species (%)

11/22/2010

Citywide total

Dead or Dying 1%
Poor 6%
Fair 35%
Good 58%

- Dead or Dying
- Poor
- Fair
- Good
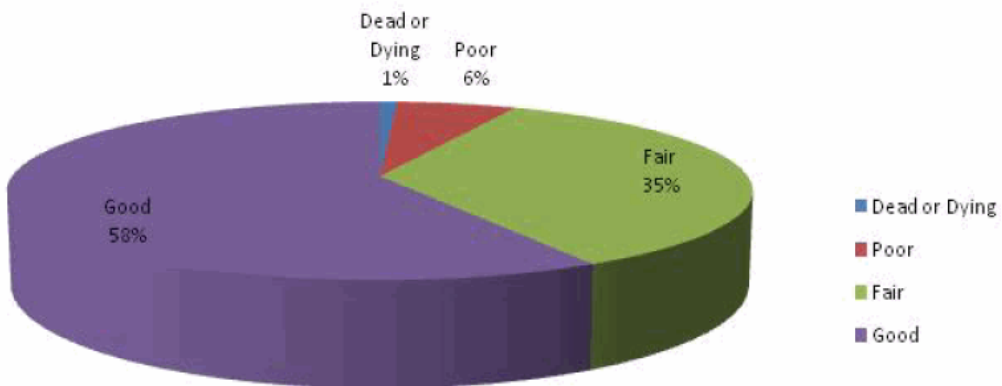
Figure 4: Wood Condition

Canopy Cover of Public Trees (Acres)

11/22/2010
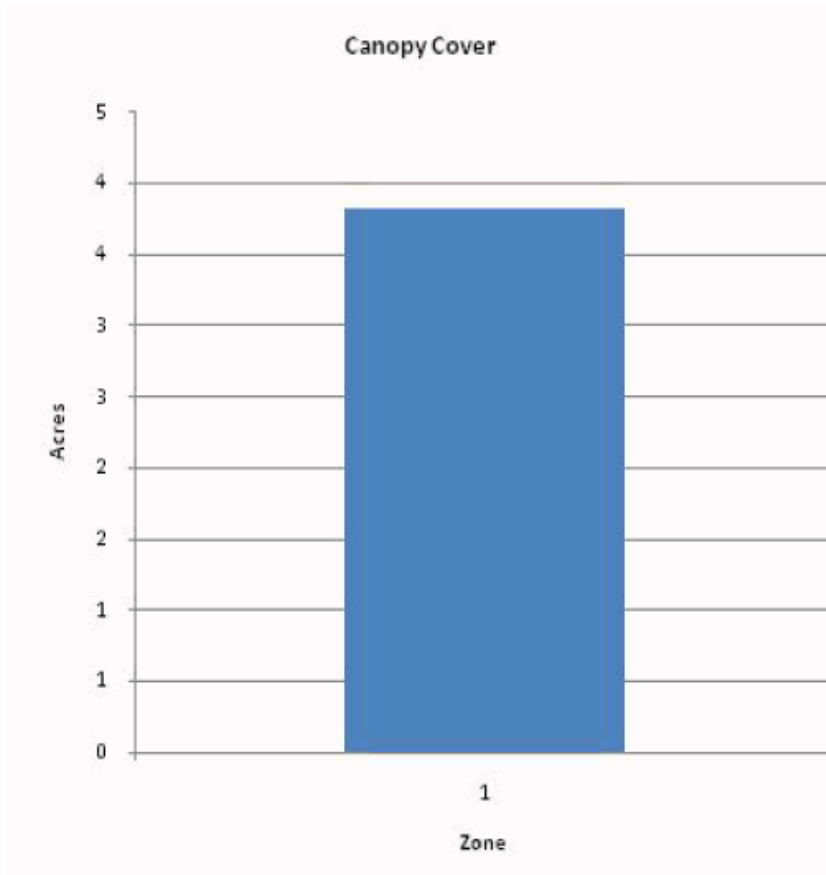
Zone	Acres	% of Total Canopy Cover
1	4	100.0
Citywide total	4	100.0

	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	4		

Figure 5: Canopy Cover in Acres

Land Use of Public Trees by Zone (%)

11/22/2010
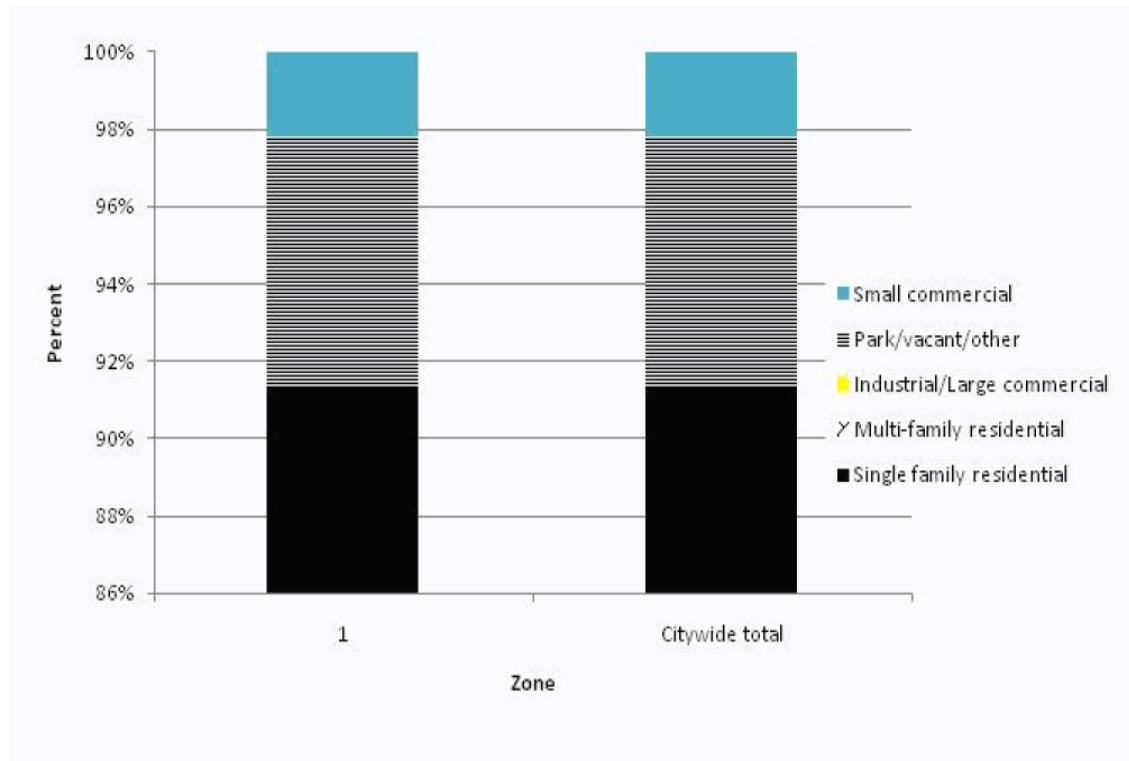
Zone	Single family residential	Multi-family residential	Industrial/ Large commercial	Park/vacant/ other	Small commercial
1	91.3	0.0	0.0	6.5	2.2
Citywide total	91.3	0.0	0.0	6.5	2.2

Figure 6: Land Use of city/park trees

Location of Public Trees by Zone (%)

11/22/2010

Zone	Front yard	Planting strip	Cutout	Median	Other maintained locations	Other un-maintained locations	Backyard
1	86.1	0.0	0.0	0.0	6.5	0.0	7.4
Citywide total	86.1	0.0	0.0	0.0	6.5	0.0	7.4
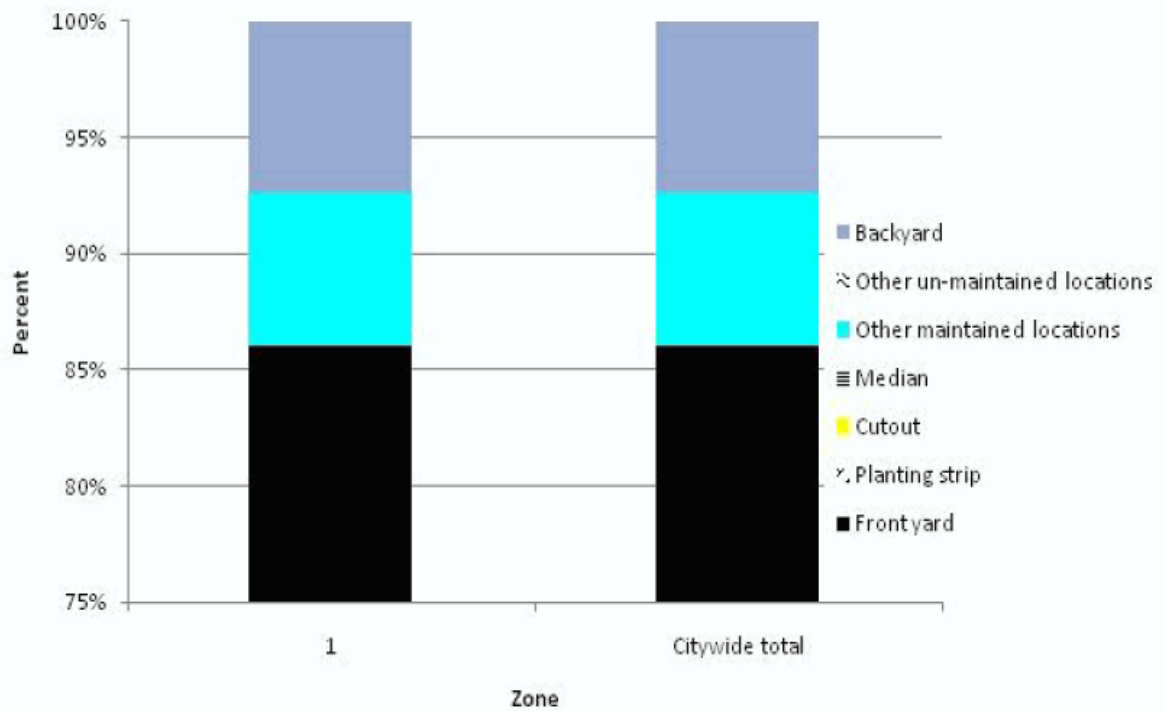
Figure 7: Location of city/park trees

Appendix B: ArcGIS Mapping
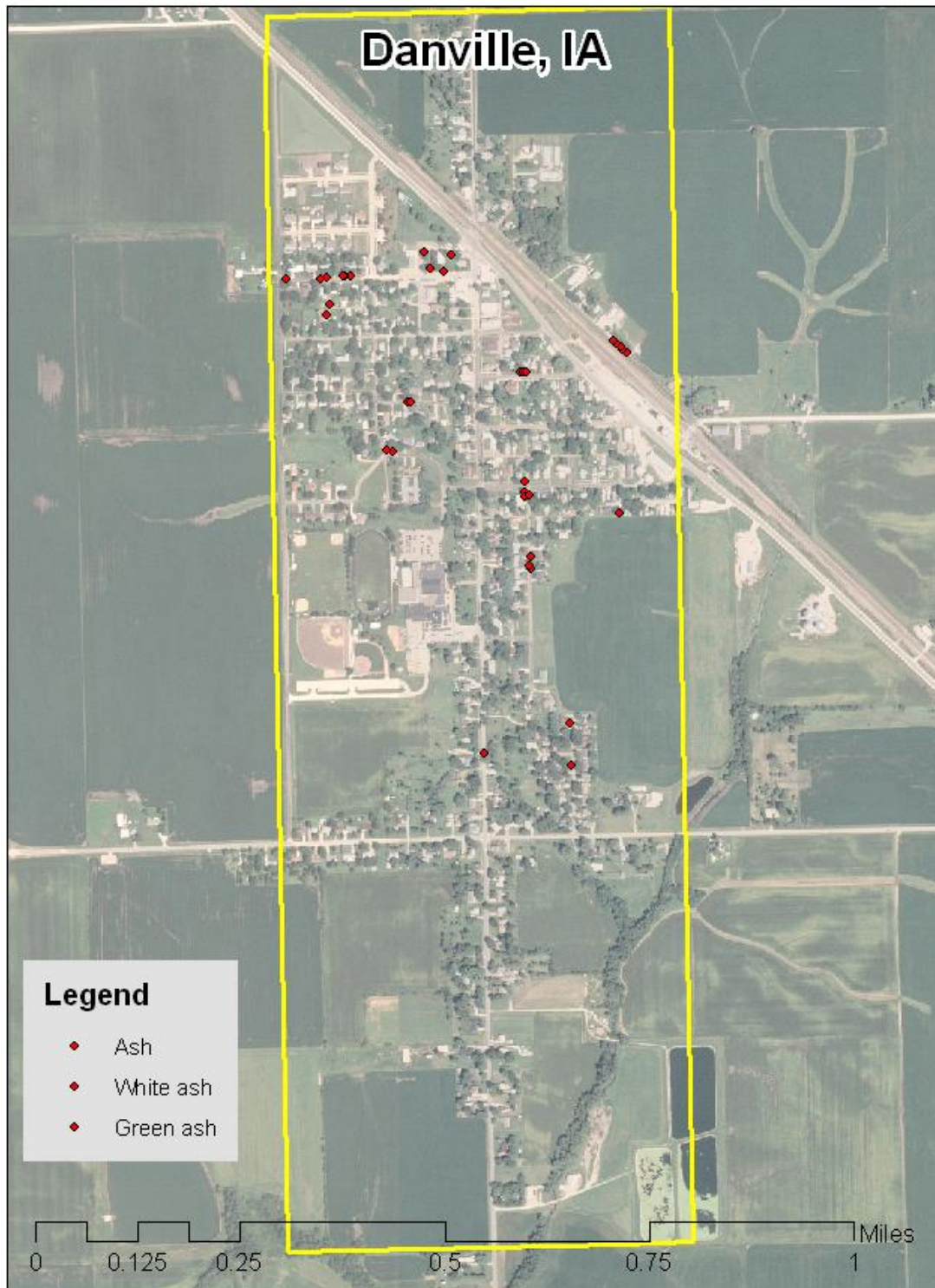
Figure 1: Location of Ash Trees
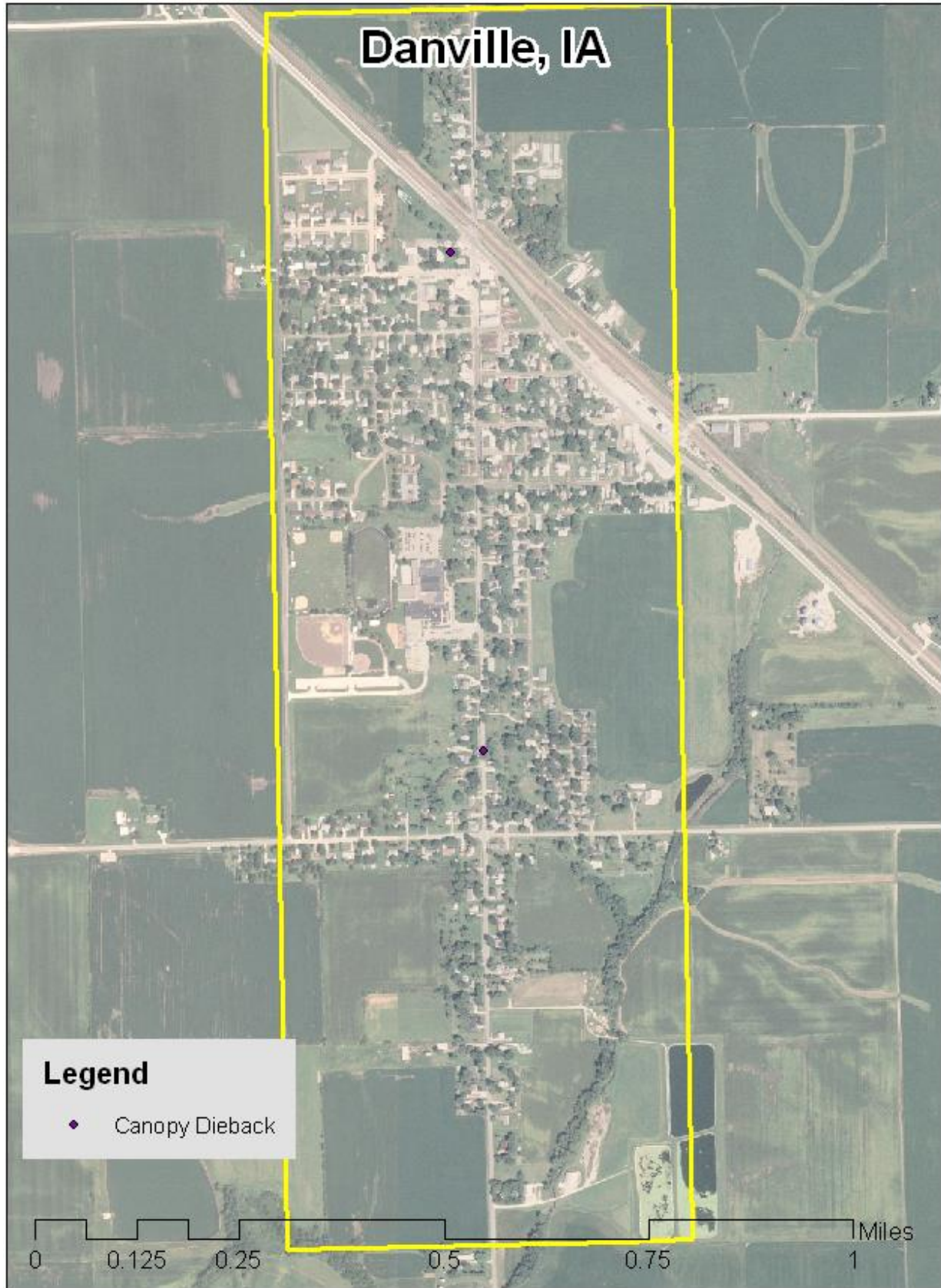
Figure 2: Location of EAB symptoms

Figure 3: Location of Poor Condition Trees

Figure 4: Location of Trees with Recommended Maintenance*City ownership of the trees recommended for removal should be verified prior to any removal*

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