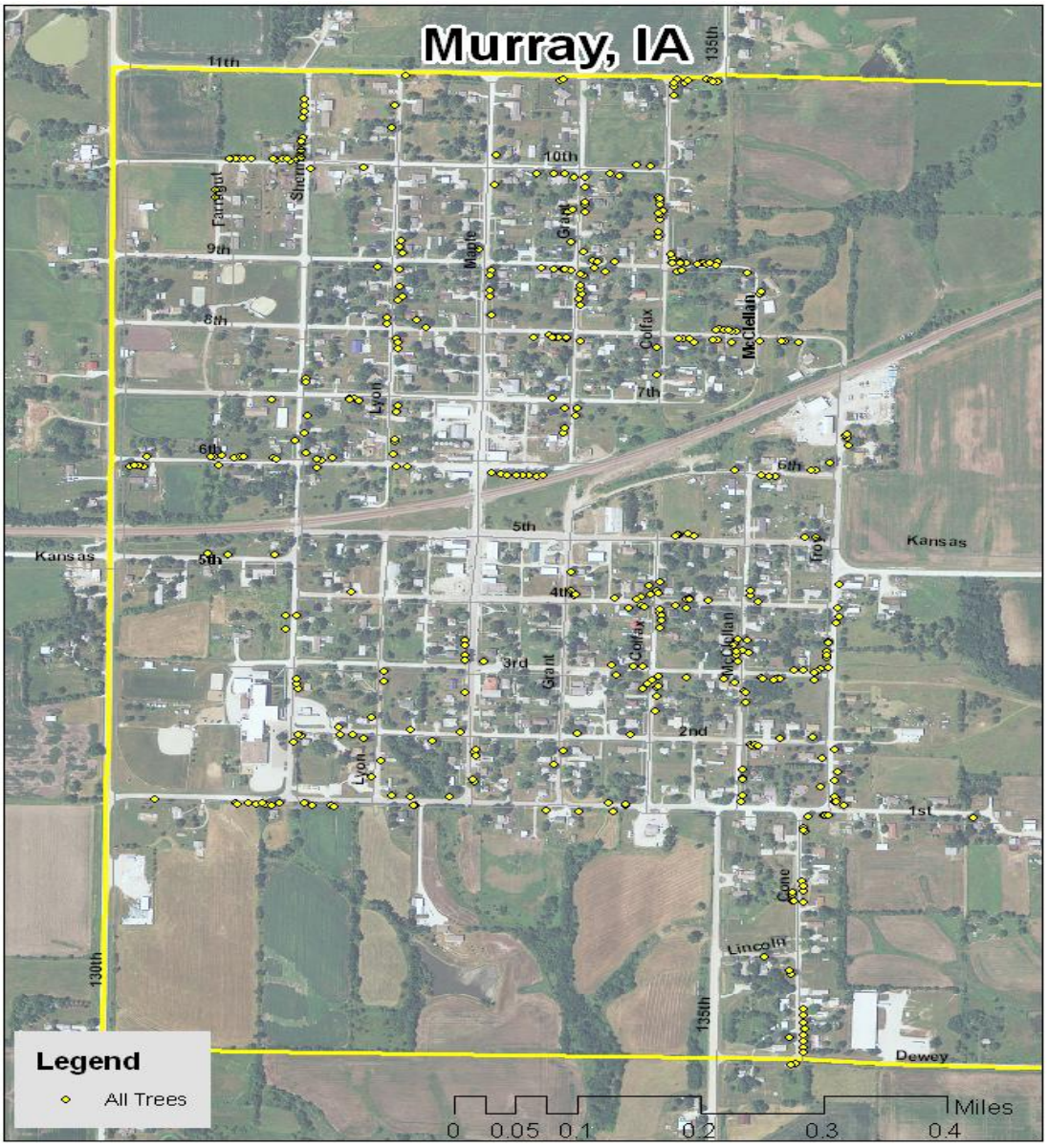
MURRAY, IA



2013 Management Plan

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Table of Contents

Executive Summary

Overview

This plan was developed to assist the City of Murray 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 22% of Murray'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 2012, 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 422 trees inventoried.

- Murray's trees provide $79,908 of benefits annually, an average of $189 a tree
- There are over 36 species of trees
- The top three genus are: Maple 28%, Ash 22%, and Elm 14%
- 56% of trees are in need of some type of management
- 84 trees are recommended for removal or for being evaluated further 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 84 trees recommended for removal/evaluation, 17 are "critical concern" trees and should be removed immediately (see Fig.4, Append. B and attached list). 13 more trees are recommended for removal within 3 years. See "Hazardous Trees", page 7. , *City ownership of the trees recommended for removal should be verified prior to any removal*
- 20 of the 94 ash trees are in need of follow up because they are displaying signs and symptoms that may be associated with EAB. Check ash trees visually each year.
- 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, silver maple, cottonwood, poplar, box elder, Chinese elm, Siberian elm, evergreen, willow or black walnut
- With an estimated tree removal cost of $500 per tree, it could take $47,000 or more to remove the 94 ash trees if EAB damage occurs. Suggestion: request budget increase of $5000 annually over the next 10 years and apply for grants to plant replacement trees, or treat ash like any other tree until an actual infestation occurs, then deal with the problem.

Introduction

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

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

Inventory

In 2012, a tree inventory was conducted that included 100% of the city owned trees on streets. 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 422 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. Murray's trees reduce energy related costs by approximately $21,664 annually (Appendix A, Table 1). These savings are both in Electricity (103.7 MWh) and in Natural Gas (14,076.7 Therms).

Annual Stormwater Benefits

Murray's trees intercept about 1,083,918 gallons of rainfall or snow melt a year (Appendix A, Table 2). This interception provides $29,375 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 Murray, it is estimated that trees remove 1,307 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 $3,679 (Appendix A, Table 3).

Annual Carbon Benefits

Carbon sequestration and storage reduce the amount of carbon in the atmosphere, mitigating climate change. In Murray, trees sequester about 402,814 lbs of carbon a year with an associated value of $3,021 (Appendix A, Table 5). In addition, the trees store 3,710,731 lbs of carbon, with a yearly benefit of $27,830 (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. Murray receives $22,167 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, :Murray's trees provide $79,908 of benefits annually. Benefits of individual trees vary based on size, species, health and location, but on average each of the 422 trees in Murray provide approximately $189 annually (Appendix A, Table 7).

Forest Structure

Species Distribution

Murray has over 36 different tree species along city streets and parks (Appendix A, Figure 1). The distribution of trees by genus is as follows:

Maple	119	28%
Ash	94	22%
Elm	58	14%
Walnut	33	8%
E. Redcedar	25	6%
Hackberry	25	6%
Others	68	16%

Others include: Catalpa, redbud, honeylocust, oak, apple, Tulip tree, mulberry, spruce, pine, sycamore, willow, E. cottonwood, chokecherry, lilac, and basswood.

Age Class

Most of Murrays's trees (74%) are between 12 and 30 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. Murray's size curve is about average for age distribution.

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 Murray indicate that 74% of the trees are in good health, with only 7% of the foliage in poor health, dead or dying (Appendix A, Figure 3 & Appendix B, Figure 3). Similarly, 60% of *CITY*'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 18% of the population. This 18% is why so many trees are recommended for removal or for further evaluation for removal.

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	146	35%
Crown Raising	3	<1%
Tree Staking	2	<1%
Tree Removal	84	20%
Crown Reduction	3	<1%

Canopy Cover

The canopy cover of Murray is approximately 12 acres (Appendix A, Figure 5).

Land Use and Location

The majority of Murray'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	100%
Park/vacant/other	0%
Industrial/Large commercial	0%
Small commercial	0%
Multifamily residential	0%

Location	
Planting strip	100%
Other maintained locations	0%
Cutout (surrounded by pavement)	0%
Front yard	0%

Recommendations

Risk Management

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

Hazardous trees

Murray has 17 critical concern trees that need immediate removal. The location of these trees is on Appendix B, Fig. 4, and in a detailed listing provided with this plan. It is recommended to start with the larger diameter trees first. After all of the critical concern trees are addressed, there should be a follow up on the trees recommended for removal within the next 3 years. There are 13 (8 mature, 5 younger) of these trees (locations listed on map, Appendix B, Figure 5). After that, there are 54 trees that should be evaluated for possible removal needs within 5 years.

Poor tree species

After the removal of the critical concern trees and those recommended for removal within 3 years, ash trees in poor health should be assessed for removal (Appendix B, Figure 3 & Appendix B, Figure 4). Of the 13 recommended removals, 2 are ash trees. There are a total of 94 ash trees in Murray and 20 of those have signs and symptoms that have been associated with EAB. Of the ash, 14 trees 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 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. There are currently 152 trees in need of some kind of pruning, mostly foliage cleaning.

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 Murray.

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 (28%) (Appendix A, Figure 1). Silver 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, Siberian elm, evergreen, willow, and 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.

Six Year Maintenance Plan with No Additional Funding-Proposed

Remove critical concern trees first, then mature trees recommended for immediate (1-3 years) removal. Then, young trees recommended for immediate removal. Then, ash in poor condition.

Year 1
- Removal: 9 largest critical concern trees
- Planting and Replacement: None
- Visual Survey for signs and symptoms of EAB

Year 2
- Removal: 8 remaining critical concern trees
- Planting and Replacement: 9 trees in open locations from year one removals
- Routine trimming: Contract to trim 50 of the city trees
- Visual Survey for signs and symptoms of EAB

Year 3
- Removal: 5 trees – and any new critical concern trees and ash in poor health
- Planting and Replacement: 8 trees in open locations from previous removals
- Visual Survey for signs and symptoms of EAB

Year 4
- Removal: 5 trees - removal of any new critical concern trees and ash in poor health
- Planting and Replacement: 5 trees in open locations from previous removals
- Routine trimming: Contract to trim 50 of the city trees
- Visual Survey for signs and symptoms of EAB

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

Year 6
- Removal: 5 trees - removal of any new critical concern trees and ash in poor health
- Planting and Replacement: 5 trees in open locations from previous removals
- Routine trimming: Contract to trim 52 of the city trees
- Visual Survey for signs and symptoms of EAB

*Reduction of ash over 6 years will probably be minimal. EAB could potentially kill all ash within 4 years of infestation. After the 6 year recommended period to remove and trim everything with designated needs, concentrate on removing ash trees if needed, those in poor condition first. Any new critical concern trees and trees evaluated as needing removal are always top candidates for priority management.

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 budgets permit, all removed ash trees should be replaced with a suitable diversity of non-ash species. Suitable species are listed in the "Acceptable Tree List" attached with this plan. All trees must meet the restrictions in any city ordinance.

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. An "Emerald Ash Borer Symptoms List" and an EAB Pest Alert are provided with this plan for your information. If you suspect that you may actually have EAB damage, the first step is to contact the ISU Plant and Insect Diagnostic Clinic at 515-294-0581.

Private Ash Trees

It is strongly recommended that private property owners start removing ash trees on their property upon arrival of EAB. This should be done in accordance with any existing or new city code. Example Code: "If it is determined with reasonable certainty that any such condition exists (trees or shrubs in the City reported or suspected to be infected with or damaged by any disease or insect or disease pests) on private property and that the 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."

Budget

Budget submitted for tree work by the City was listed at $1,500 per year for the last 2 years. City resources were listed as 2 employees and 1 chainsaw. Consequently, assuming that the budget for tree maintenance will remain minimal, the following are some estimated costs associated with the recommended maintenance work.

If a budget increase may be possible, a recommendation would be to shoot for setting it at $2 per capita, which is a requirement for becoming a Tree City USA.

Tree removal costs average around $500 per tree, depending on the size and numbers of trees. the estimated range would be $350-$1,000.

Trimming (including cleaning, raising, reducing) averages $75 per tree and can range from $70 to $200 per tree.

New planting averages about $150 per tree (5' trees in 10 gallon containers are about $75-$100 plus the cost of watering).

Purposed Budget Increase

EAB could potentially kill all ash trees in Leon within 4 years of its arrival. To remove all ash trees within 6 years the budget would need to be increased by $6,900 per year or more. Additionally, it is recommended that Leon 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. For more information about grants please contact Emma Bruemmer, DNR State Urban Forester, at 515-281-5600 or by e-mail at Emma.Bruemmer@dnr.iowa.gov

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Appendix A: i-Tree Data

Table 1: Annual Energy Benefits

Murray

Annual Energy Benefits of Public Trees by Species

1/14/2013

Species	Total Electricity (MWh)	Electricity ($)	Total Natural Gas (Therms)	Natural Gas ($)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Green ash	25.0	1,896	3,423.3	3,355	5,250	(N/A)	22.3	24.2	55.86
Silver maple	26.5	2,014	3,493.1	3,423	5,437	(N/A)	22.0	25.1	58.46
Siberian elm	12.7	967	1,716.7	1,682	2,649	(N/A)	10.2	12.2	61.61
Black walnut	8.0	608	1,068.6	1,047	1,655	(N/A)	7.8	7.6	50.16
Northern hackberry	7.1	542	990.7	971	1,513	(N/A)	5.9	7.0	60.53
Eastern red cedar	2.5	188	368.5	361	549	(N/A)	5.9	2.5	21.95
Elm	2.8	215	367.4	360	575	(N/A)	3.6	2.7	38.32
Spruce	0.5	41	86.2	84	126	(N/A)	1.9	0.6	15.69
Eastern white pine	1.0	78	127.0	124	203	(N/A)	1.9	0.9	25.36
Sugar maple	1.7	126	222.9	218	345	(N/A)	1.7	1.6	49.27
Mulberry	1.2	94	188.7	185	279	(N/A)	1.7	1.3	39.86
Boxelder	1.2	88	155.1	152	240	(N/A)	1.4	1.1	40.00
Norway maple	1.5	116	205.0	201	317	(N/A)	1.4	1.5	52.77
Lilac	1.2	91	189.7	186	277	(N/A)	1.4	1.3	46.14
Eastern redbud	0.4	32	70.7	69	102	(N/A)	1.2	0.5	20.32
Cottonwood	2.1	158	281.6	276	434	(N/A)	1.2	2.0	86.72
Other street trees	8.1	616	1,121.5	1,099	1,715	(N/A)	8.5	7.9	47.63
Citywide total	103.7	7,869	14,076.7	13,795	21,664	(N/A)	100.0	100.0	51.34

Table 2: Annual Stormwater Benefits

Murray

Annual Stormwater Benefits of Public Trees by Species

1/14/2013

Species	Total rainfall interception (Gal)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Green ash	258,655	7,010	(N/A)	22.3	23.9	74.57
Silver maple	336,425	9,118	(N/A)	22.0	31.0	98.04
Siberian elm	117,457	3,183	(N/A)	10.2	10.8	74.03
Black walnut	69,010	1,870	(N/A)	7.8	6.4	56.68
Northern hackberry	54,360	1,473	(N/A)	5.9	5.0	58.93
Eastern red cedar	35,984	975	(N/A)	5.9	3.3	39.01
Elm	21,563	584	(N/A)	3.6	2.0	38.96
Spruce	7,137	193	(N/A)	1.9	0.7	24.18
Eastern white pine	15,861	430	(N/A)	1.9	1.5	53.73
Sugar maple	14,475	392	(N/A)	1.7	1.3	56.04
Mulberry	6,293	171	(N/A)	1.7	0.6	24.37
Boxelder	10,331	280	(N/A)	1.4	1.0	46.66
Norway maple	11,879	322	(N/A)	1.4	1.1	53.66
Lilac	7,044	191	(N/A)	1.4	0.7	31.82
Eastern redbud	1,975	54	(N/A)	1.2	0.2	10.70
Cottonwood	31,148	844	(N/A)	1.2	2.9	168.83
Other street trees	84,320	2,285	(N/A)	8.5	7.8	63.48
Citywide total	1,083,918	29,376	(N/A)	100.0	100.0	69.61

Table 3: Annual Air Quality Benefits

Murray

Annual Air Quality Benefits of Public Trees by Species

1/14/2013

	Deposition (lb)				Total	Avoided (lb)				Total	BVOC	BVOC	Total	Total	Standard	% of Total	Avg.
Species	O_3	NO_2	PM_{10}	SO_2	Depos. ($)	NO_2	PM_{10}	VOC	SO_2	Avoided ($)	Emissions (lb)	Emissions ($)	(lb)	($)	Error	Trees	$/tree
Green ash	30.3	4.8	14.8	1.4	162	119.3	17.4	16.6	113.2	743	0.0	0	317.7	905	(N/A)	22.3	9.63
Silver maple	53.3	9.0	26.8	2.4	289	125.1	18.3	17.5	120.1	783	-29.0	-109	343.4	963	(N/A)	22.0	10.35
Siberian elm	16.8	2.9	8.6	0.7	92	60.5	8.8	8.4	57.7	378	0.0	0	164.5	469	(N/A)	10.2	10.91
Black walnut	6.7	1.1	3.5	0.3	37	38.0	5.6	5.3	36.3	237	0.0	0	96.8	274	(N/A)	7.8	8.30
Northern hackberry	7.1	1.2	3.9	0.3	39	34.3	5.0	4.7	32.4	213	0.0	0	88.9	253	(N/A)	5.9	10.11
Eastern red cedar	7.2	1.4	5.7	0.9	47	12.0	1.7	1.6	11.2	74	-19.8	-74	22.0	47	(N/A)	5.9	1.87
Elm	1.8	0.3	1.0	0.1	10	13.3	2.0	1.9	12.8	83	0.0	0	33.2	94	(N/A)	3.6	6.24
Spruce	0.7	0.1	0.7	0.1	5	2.7	0.4	0.4	2.5	16	-2.5	-10	4.9	12	(N/A)	1.9	1.47
Eastern white pine	1.8	0.4	1.5	0.2	12	4.8	0.7	0.7	4.7	30	-7.1	-27	7.6	15	(N/A)	1.9	1.93
Sugar maple	1.6	0.3	0.9	0.1	9	7.9	1.2	1.1	7.5	49	-1.3	-5	19.2	53	(N/A)	1.7	7.63
Mulberry	2.2	0.4	1.0	0.1	12	6.1	0.9	0.8	5.6	37	0.0	0	17.1	49	(N/A)	1.7	7.01
Boxelder	1.2	0.2	0.6	0.1	6	5.5	0.8	0.8	5.2	34	-0.5	-2	13.8	39	(N/A)	1.4	6.44
Norway maple	2.2	0.4	1.1	0.1	12	7.3	1.1	1.0	6.9	45	-0.5	-2	19.5	55	(N/A)	1.4	9.24
Lilac	2.6	0.4	1.2	0.1	14	5.9	0.8	0.8	5.4	36	0.0	0	17.3	50	(N/A)	1.4	8.35
Eastern redbud	0.6	0.1	0.3	0.0	3	2.1	0.3	0.3	1.9	13	0.0	0	5.6	16	(N/A)	1.2	3.22
Cottonwood	5.2	0.8	2.3	0.2	27	9.9	1.4	1.4	9.4	62	0.0	0	30.7	89	(N/A)	1.2	17.76
Other street trees	13.3	2.2	6.6	0.7	72	38.8	5.6	5.4	36.8	242	-4.7	-18	104.8	296	(N/A)	8.5	8.23
Citywide total	154.6	26.0	80.5	7.7	848	493.6	72.0	68.6	469.7	3,078	-65.7	-246	1,307.0	3,679	(N/A)	100.0	8.72

Table 4: Annual Carbon Stored

Murray

Stored CO2 Benefits of Public Trees by Species

1/14/2013

Species	Total Stored CO2 (lbs)	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Green ash	982,193	7,366	(N/A)	22.3	26.5	78.37
Silver maple	1,194,245	8,957	(N/A)	22.0	32.2	96.31
Siberian elm	413,198	3,099	(N/A)	10.2	11.1	72.07
Black walnut	215,649	1,617	(N/A)	7.8	5.8	49.01
Northern	98,662	740	(N/A)	5.9	2.7	29.60
Eastern red cedar	23,427	176	(N/A)	5.9	0.6	7.03
Elm	60,926	457	(N/A)	3.6	1.6	30.46
Spruce	5,140	39	(N/A)	1.9	0.1	4.82
Eastern white pine	16,941	127	(N/A)	1.9	0.5	15.88
Sugar maple	46,465	348	(N/A)	1.7	1.3	49.78
Mulberry	33,953	255	(N/A)	1.7	0.9	36.38
Boxelder	32,185	241	(N/A)	1.4	0.9	40.23
Norway maple	36,722	275	(N/A)	1.4	1.0	45.90
Lilac	40,456	303	(N/A)	1.4	1.1	50.57
Eastern redbud	9,480	71	(N/A)	1.2	0.3	14.22
Cottonwood	176,215	1,322	(N/A)	1.2	4.8	264.32
Other street trees	147,361	2,437	(N/A)	8.5	8.8	67.68
Citywide total	3,710,731	27,830	(N/A)	100.0	100.0	65.95

Table 5: Annual Carbon Sequestered

Murray

Annual CO_2 Benefits of Public Trees by Species

1/14/2013

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
Green ash	59,309	445	-4,715	-18	-35	41,893	314	96,469	724	(N/A)	22.3	24.0	7.70
Silver maple	98,302	737	-5,732	-18	-43	44,507	334	137,058	1,028	(N/A)	22.0	34.0	11.05
Siberian elm	22,874	172	-1,983	-8	-15	21,366	160	42,247	317	(N/A)	10.2	10.5	7.37
Black walnut	18,270	137	-1,035	-6	-8	13,437	101	30,665	230	(N/A)	7.8	7.6	6.97
Northern hackberry	7,588	57	-474	-5	-4	11,986	90	19,096	143	(N/A)	5.9	4.7	5.73
Eastern red cedar	928	7	-112	-5	-1	4,147	31	4,957	37	(N/A)	5.9	1.2	1.49
Elm	6,101	46	-292	-3	-2	4,745	36	10,550	79	(N/A)	3.6	2.6	5.28
Spruce	556	4	-25	-2	0	907	7	1,437	11	(N/A)	1.9	0.4	1.35
Eastern white pine	1,074	8	-81	-2	-1	1,734	13	2,725	20	(N/A)	1.9	0.7	2.55
Sugar maple	3,112	23	-223	-1	-2	2,794	21	5,682	43	(N/A)	1.7	1.4	6.09
Mulberry	1,606	12	-163	-1	-1	2,080	16	3,522	26	(N/A)	1.7	0.9	3.77
Boxelder	3,101	23	-154	-1	-1	1,944	15	4,889	37	(N/A)	1.4	1.2	6.11
Norway maple	2,384	18	-176	-1	-1	2,559	19	4,765	36	(N/A)	1.4	1.2	5.96
Lilac	957	7	-194	-1	-1	2,009	15	2,770	21	(N/A)	1.4	0.7	3.46
Eastern redbud	829	6	-46	-1	0	713	5	1,495	11	(N/A)	1.2	0.4	2.24
Cottonwood	4,120	31	-846	-1	-6	3,484	26	6,757	51	(N/A)	1.2	1.7	10.13
Other street trees	15,689	118	-1,559	-7	-12	13,606	102	27,728	208	(N/A)	8.5	6.9	5.78
Citywide total	246,798	1,851	-17,812	-82	-134	173,910	1,304	402,814	3,021	(N/A)	100.0	100.0	7.16

Table 6: Annual Social and Aesthetic Benefits

Murray

Annual Aesthetic/Other Benefits of Public Trees by Species

1/14/2013

Species	Total ($)	Standard Error	% of Total Trees	% of Total $	Avg. $/tree
Green ash	5,058	(N/A)	22.3	22.8	53.81
Silver maple	8,182	(N/A)	22.0	36.9	87.98
Siberian elm	1,773	(N/A)	10.2	8.0	41.22
Black walnut	1,684	(N/A)	7.8	7.6	51.03
Northern hackberry	1,173	(N/A)	5.9	5.3	46.91
Eastern red cedar	339	(N/A)	5.9	1.5	13.57
Elm	627	(N/A)	3.6	2.8	41.83
Spruce	155	(N/A)	1.9	0.7	19.38
Eastern white pine	250	(N/A)	1.9	1.1	31.29
Sugar maple	353	(N/A)	1.7	1.6	50.37
Mulberry	95	(N/A)	1.7	0.4	13.57
Boxelder	261	(N/A)	1.4	1.2	43.45
Norway maple	231	(N/A)	1.4	1.0	38.52
Lilac	58	(N/A)	1.4	0.3	9.60
Eastern redbud	48	(N/A)	1.2	0.2	9.61
Cottonwood	277	(N/A)	1.2	1.3	55.49
Other street trees	1,602	(N/A)	8.5	7.2	44.51
Citywide total	22,167	(N/A)	100.0	100.0	52.53

Table 7: Summary of Benefits in Dollars

Murray

Total Annual Benefits of Public Trees by Species ($)

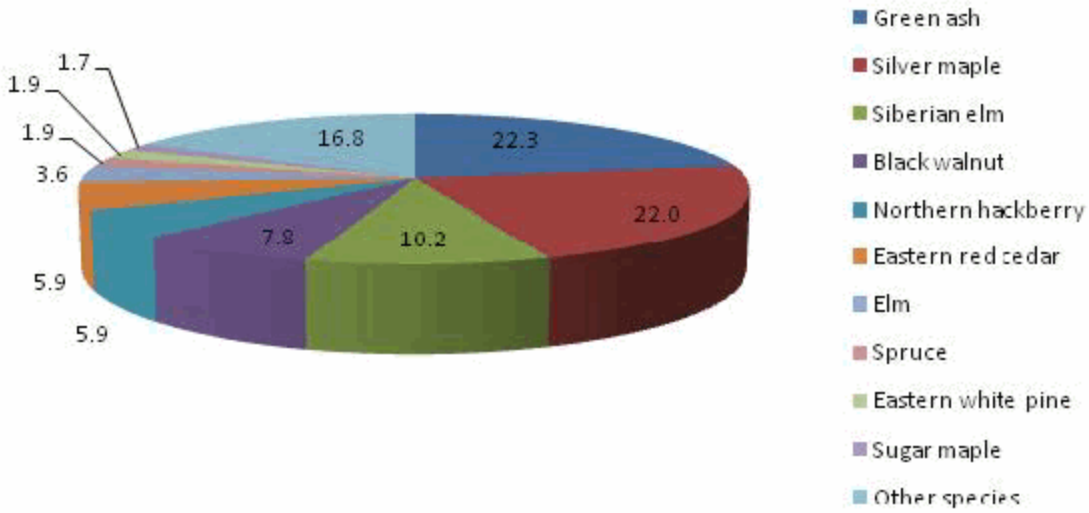
1/14/201

Species	Energy	CO_2	Air Quality	Stormwater	Aesthetic/Other	Total ($)	Standard Error	% of Total $
Green ash	5,250	724	905	7,010	5,058	18,948	(±0)	23.7
Silver maple	5,437	1,028	963	9,118	8,182	24,728	(±0)	30.9
Siberian elm	2,649	317	469	3,183	1,773	8,391	(±0)	10.5
Black walnut	1,655	230	274	1,870	1,684	5,714	(±0)	7.2
Northern hackberry	1,513	143	253	1,473	1,173	4,555	(±0)	5.7
Eastern red cedar	549	37	47	975	339	1,947	(±0)	2.4
Elm	575	79	94	584	627	1,959	(±0)	2.5
Spruce	126	11	12	193	155	497	(±0)	0.6
Eastern white pine	203	20	15	430	250	919	(±0)	1.2
Sugar maple	345	43	53	392	353	1,186	(±0)	1.5
Mulberry	279	26	49	171	95	620	(±0)	0.8
Boxelder	240	37	39	280	261	856	(±0)	1.1
Norway maple	317	36	55	322	231	961	(±0)	1.2
Lilac	277	21	50	191	58	596	(±0)	0.7
Eastern redbud	102	11	16	54	48	230	(±0)	0.3
Cottonwood	434	51	89	844	277	1,695	(±0)	2.1
Other street trees	1,715	208	296	2,285	1,602	6,107	(±0)	7.6
Citywide Total	21,664	3,021	3,679	29,376	22,167	79,908	(±0)	100.0

Murray

Species Distribution of Public Trees (%)

1/14/2013



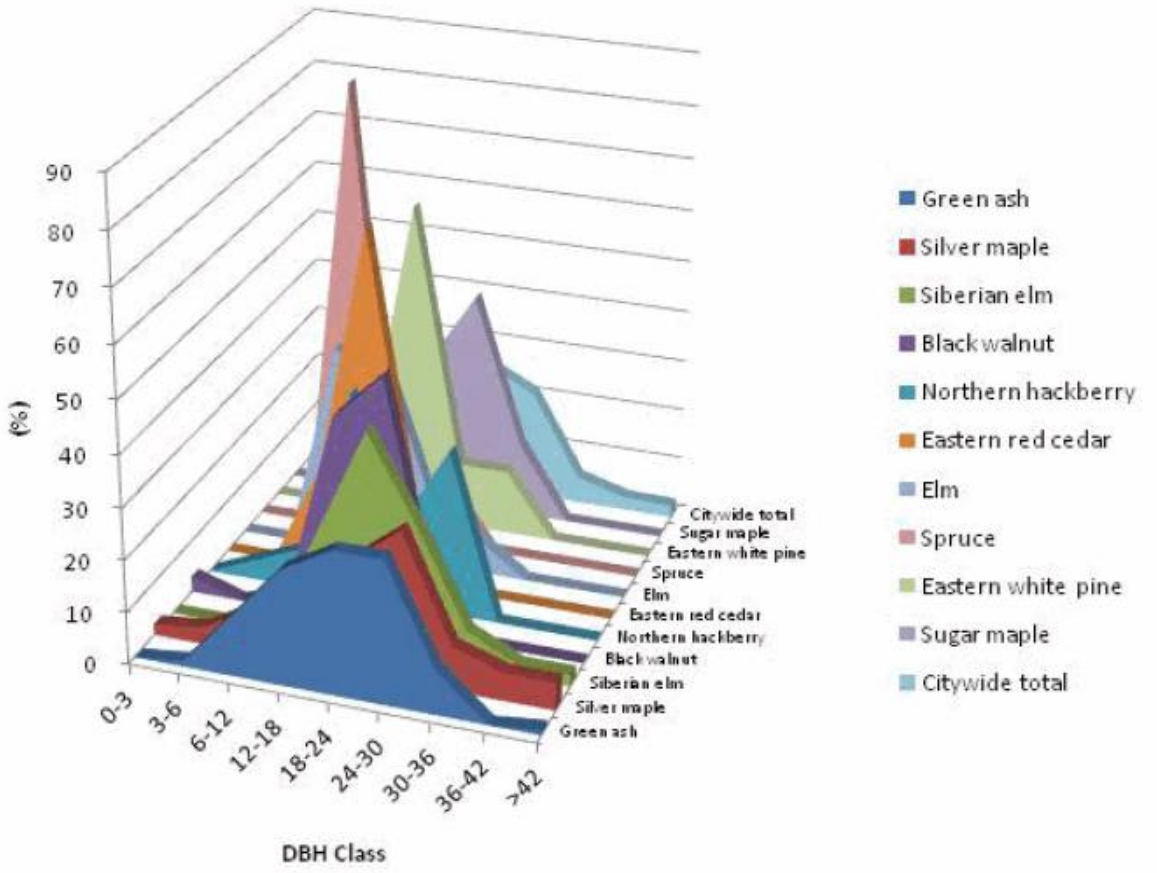
Species	Percent
Green ash	22.3
Silver maple	22.0
Siberian elm	10.2
Black walnut	7.8
Northern hackberry	5.9
Eastern red cedar	5.9
Elm	3.6
Spruce	1.9
Eastern white pine	1.9
Sugar maple	1.7
Other species	16.8
Total	100.0

Figure 1: Species Distribution

Murray

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

1/14/2013



	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	1.1	11.7	22.3	27.7	27.7	8.5	0.0	1.1
Silver maple	2.2	3.2	8.6	16.1	21.5	29.0	8.6	5.4	5.4
Siberian elm	0.0	0.0	0.0	20.9	41.9	25.6	7.0	2.3	2.3
Black walnut	3.0	0.0	3.0	39.4	48.5	6.1	0.0	0.0	0.0
Northern hackberry	0.0	4.0	8.0	40.0	16.0	32.0	0.0	0.0	0.0
Eastern red cedar	0.0	0.0	20.0	68.0	12.0	0.0	0.0	0.0	0.0
Elm	0.0	0.0	40.0	40.0	13.3	6.7	0.0	0.0	0.0
Spruce	0.0	0.0	87.5	0.0	12.5	0.0	0.0	0.0	0.0
Eastern white pine	0.0	0.0	12.5	62.5	12.5	12.5	0.0	0.0	0.0
Sugar maple	0.0	0.0	14.3	28.6	42.9	14.3	0.0	0.0	0.0
Citywide total	0.9	1.4	12.8	27.7	25.8	21.1	5.2	2.6	2.4

Figure 2: Relative Age Class

Murray

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

1/14/2013

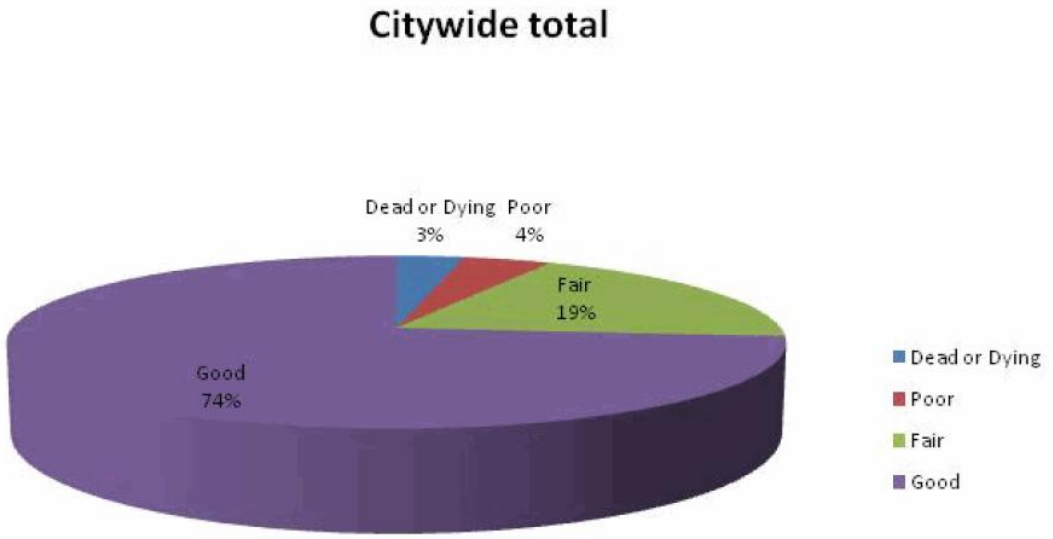


Figure 3: Foliage Condition

Murray

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

1/14/2013

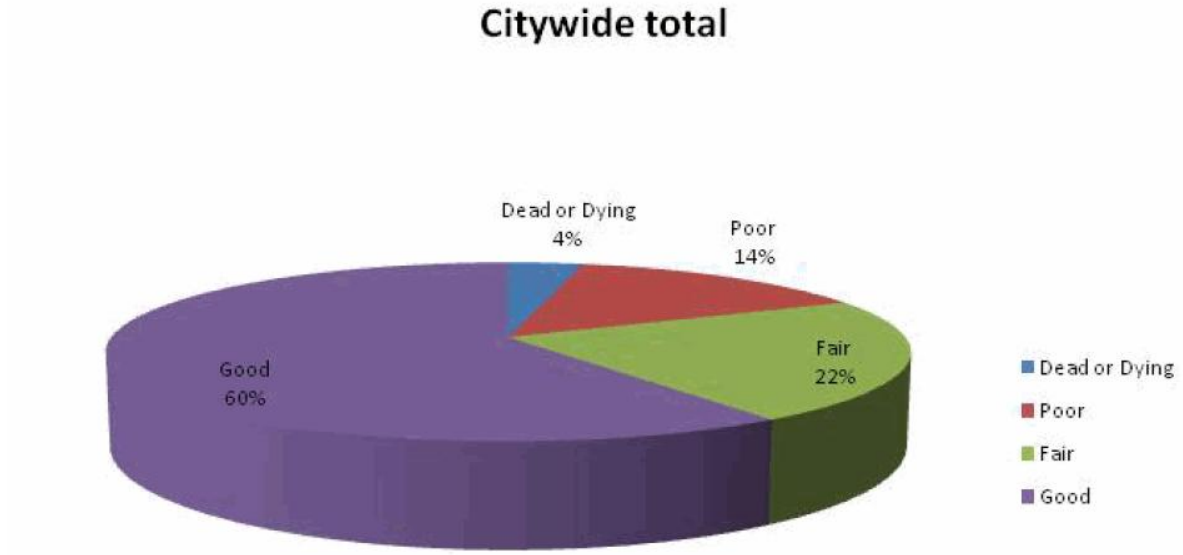
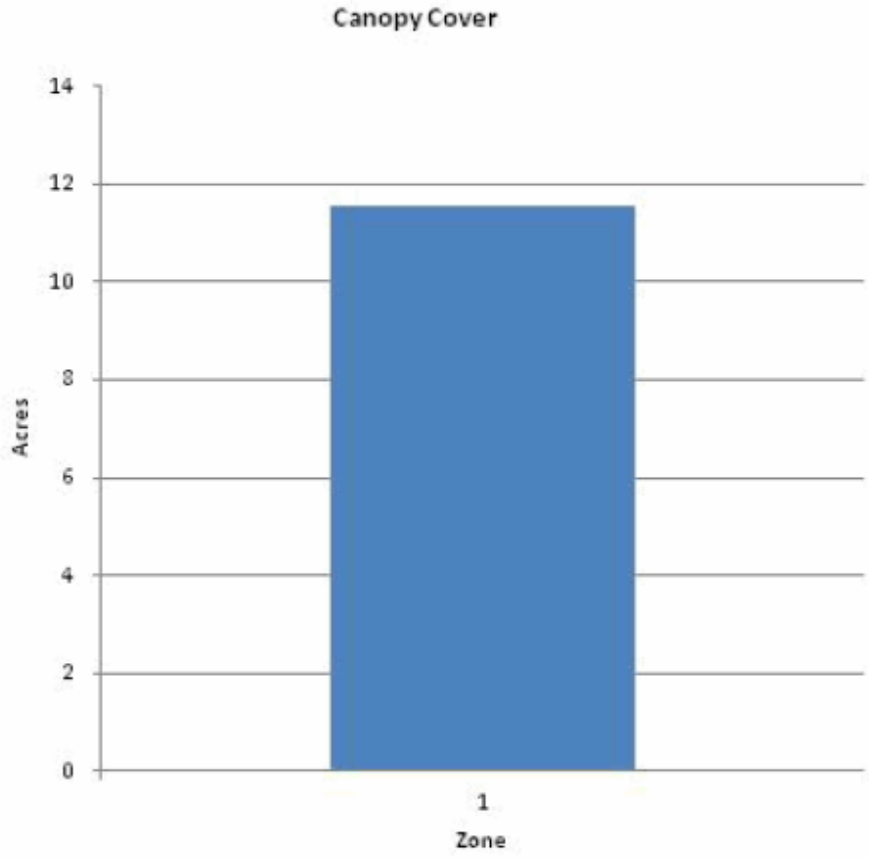


Figure 4: Wood Condition

Murray

Canopy Cover of Public Trees (Acres)

1/14/2013



Zone	Acres	% of Total Canopy Cover
1	12	100.0
Citywide total	12	100.0

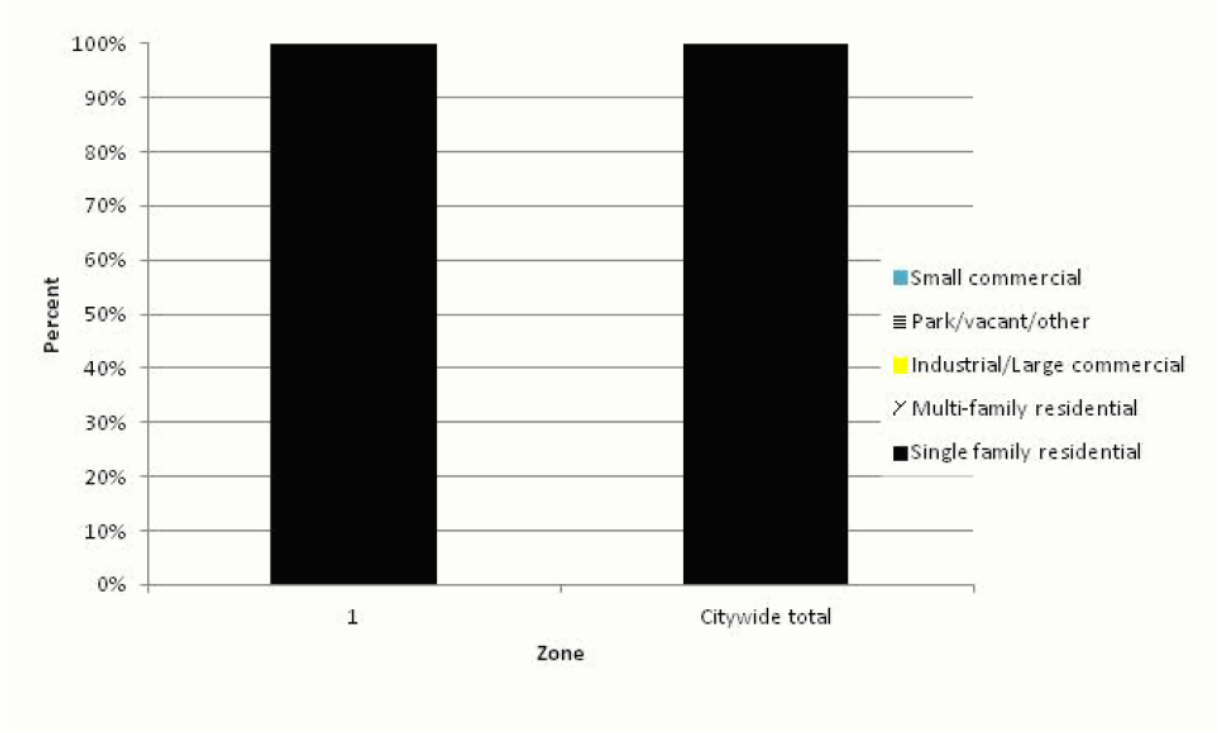
	Total Land Area	Total Street and Sidewalk Area	Total Canopy Cover	Canopy Cover as % of Total Land Area	Canopy Cover as % of Total Streets and Sidewalks
Citywide	0	0	12		

Figure 5: Canopy Cover in Acres

Murray

Land Use of Public Trees by Zone (%)

1/14/2013



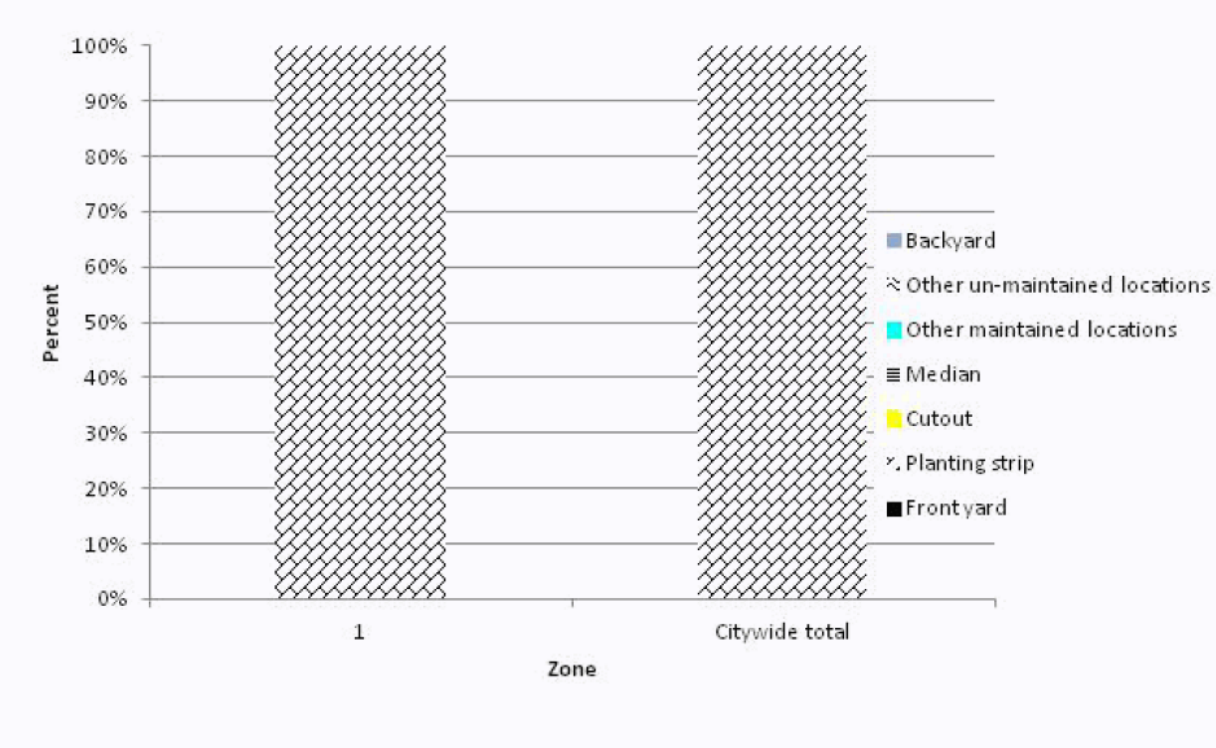
Zone	Single family residential	Multi-family residential	Industrial/ Large commercial	Park/vacant/ other	Small commercial
1	100.0	0.0	0.0	0.0	0.0
Citywide total	100.0	0.0	0.0	0.0	0.0

Figure 6: Land Use of city/park trees

Murray

Location of Public Trees by Zone (%)

1/14/2013



Zone	Front yard	Planting strip	Cutout	Median	Other maintained locations	Other un-maintained locations	Backyard
1	0.0	100.0	0.0	0.0	0.0	0.0	0.0
Citywide total	0.0	100.0	0.0	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

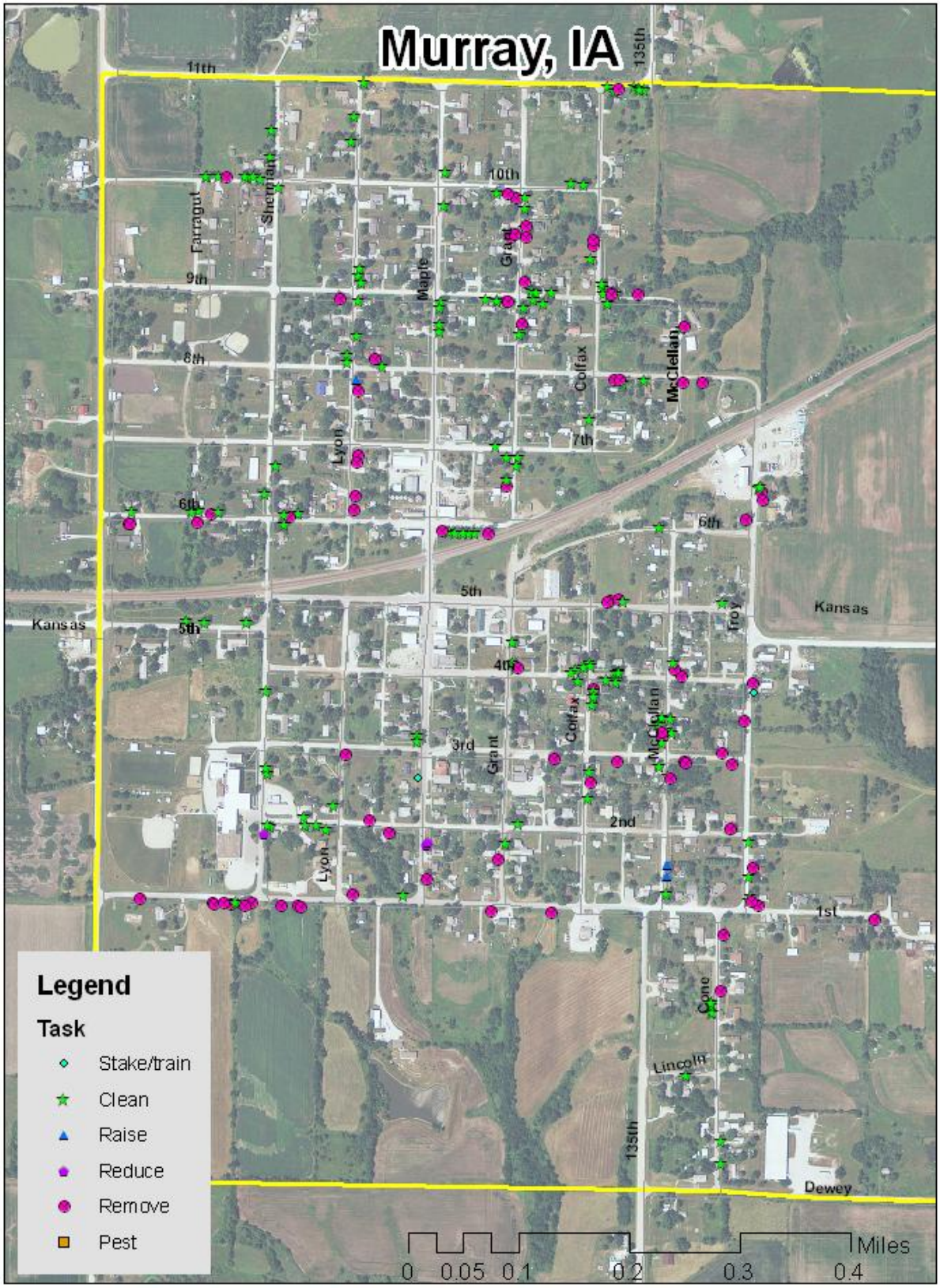


Figure 5: Maintenance Tasks *City ownership of the trees recommended for removal should be verified prior to any removal*

Appendix C: Tree Ordinances

Chapter 151 of the Murray City Ordinance

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 515-281-5918.