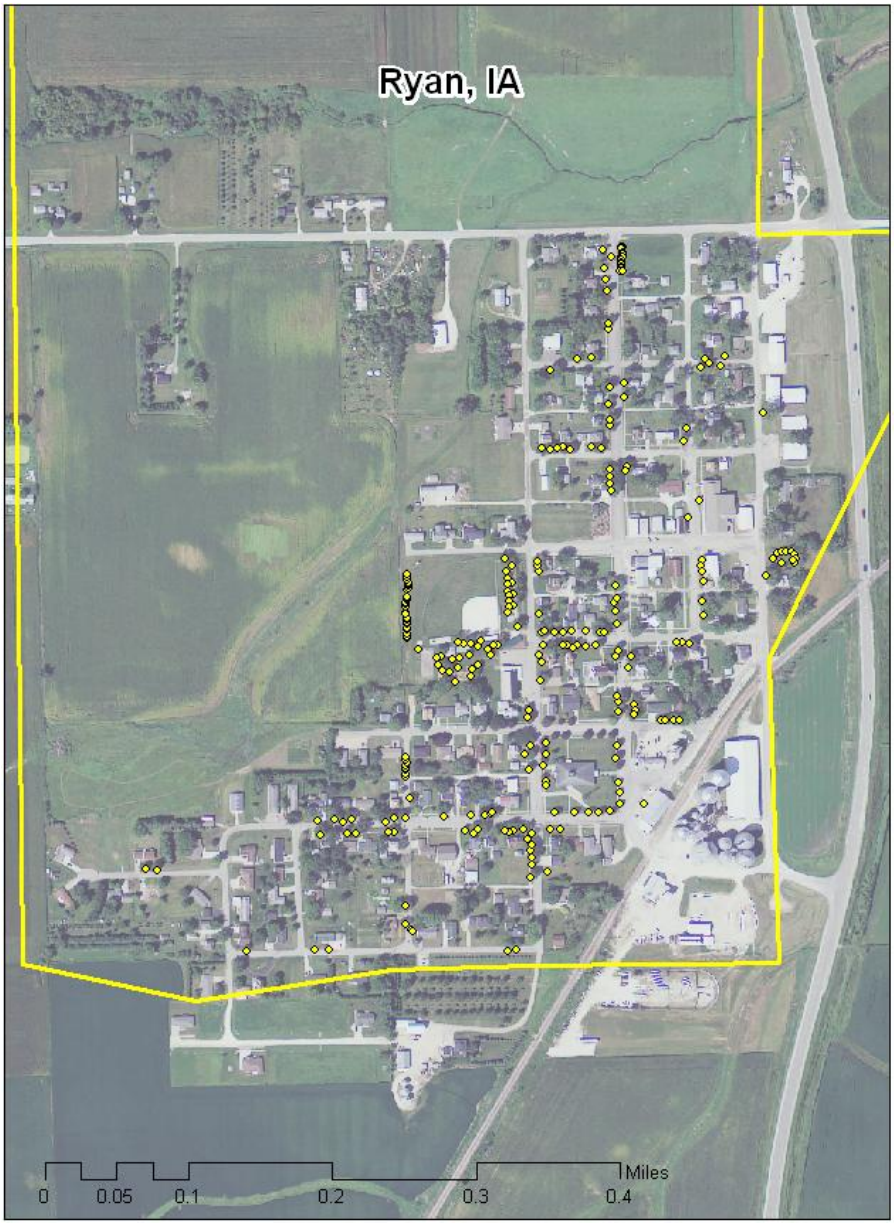
# RYAN, IA




2011 Management Plan

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# Executive Summary

**Overview**

This plan has been developed to assist the City of Ryan with managing its urban forest, including budgeting and future planning. Trees can provide a multitude of benefits to the community, and sound management allows communities 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 that kills all species of native ash trees. There is a strong possibility that over 18% of Ryan's city managed ash trees could 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 several years mitigating public safety issues.

**Inventory and Results**

In summer of 2011, a street tree inventory was conducted using an integrated Global Positioning System (GPS) data collector. This involved a complete inventory of the street trees within the City's Right-of-Way. Below are some key findings of the 252 trees inventoried.

- Ryan's street trees provide roughly $29,672 of annual benefits, an average of $118 per tree.
- The top three species groups are: Maples 43%, Arborvitae 20% and Ash 18%.
- Approximately 19% of trees are in need of some type of management.
- For various reasons, 9 trees are recommended for removal.

**Recommendations**

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

- Of the 9 trees needing removal, 1 of the trees should be removed very soon due to public safety concerns.
- Two of the 46 ash trees inventoried are in need of follow up checking because they are displaying some 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, soft maple, autumn olive, black locust, black walnut, boxelder, Chinese elm, Siberian elm, cottonwood, poplar and tree-of-heaven.
- Check ash trees with a visual survey, yearly.

# Introduction

This plan was developed to assist Ryan with the management, budgeting and future planning of their urban forest. Across the state, forestry budgets continue to decrease with a greater proportion 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 Ryan, these costs can be extended over several years and public safety issues from dead and dying ash trees can be mitigated.

Trees are an important component of Ryan's infrastructure and are one of the greatest assets to the community. Through research, it has been shown that trees provide a community with numerous public benefits including: improved air quality, storm water runoff interception, energy conservation, lower traffic speeds, increased property values, reduced crime, improved mental health and creating a desirable place to live. It is essential that these benefits be maintained for the people of Ryan and future generations through sound urban forestry management.

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

# Inventory

In 2011, a tree inventory was conducted that included just the city managed street and park trees. The tree data was collected using a handheld Global Positioning System (GPS) receiver/data logger. This devise records Geographic Information System (GIS) coordinates with an accuracy of 3 meters. The data can then 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 collector was written to be compatible with a state-of-the-art software suite called i-Tree. This software was developed by the USDA Forest Service to quantify the structure of community trees and the environmental services that trees provide. This software is in the public domain and can be accessed for free.

To quantify the urban forest structure and its benefits, specific data was collected for each tree. This data included: location, land use, tree species, diameter at 4.5 ft (DBH), 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 by the data logger was downloaded and analyzed by software developed by the USDA Forest service called *Street Tree Resource Analysis Tool for Urban forestry Management (STRATUM)*. This is software is also part of the i-Tree suite. The following are results from the i-Tree STRATUM analysis of Ryan's inventory data.

## ***Annual Benefits***

### Annual Energy Benefits

Trees conserve energy by shading buildings and blocking wind. Ryan's trees reduce energy related costs by approximately $8,372 annually (Appendix A, Table 1). These savings are both in Electricity (40.8 MWh) and in Natural Gas (5,387 Therms).

### Annual Storm water Benefits

Ryan's trees intercept about 363,385 gallons of rainfall and snow melt per year (Appendix A, Table 2). This interception provides $9,848 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 that emit volatile organic matter (ozone). In Ryan, it is estimated that trees remove 494 lbs. of air pollution (ozone ($O_3$), particulate matter less than 10 microns ($PM_{10}$), carbon monoxide (CO), nitrogen dioxide ($NO_2$), and sulfur dioxide ($SO_2$)) per year with a net value of $1,384 (Appendix A, Table 3).

### Annual Carbon Benefits

Carbon sequestration and storage reduce the amount of carbon in the atmosphere, mitigating climate change. Of the 252 trees inventoried, the amount of carbon stored amounts to approximately 1,163,080 total lbs of $CO_2$ (Appendix A, Table 4) . Those trees are sequestering about 86,169 lbs of carbon per year (Appendix A, Table 5). The benefits these trees provide from summer shading and from reductions in household wind infiltration in the winter result in approximately 68,359 fewer lbs of $CO_2$ being released into the atmosphere (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. Ryan receives approximately $8,951 in annual social benefits from its street trees (Appendix A, Table 6).

**Financial Summary of all Benefits**

According to the USDA Forest Service i-Tree STRATUM analysis, Ryan's trees provide $29,672 of benefits annually. Benefits of individual trees vary based on size, species, health and location. On average, each of the 252 trees in Ryan's inventory provides approximately $118 annually (Appendix A, Table 7).

## ***Forest Structure***

**Species Distribution**

There were over 33 different tree species surveyed. Appendix A, Figure 1 shows the species distribution graphically. The distribution of trees by genus is demonstrated in the follow table.

| Genus | # of trees | % of total |
|---|---|---|
| Maple (*acer*) | 109 | 43.3% |
| Arborvitae | 51 | 20.2% |
| Ash (*fraxius*) | 46 | 18.3% |
| Walnut (*juglans*) | 5 | 2.0% |
| Honeylocust (*gleditsia*) | 5 | 2.0% |
| Linden (*tilia*) | 5 | 2.0% |
| Spruce (*picea*) | 4 | 1.6% |
| Birch (*betula*) | 4 | 1.6% |
| Other | 3 | 1.2% |
| Elm (*ulmus*) | 3 | 1.2% |
| Cherry (*prunus*) | 3 | 1.2% |
| Hackberry *(Celtis)* | 3 | 1.2% |
| Apple (*malus*) | 2 | 0.8% |
| Oak (*quercus*) | 2 | 0.8% |
| Pine (*Pinus*) | 2 | 0.8% |
| Eastern Red Cedar (*juniperus*) | 2 | 0.8% |
| Sycamore (*platanus*) | 1 | 0.4% |
| Poplar (*populus*) | 1 | 0.4% |
| Kentucky Coffeetree (*gymnocladus*) | 1 | 0.4% |
| | 252 | 100.0% |

The table below summarizes distribution of surveyed trees by their diameter in inches when measured at 4.5 above the ground. Trees between 12 and 18" in diameter were most abundant (32.9%). There were also plenty of smaller trees in the 0 to 3 inch size range (22.6%). The size distribution indicates there should be plenty of younger trees to replace older trees as they are removed. See Appendix A, Figure 2 for a breakdown of size distributions by species.

| Size Classes (inches of diameter at 4.5 feet) | # of trees | % of trees |
|---|---|---|
| 0 - 3 | 57 | 22.6% |
| 3 - 6 | 21 | 8.3% |
| 6 - 12 | 30 | 11.9% |
| 12 - 18 | 83 | 32.9% |
| 18 - 24 | 39 | 15.5% |
| 24 - 30 | 8 | 3.2% |
| 30 - 36 | 7 | 2.8% |
| 36 - 42 | 5 | 2.0% |
| 42+ | 2 | 0.8% |
| | 252 | 100.0% |

**Condition: Wood and Foliage**

Leaf condition is a good indicator of the overall health of urban trees. At the time of the survey, the foliage condition results indicated that 91% of the trees were in good health, 6% in fair health, 1% in poor health and 2% dead or dying. (Appendix A, Figure 3).

The condition of the wood in urban trees is another important indicator of tree health. The wood forms the structural support system for the leaves and branches. Extensive decay in the main stem makes a tree structurally unsafe which leads to a tree becoming a safety hazard. In Ryan, 84% of the surveyed trees were in good health, 11% in fair health, 4% in poor health and 1% dead or dying for wood condition (Appendix A, Figure 4). The 5% in poor, or dead or dying, condition should be assessed more carefully. Some of these trees we recommend to be removed for the sake of public safety.

**Management Needs**

Each tree was assessed for any recommended maintenance needs. The following tables list the specific management needs and recommendations for the surveyed trees. Of the trees recommended for removal, none were judged to be of critical concern for public safety, but three should be removed as soon as possible (See Appendix B, figure 4).

| Priority Task | # of trees | % of trees |
|---|---|---|
| none | 203 | 80.6% |
| stake/train | 12 | 4.8% |
| reduce | 12 | 4.8% |
| clean | 11 | 4.4% |
| remove | 9 | 3.6% |
| raise | 5 | 2.0% |
| | 252 | 100.0% |

| Maintenance Recommendation | # of trees | % of trees |
|---|---|---|
| None | 202 | 80.2% |
| mature tree (routine) | 34 | 13.5% |
| young tree (routine) | 13 | 5.2% |
| young tree (immediate) | 2 | 0.8% |
| mature tree (immediate) | 1 | 0.4% |
| critical concern (public safety) | 0 | 0.0% |
| | 252 | 100.0% |

**Land Use and Location**

The majority of Ryan's surveyed trees are 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 | 55% |
| Park/vacant/other | 43% |
| Small commercial | 2% |

| Location | |
|---|---|
| Front yard | 8% |
| Planting strip | 47% |
| Back yard | 9% |
| Other maintained locations | 36% |

# 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 trimmed or removed to eliminate the hazard.

Hazardous trees

Ryan has 3 trees of that should be removed immediately. These trees can be seen on the *Location of Trees with Recommended Maintenance* map (Appendix B, Figure 4). A total of 9 trees were recommended for removal for one reason or another. Of those, 3 were dead or dying and 5 have poor wood condition or showed signs of severe decay. Therefore, they could easily break off or topple over in storms or under ice and snow loads and possible hurt someone or damage property.

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 9 trees recommended for removal, 3 trees were green ash that were either dead or dying or had poor wood condition. There were a total of 46 ash trees inventoried, and two of those have potential signs and symptoms that have been associated with EAB.

**Pruning Cycle**

Proper pruning can extend the life and improve the overall health of trees, and can reduce public safety issues. In the Management Needs section of the Findings there are four main maintenance issues to be addressed: routine pruning (stake/train), crown cleaning (clean), crown raising (raise), and crown reduction (reduce). 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. Staking and training is recommended for younger trees so they can develop good architecture. It is recommended that all trees be pruned on a routine schedule every five to seven years.

| Priority Task | # of trees | % of trees |
|---|---|---|
| none | 203 | 80.6% |
| stake/train | 12 | 4.8% |
| reduce | 12 | 4.8% |
| clean | 11 | 4.4% |
| remove | 9 | 3.6% |
| raise | 5 | 2.0% |

### Planting

Most of the planting over the next six years should be directed to replace the trees that are recommended for removal. It is recommended to plant two trees for every one tree removed since survival rates will not be 100%. It is not essential that the new trees be planted in the same location as the trees being removed. However, maintaining the same number of trees helps ensure continuation of the benefits of the existing forest in Ryan.

Since most insects and diseases target a particular genus (e.g. ash) or species (e.g. green ash) of trees, it is important to always plant a diverse mix of species. Current diversity recommendations advise that any genus (e.g. maple, oak or ash) not make up more than 20% of the urban forest. Any single species (e.g. silver maple, sugar maple, white oak or bur oak) not make up more than 10% of the total urban forest. Presently, the forest is heavily planted with Maple (43%), Arborvitae (20%) and ash (18%) (Appendix A, Figure 1). Maples should not be planted. Also, ash trees have not been recommended for planting since 2002 due to the threat of EAB. Other species to avoid because they are public nuisances include: Autumn olive, black locust, black walnut, boxelder, Chinese elm, Siberian elm, cottonwood, poplars, tree-of-heaven, and willow species.

### 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 (EAB) Plan

### Ash Tree Removal

Tree removal should 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 always 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 many millions ash trees throughout the Eastern United States and Canada. Ash in both forestlands and urban settings constitutes a very significant portion of the canopy cover. 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 its spread beyond its known locations 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 urban 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 your budget permits, all removed ash trees should be replaced. All trees should meet the restrictions in your city's ordinance. The new plantings should be a diverse mix and should not include ash, Autumn olive, black locust, black walnut, boxelder, Chinese elm, Siberian elm, cottonwood, poplar, tree of heaven, or willow.

**Postponed Work**

While finances, staffing and equipment are focused on the management of ash, usual services may be delayed. Tree removal requests on genus's 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 as trees are infested with Emerald Ash Borer. Trees that are on private property are part of Ryan's urban forest.

Private property owners should be given direction to the proper species to plant, spacing, and location. Ryan has a city ordinance for trees. However, this ordinance dates back to the Dutch elm disease days and needs to be updated. The current ordinances only relate to nuisances and mention nothing about placement regulations or an expectable species list. (Appendix C)

# Budget

EAB could potentially kill all of the ash trees in Ryan within a decade after its arrival. It is recommended that the City apply for grants to fund replacement tree planting. 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. There were a total of 46 ash trees surveyed. We recommend that at least 1/3 (15 trees) of them be removed and replaced over the next 6 years. Remember to plant 2 trees for everyone removed. First, remove the 4 trees that are dead or dying (Appendix B, Figure 3). Also remove the 3 trees showing signs and symptom consistent with possible EAB infestation (Appendix B, Figure 2). Next, remove 10 of the twenty ash trees in the City Park (Appendix B, Figure 1). We recommend that the City adopt a policy of allocating somewhere between $2 to $4 per capita per year into a forestry budget to be used for planting, removals and maintenance of Ryan's urban forest.

**Recommended Budget**

**Budget a total of $14,400 over the next 6 years ($2400/year) for dealing with the imminent EAB threat.**

**FY 2012 Budget**

Removal: $1500
Planting: $600
Routine trimming: $200
Watering & Maintenance: $100

**FY 2013 Budget**

Removal: $1500
Planting: $600
Routine trimming: $200
Watering & Maintenance: $100

**FY 2014 Budget**

Removal: $1500
Planting: $600
Routine trimming: $200
Watering & Maintenance: $100

**FY 2015 Budget**

Removal: $1500

Planting: $600
Routine trimming: $200
Watering & Maintenance: $100

**FY 2016 Budget**

Removal: $1500
Planting: $600
Routine trimming: $200
Watering & Maintenance: $100

**FY 2017 Budget**

Removal: $1500
Planting: $600
Routine trimming: $200
Watering & Maintenance: $100

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# Appendix A: i-Tree Data

**Table 1: Annual Energy Benefits**

## Annual Energy Benefits of Public Trees by Species

9/22/2011

| Species | Total Electricity (MWh) | Electricity ($) | Total Natural Gas (Therms) | Natural Gas ($) | Total ($) | Standard Error | % of Total Trees | % of Total $ | Avg. $/tree |
|---|---|---|---|---|---|---|---|---|---|
| Norway maple | 11.4 | 862 | 1,555.7 | 1,525 | 2,387 | (N/A) | 21.4 | 28.5 | 44.20 |
| Northern white cedar | 0.6 | 45 | 103.4 | 101 | 147 | (N/A) | 20.2 | 1.8 | 2.87 |
| Green ash | 11.1 | 844 | 1,457.9 | 1,429 | 2,273 | (N/A) | 17.9 | 27.1 | 50.50 |
| Silver maple | 5.7 | 435 | 728.7 | 714 | 1,149 | (N/A) | 9.9 | 13.7 | 45.97 |
| Sugar maple | 5.5 | 418 | 683.8 | 670 | 1,088 | (N/A) | 9.5 | 13.0 | 45.35 |
| Honeylocust | 1.4 | 108 | 175.8 | 172 | 280 | (N/A) | 2.0 | 3.3 | 55.98 |
| Black walnut | 1.1 | 80 | 132.8 | 130 | 211 | (N/A) | 2.0 | 2.5 | 42.13 |
| Paper birch | 0.4 | 29 | 54.9 | 54 | 83 | (N/A) | 1.6 | 1.0 | 20.64 |
| American basswood | 0.1 | 7 | 14.1 | 14 | 21 | (N/A) | 1.6 | 0.3 | 5.17 |
| Boxelder | 0.7 | 51 | 91.0 | 89 | 141 | (N/A) | 1.2 | 1.7 | 46.84 |
| Red maple | 0.1 | 6 | 11.2 | 11 | 17 | (N/A) | 1.2 | 0.2 | 5.58 |
| Northern hackberry | 0.0 | 1 | 2.4 | 2 | 3 | (N/A) | 1.2 | 0.0 | 1.14 |
| Norway spruce | 0.4 | 28 | 48.7 | 48 | 76 | (N/A) | 1.2 | 0.9 | 25.30 |
| Cherry plum | 0.2 | 17 | 38.5 | 38 | 55 | (N/A) | 1.2 | 0.7 | 18.19 |
| Other street trees | 2.1 | 162 | 287.9 | 282 | 444 | (N/A) | 7.9 | 5.3 | 22.20 |
| Citywide total | 40.8 | 3,093 | 5,386.8 | 5,279 | 8,372 | (N/A) | 100.0 | 100.0 | 33.22 |

**Table 2: Annual Stormwater Benefits**

## Annual Stormwater Benefits of Public Trees by Species

9/22/2011

| Species | Total rainfall interception (Gal) | Total ($) | Standard Error | % of Total Trees | % of Total $ | Avg. $/tree |
|---|---|---|---|---|---|---|
| Norway maple | 83,883 | 2,273 | (N/A) | 21.4 | 23.1 | 42.10 |
| Northern white cedar | 6,586 | 179 | (N/A) | 20.2 | 1.8 | 3.50 |
| Green ash | 100,729 | 2,730 | (N/A) | 17.9 | 27.7 | 60.67 |
| Silver maple | 68,836 | 1,866 | (N/A) | 9.9 | 18.9 | 74.62 |
| Sugar maple | 42,483 | 1,151 | (N/A) | 9.5 | 11.7 | 47.97 |
| Honeylocust | 9,132 | 248 | (N/A) | 2.0 | 2.5 | 49.50 |
| Black walnut | 7,595 | 206 | (N/A) | 2.0 | 2.1 | 41.17 |
| Paper birch | 2,431 | 66 | (N/A) | 1.6 | 0.7 | 16.47 |
| American basswood | 362 | 10 | (N/A) | 1.6 | 0.1 | 2.45 |
| Boxelder | 6,778 | 184 | (N/A) | 1.2 | 1.9 | 61.24 |
| Red maple | 286 | 8 | (N/A) | 1.2 | 0.1 | 2.59 |
| Northern hackberry | 54 | 1 | (N/A) | 1.2 | 0.0 | 0.49 |
| Norway spruce | 6,738 | 183 | (N/A) | 1.2 | 1.9 | 60.87 |
| Cherry plum | 793 | 22 | (N/A) | 1.2 | 0.2 | 7.17 |
| Other street trees | 26,697 | 724 | (N/A) | 7.9 | 7.4 | 36.18 |
| Citywide total | 363,385 | 9,848 | (N/A) | 100.0 | 100.0 | 39.08 |

**Table 3: Annual Air Quality Benefits**

## Annual Air Quality Benefits of Public Trees by Species

9/22/2011

| Species | Deposition (lb) $O_3$ | $NO_2$ | $PM_{10}$ | $SO_2$ | Total Depos. ($) | Avoided (lb) $NO_2$ | $PM_{10}$ | VOC | $SO_2$ | Total Avoided ($) | BVOC Emissions (lb) | BVOC Emissions ($) | Total (lb) | Total ($) | Standard Error | % of Total Trees | Avg. $/tree |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Norway maple | 14.8 | 2.6 | 7.6 | 0.7 | 81 | 54.4 | 7.9 | 7.5 | 51.6 | 338 | -3.7 | -14 | 143.3 | 406 | (N/A) | 21.4 | 7.51 |
| Northern white cedar | 0.3 | 0.1 | 0.4 | 0.0 | 3 | 3.0 | 0.4 | 0.4 | 2.7 | 18 | -2.0 | -8 | 5.5 | 14 | (N/A) | 20.2 | 0.27 |
| Green ash | 10.6 | 1.7 | 5.4 | 0.5 | 58 | 52.5 | 7.7 | 7.3 | 50.4 | 329 | 0.0 | 0 | 136.2 | 386 | (N/A) | 17.9 | 8.58 |
| Silver maple | 10.5 | 1.8 | 5.3 | 0.5 | 57 | 26.8 | 3.9 | 3.8 | 25.9 | 168 | -6.0 | -23 | 72.6 | 203 | (N/A) | 9.9 | 8.12 |
| Sugar maple | 4.7 | 0.8 | 2.6 | 0.2 | 26 | 25.7 | 3.8 | 3.6 | 25.0 | 161 | -3.9 | -15 | 62.4 | 173 | (N/A) | 9.5 | 7.21 |
| Honeylocust | 1.6 | 0.3 | 0.8 | 0.1 | 8 | 6.6 | 1.0 | 0.9 | 6.4 | 42 | -1.0 | -4 | 16.6 | 46 | (N/A) | 2.0 | 9.24 |
| Black walnut | 0.6 | 0.1 | 0.4 | 0.0 | 3 | 5.0 | 0.7 | 0.7 | 4.8 | 31 | 0.0 | 0 | 12.3 | 35 | (N/A) | 2.0 | 6.92 |
| Paper birch | 0.1 | 0.0 | 0.1 | 0.0 | 1 | 1.8 | 0.3 | 0.3 | 1.7 | 11 | 0.0 | 0 | 4.3 | 12 | (N/A) | 1.6 | 2.99 |
| American basswood | 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) | 1.6 | 0.69 |
| Boxelder | 0.9 | 0.1 | 0.4 | 0.0 | 5 | 3.2 | 0.5 | 0.4 | 3.1 | 20 | -0.4 | -1 | 8.3 | 23 | (N/A) | 1.2 | 7.74 |
| Red maple | 0.0 | 0.0 | 0.0 | 0.0 | 0 | 0.4 | 0.1 | 0.1 | 0.3 | 2 | 0.0 | 0 | 0.8 | 2 | (N/A) | 1.2 | 0.79 |
| Northern hackberry | 0.0 | 0.0 | 0.0 | 0.0 | 0 | 0.1 | 0.0 | 0.0 | 0.1 | 0 | 0.0 | 0 | 0.2 | 0 | (N/A) | 1.2 | 0.14 |
| Norway spruce | 0.8 | 0.2 | 0.6 | 0.1 | 5 | 1.7 | 0.3 | 0.2 | 1.7 | 11 | -3.6 | -13 | 2.0 | 3 | (N/A) | 1.2 | 0.91 |
| Cherry plum | 0.1 | 0.0 | 0.1 | 0.0 | 1 | 1.1 | 0.2 | 0.2 | 1.0 | 7 | 0.0 | 0 | 2.7 | 8 | (N/A) | 1.2 | 2.55 |
| Other street trees | 4.6 | 0.8 | 2.7 | 0.3 | 26 | 10.1 | 1.5 | 1.4 | 9.7 | 63 | -5.1 | -19 | 26.0 | 71 | (N/A) | 7.9 | 3.53 |
| Citywide total | 49.7 | 8.4 | 26.4 | 2.4 | 274 | 192.9 | 28.2 | 26.9 | 184.7 | 1,206 | -25.6 | -96 | 494.1 | 1,384 | (N/A) | 100.0 | 5.49 |

**Table 4: Annual Carbon Stored**

## Stored CO2 Benefits of Public Trees by Species

9/22/2011

| Species | Total Stored CO2 (lbs) | Total ($) | Standard Error | % of Total Trees | % of Total $ | Avg. $/tree |
|---|---|---|---|---|---|---|
| Norway maple | 244,058 | 1,830 | (N/A) | 21.4 | 21.0 | 33.90 |
| Northern white | 1,830 | 14 | (N/A) | 20.2 | 0.2 | 0.27 |
| Green ash | 346,116 | 2,596 | (N/A) | 17.9 | 29.8 | 57.69 |
| Silver maple | 248,391 | 1,863 | (N/A) | 9.9 | 21.4 | 74.52 |
| Sugar maple | 136,518 | 1,024 | (N/A) | 9.5 | 11.7 | 42.66 |
| Honeylocust | 18,891 | 142 | (N/A) | 2.0 | 1.6 | 28.34 |
| Black walnut | 20,508 | 154 | (N/A) | 2.0 | 1.8 | 30.76 |
| Paper birch | 4,138 | 31 | (N/A) | 1.6 | 0.4 | 7.76 |
| American | 572 | 4 | (N/A) | 1.6 | 0.1 | 1.07 |
| Boxelder | 25,850 | 194 | (N/A) | 1.2 | 2.2 | 64.62 |
| Red maple | 454 | 3 | (N/A) | 1.2 | 0.0 | 1.13 |
| Northern | 14 | 0 | (N/A) | 1.2 | 0.0 | 0.04 |
| Norway spruce | 8,917 | 67 | (N/A) | 1.2 | 0.8 | 22.29 |
| Cherry plum | 2,724 | 20 | (N/A) | 1.2 | 0.2 | 6.81 |
| Other street trees | 47,219 | 781 | (N/A) | 7.9 | 9.0 | 39.04 |
| Citywide total | 1,163,080 | 8,723 | (N/A) | 100.0 | 100.0 | 34.62 |

**Table 5: Annual Carbon Sequestered**

## Annual $CO_2$ Benefits of Public Trees by Species

9/22/2011

| Species | Sequestered (lb) | Sequestered ($) | Decomposition Release (lb) | Maintenance Release (lb) | Total Released ($) | Avoided (lb) | Avoided ($) | Net Total (lb) | Total ($) | Standar d Error | % of Total Trees | % of Total $ | Avg. $/tree |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Norway maple | 18,882 | 142 | -1,171 | -11 | -9 | 19,054 | 143 | 36,755 | 276 | (N/A) | 21.4 | 24.7 | 5.10 |
| Northern white cedar | 547 | 4 | -9 | -10 | 0 | 998 | 7 | 1,527 | 11 | (N/A) | 20.2 | 1.0 | 0.22 |
| Green ash | 24,998 | 187 | -1,661 | -9 | -13 | 18,647 | 140 | 41,975 | 315 | (N/A) | 17.9 | 28.2 | 7.00 |
| Silver maple | 20,359 | 153 | -1,192 | -5 | -9 | 9,614 | 72 | 28,776 | 216 | (N/A) | 9.9 | 19.3 | 8.63 |
| Sugar maple | 9,268 | 70 | -655 | -5 | -5 | 9,244 | 69 | 17,852 | 134 | (N/A) | 9.5 | 12.0 | 5.58 |
| Honeylocust | 2,833 | 21 | -91 | -1 | -1 | 2,379 | 18 | 5,120 | 38 | (N/A) | 2.0 | 3.4 | 7.68 |
| Black walnut | 2,204 | 17 | -98 | -1 | -1 | 1,779 | 13 | 3,884 | 29 | (N/A) | 2.0 | 2.6 | 5.83 |
| Paper birch | 835 | 6 | -20 | -1 | 0 | 635 | 5 | 1,450 | 11 | (N/A) | 1.6 | 1.0 | 2.72 |
| American basswood | 104 | 1 | -3 | -1 | 0 | 151 | 1 | 252 | 2 | (N/A) | 1.6 | 0.2 | 0.47 |
| Boxelder | 2,151 | 16 | -124 | -1 | -1 | 1,135 | 9 | 3,162 | 24 | (N/A) | 1.2 | 2.1 | 7.90 |
| Red maple | 80 | 1 | -2 | -1 | 0 | 128 | 1 | 205 | 2 | (N/A) | 1.2 | 0.1 | 0.51 |
| Northern hackberry | 10 | 0 | 0 | -1 | 0 | 23 | 0 | 32 | 0 | (N/A) | 1.2 | 0.0 | 0.08 |
| Norway spruce | 168 | 1 | -43 | -1 | 0 | 622 | 5 | 747 | 6 | (N/A) | 1.2 | 0.5 | 1.87 |
| Cherry plum | 342 | 3 | -13 | -1 | 0 | 372 | 3 | 700 | 5 | (N/A) | 1.2 | 0.5 | 1.75 |
| Other street trees | 3,385 | 25 | -500 | -4 | -4 | 3,577 | 27 | 6,459 | 48 | (N/A) | 7.9 | 4.3 | 2.42 |
| Citywide total | 86,169 | 646 | -5,583 | -49 | -42 | 68,359 | 513 | 148,896 | 1,117 | (N/A) | 100.0 | 100.0 | 4.43 |

**Table 6: Annual Social and Aesthetic Benefits**

## Annual Aesthetic/Other Benefits of Public Trees by Species

9/22/2011

| Species | Total ($) | Standar d Error | % of Total Trees | % of Total $ | Avg. $/tree |
|---|---|---|---|---|---|
| Norway maple | 1,880 | (N/A) | 21.4 | 21.0 | 34.81 |
| Northern white cedar | 357 | (N/A) | 20.2 | 4.0 | 7.00 |
| Green ash | 2,267 | (N/A) | 17.9 | 25.3 | 50.38 |
| Silver maple | 1,755 | (N/A) | 9.9 | 19.6 | 70.18 |
| Sugar maple | 1,070 | (N/A) | 9.5 | 12.0 | 44.59 |
| Honeylocust | 605 | (N/A) | 2.0 | 6.8 | 121.08 |
| Black walnut | 224 | (N/A) | 2.0 | 2.5 | 44.76 |
| Paper birch | 114 | (N/A) | 1.6 | 1.3 | 28.56 |
| American basswood | 15 | (N/A) | 1.6 | 0.2 | 3.68 |
| Boxelder | 156 | (N/A) | 1.2 | 1.8 | 52.14 |
| Red maple | 15 | (N/A) | 1.2 | 0.2 | 4.87 |
| Northern hackberry | 11 | (N/A) | 1.2 | 0.1 | 3.69 |
| Norway spruce | 48 | (N/A) | 1.2 | 0.5 | 15.91 |
| Cherry plum | 19 | (N/A) | 1.2 | 0.2 | 6.40 |
| Other street trees | 415 | (N/A) | 7.9 | 4.6 | 20.75 |
| Citywide total | 8,951 | (N/A) | 100.0 | 100.0 | 35.52 |

**Table 7: Summary of Benefits in Dollars**

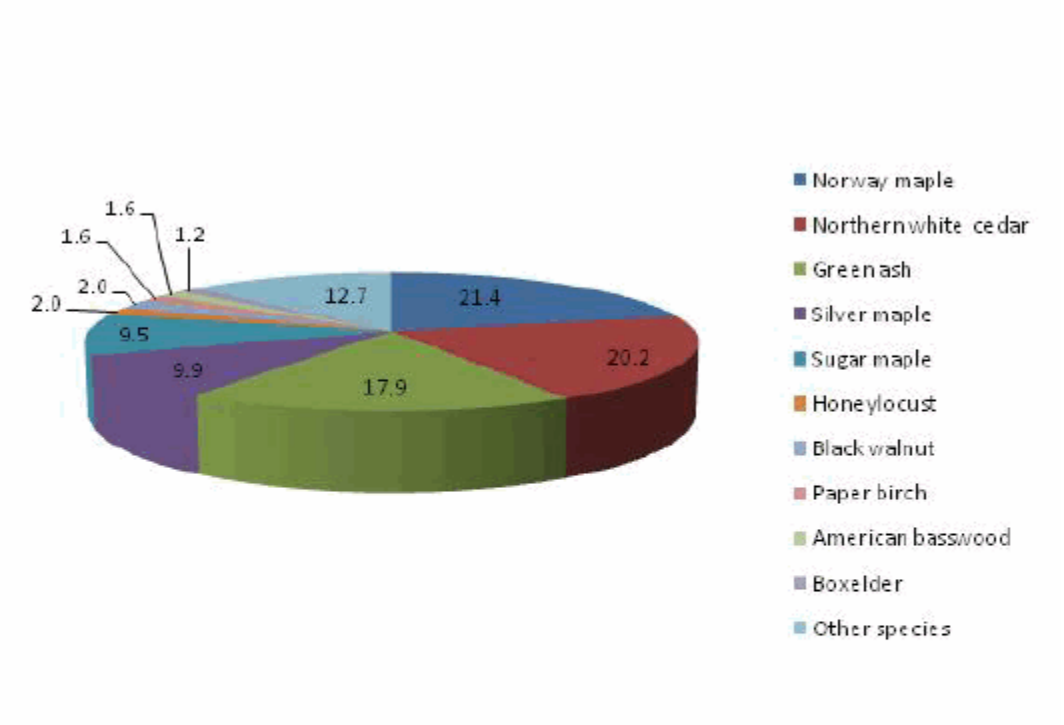
## Total Annual Benefits of Public Trees by Species ($)

9/22/201

| Species | Energy | $CO_2$ | Air Quality | Stormwater | Aesthetic/Other | Total ($) | Standard Error | % of Total $ |
|---|---|---|---|---|---|---|---|---|
| Norway maple | 2,387 | 276 | 406 | 2,273 | 1,880 | 7,221 | (±0) | 24.3 |
| Northern white cedar | 147 | 11 | 14 | 178 | 357 | 707 | (±0) | 2.4 |
| Green ash | 2,272 | 315 | 386 | 2,730 | 2,267 | 7,970 | (±0) | 26.9 |
| Silver maple | 1,149 | 216 | 203 | 1,866 | 1,755 | 5,188 | (±0) | 17.5 |
| Sugar maple | 1,088 | 134 | 173 | 1,151 | 1,070 | 3,617 | (±0) | 12.2 |
| Honeylocust | 280 | 38 | 46 | 247 | 605 | 1,217 | (±0) | 4.1 |
| Black walnut | 211 | 29 | 35 | 206 | 224 | 704 | (±0) | 2.4 |
| Paper birch | 83 | 11 | 12 | 66 | 114 | 286 | (±0) | 1.0 |
| American basswood | 21 | 2 | 3 | 10 | 15 | 50 | (±0) | 0.2 |
| Boxelder | 141 | 24 | 23 | 184 | 156 | 528 | (±0) | 1.8 |
| Red maple | 17 | 2 | 2 | 8 | 15 | 43 | (±0) | 0.1 |
| Northern hackberry | 3 | 0 | 0 | 1 | 11 | 17 | (±0) | 0.1 |
| Norway spruce | 76 | 6 | 3 | 183 | 48 | 315 | (±0) | 1.1 |
| Cherry plum | 55 | 5 | 8 | 22 | 19 | 108 | (±0) | 0.4 |
| Other street trees | 444 | 48 | 71 | 724 | 415 | 1,702 | (±0) | 5.7 |
| Citywide Total | 8,372 | 1,117 | 1,384 | 9,848 | 8,951 | 29,672 | (±0) | 100.0 |

## Species Distribution of Public Trees (%)

9/22/2011

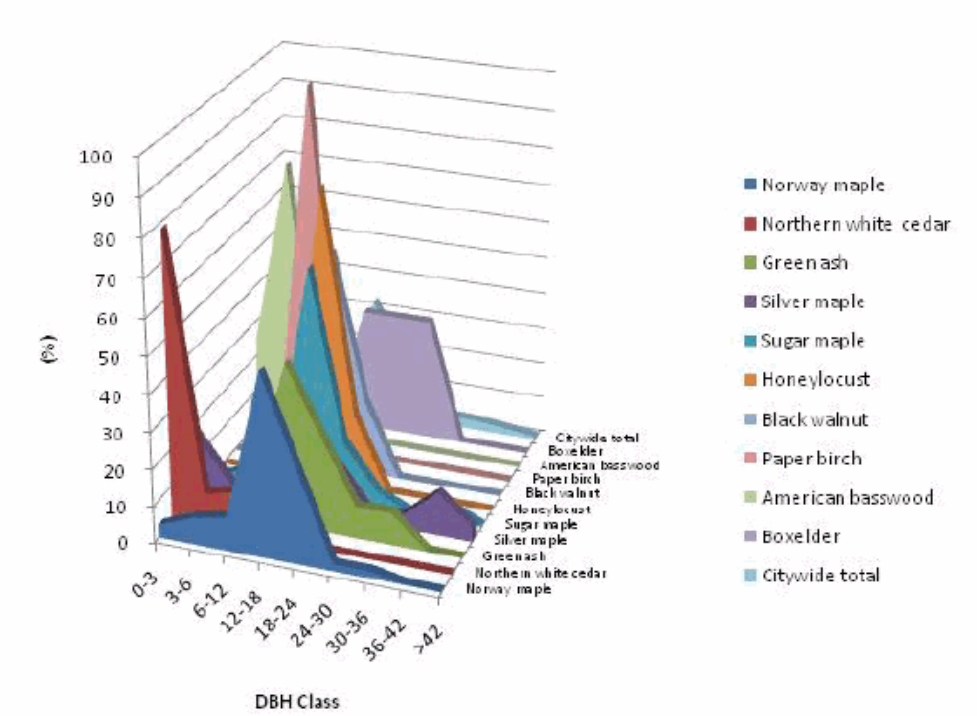



| Species | Percent |
|---|---|
| Norway maple | 21.4 |
| Northern white cedar | 20.2 |
| Green ash | 17.9 |
| Silver maple | 9.9 |
| Sugar maple | 9.5 |
| Honeylocust | 2.0 |
| Black walnut | 2.0 |
| Paper birch | 1.6 |
| American basswood | 1.6 |
| Boxelder | 1.2 |
| Other species | 12.7 |
| Total | 100.0 |

**Figure 1: Species Distribution**

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

9/22/2011




| | DBH class (in) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Species | 0-3 | 3-6 | 6-12 | 12-18 | 18-24 | 24-30 | 30-36 | 36-42 | >42 |
| Norway maple | 3.7 | 7.4 | 9.3 | 50.0 | 25.9 | 1.9 | 1.9 | 0.0 | 0.0 |
| Northern white cedar | 78.4 | 9.8 | 11.8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Green ash | 0.0 | 2.2 | 8.9 | 44.4 | 26.7 | 8.9 | 8.9 | 0.0 | 0.0 |
| Silver maple | 16.0 | 4.0 | 8.0 | 32.0 | 16.0 | 4.0 | 4.0 | 12.0 | 4.0 |
| Sugar maple | 0.0 | 4.2 | 8.3 | 62.5 | 16.7 | 4.2 | 0.0 | 4.2 | 0.0 |
| Honeylocust | 0.0 | 0.0 | 0.0 | 80.0 | 20.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Black walnut | 0.0 | 0.0 | 20.0 | 60.0 | 20.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Paper birch | 0.0 | 0.0 | 100.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| American basswood | 25.0 | 75.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Boxelder | 0.0 | 0.0 | 0.0 | 33.3 | 33.3 | 33.3 | 0.0 | 0.0 | 0.0 |
| Citywide total | 22.6 | 8.3 | 11.9 | 32.9 | 15.5 | 3.2 | 2.8 | 2.0 | 0.8 |

**Figure 2: Relative Age Class**

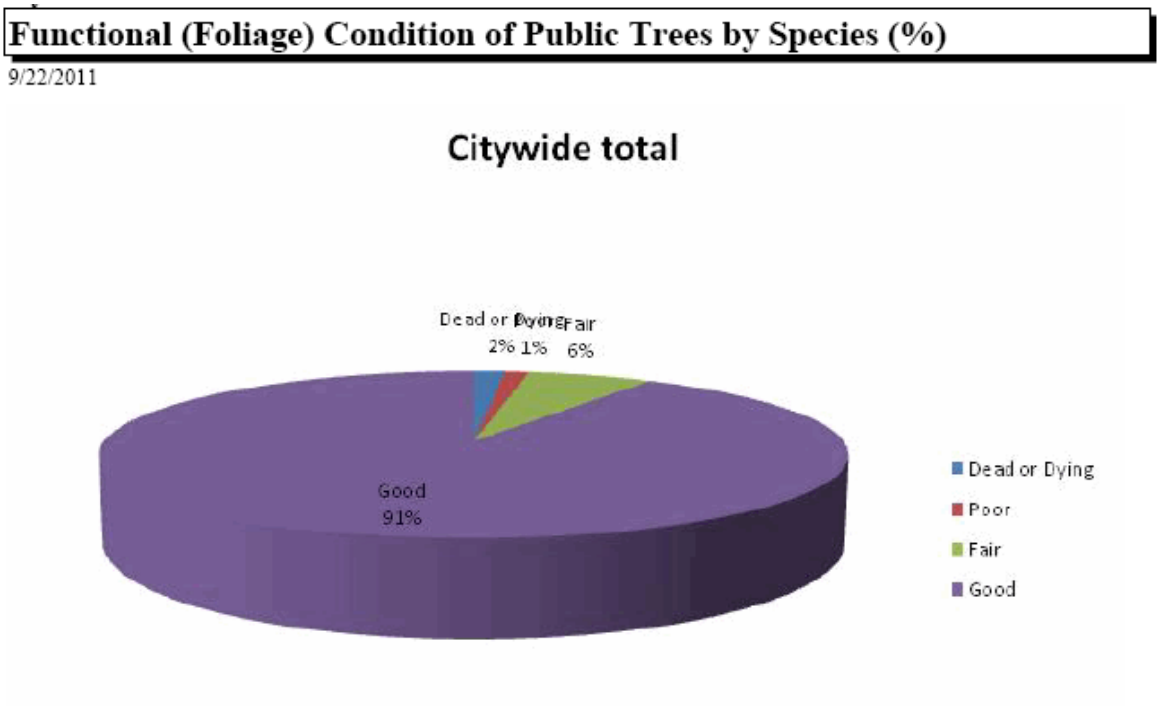



**Figure 3: Foliage Condition**

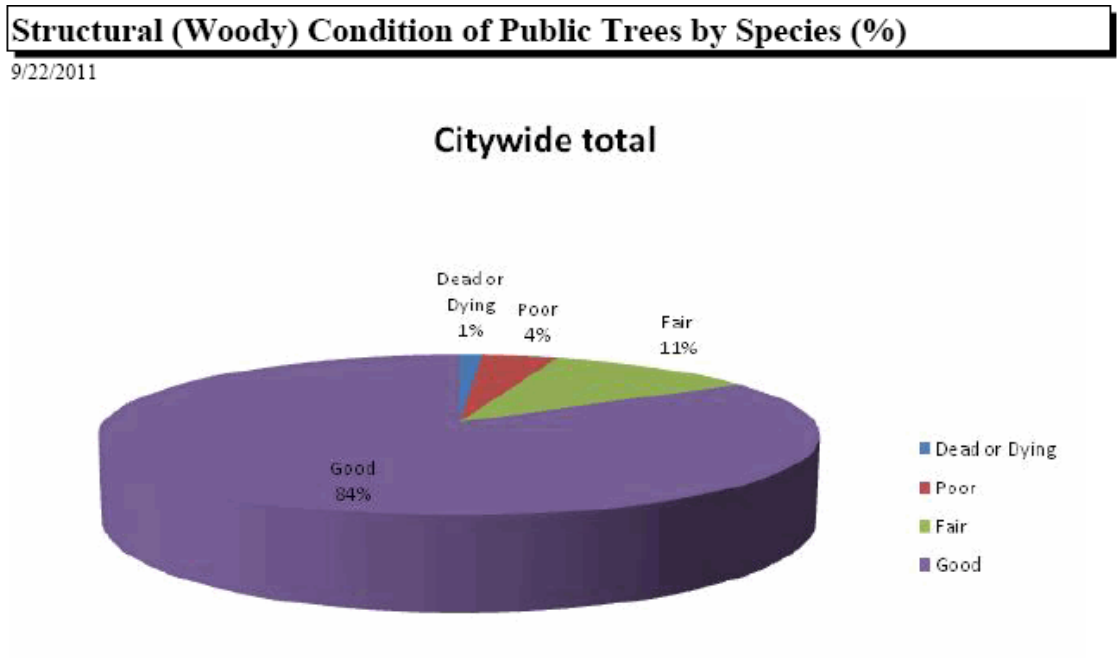
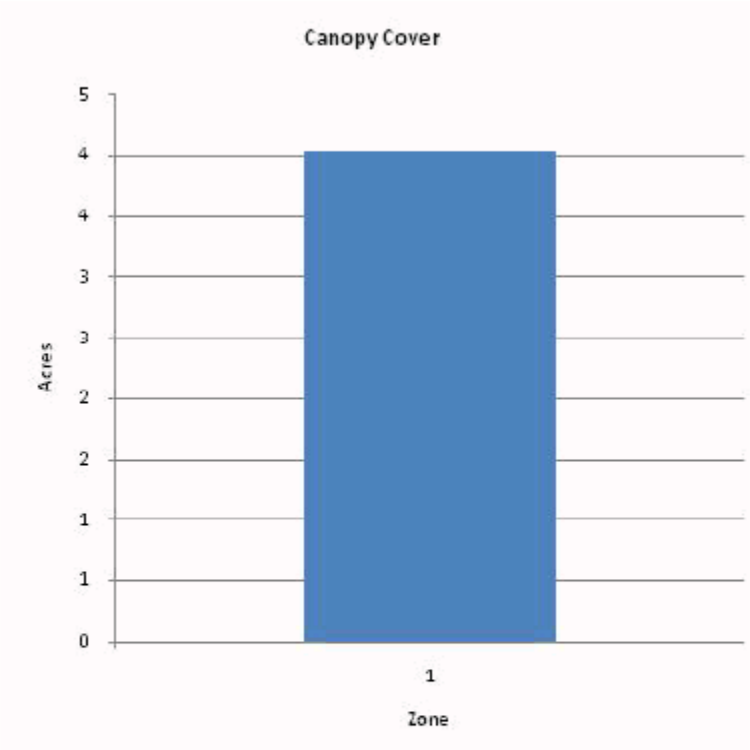



**Figure 4: Wood Condition**

## Canopy Cover of Public Trees (Acres)

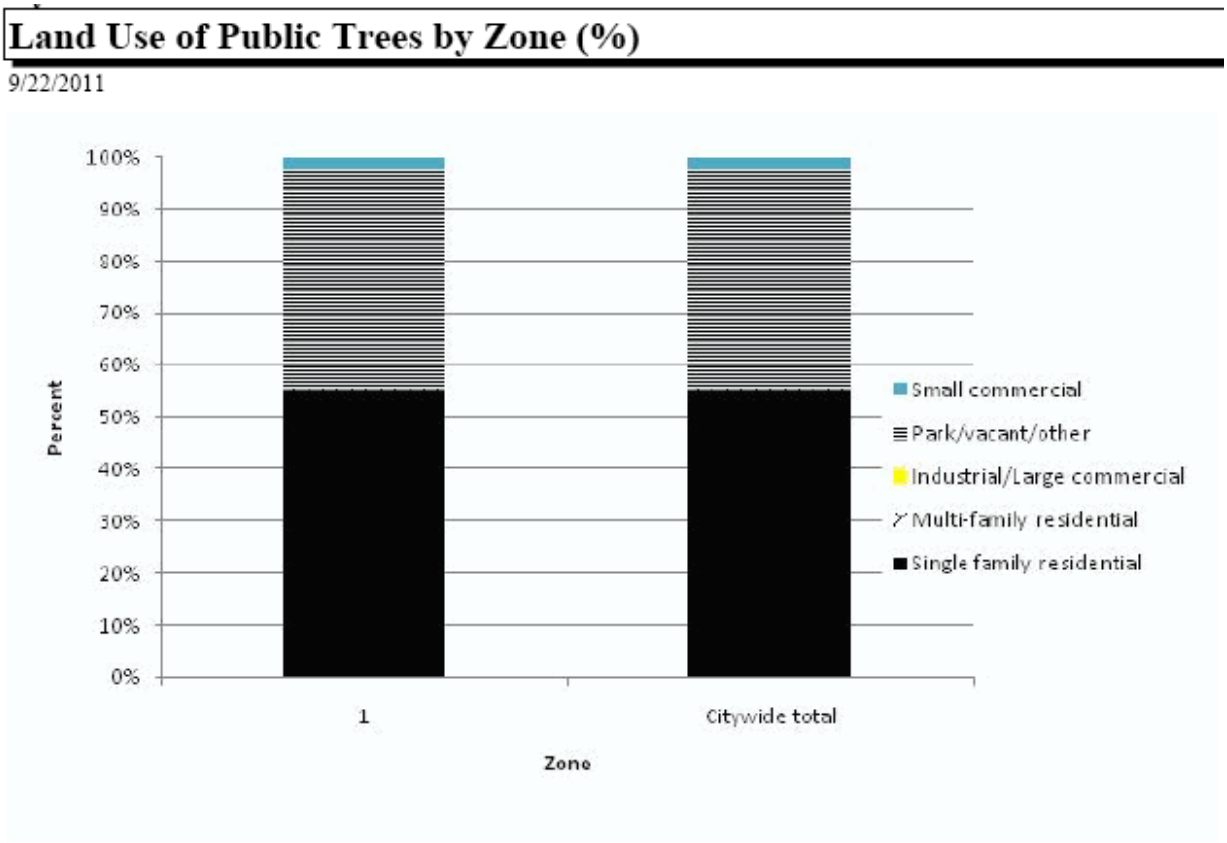
9/22/2011




| Zone | Acres | % of Total Canopy Cover |
|---|---|---|
| 1 | 4 | 100.0 |
| Citywide total | 4 | 100.0 |

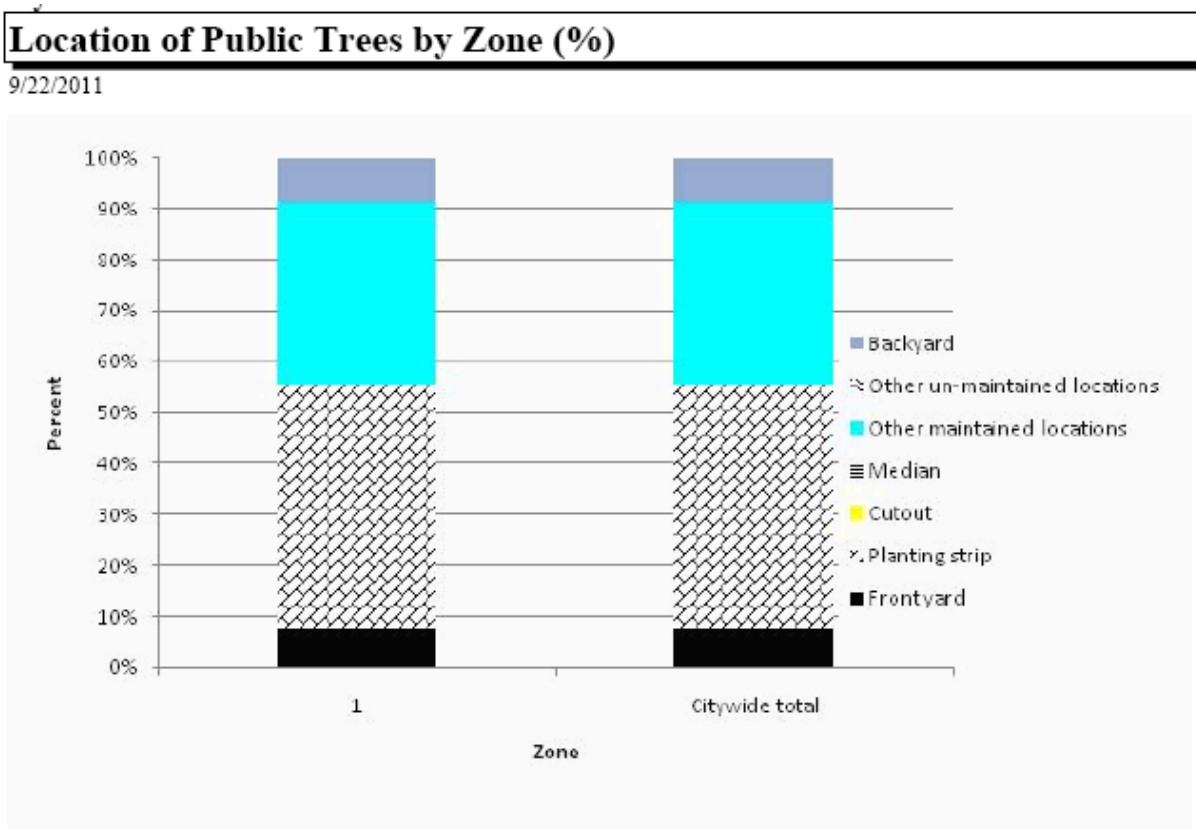
| | Total Land Area | Total Street and Sidewalk Area | Total Canopy Cover | Canopy Cover as % of Total Land Area | Canopy Cover as % of Total Streets and Sidewalks |
|---|---|---|---|---|---|
| Citywide | 0 | 0 | 4 | | |

**Figure 5: Canopy Cover in Acres**




| Zone | Single family residential | Multi-family residential | Industrial/ Large commercial | Park/vacant/ other | Small commercial |
|---|---|---|---|---|---|
| 1 | 55.2 | 0.4 | 0.0 | 42.1 | 2.4 |
| Citywide total | 55.2 | 0.4 | 0.0 | 42.1 | 2.4 |

**Figure 6: Land Use of city/park trees**




| Zone | Front yard | Planting strip | Cutout | Median | Other maintained locations | Other un-maintained locations | Backyard |
|---|---|---|---|---|---|---|---|
| 1 | 7.9 | 47.6 | 0.0 | 0.0 | 35.7 | 0.0 | 8.7 |
| Citywide total | 7.9 | 47.6 | 0.0 | 0.0 | 35.7 | 0.0 | 8.7 |

**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**

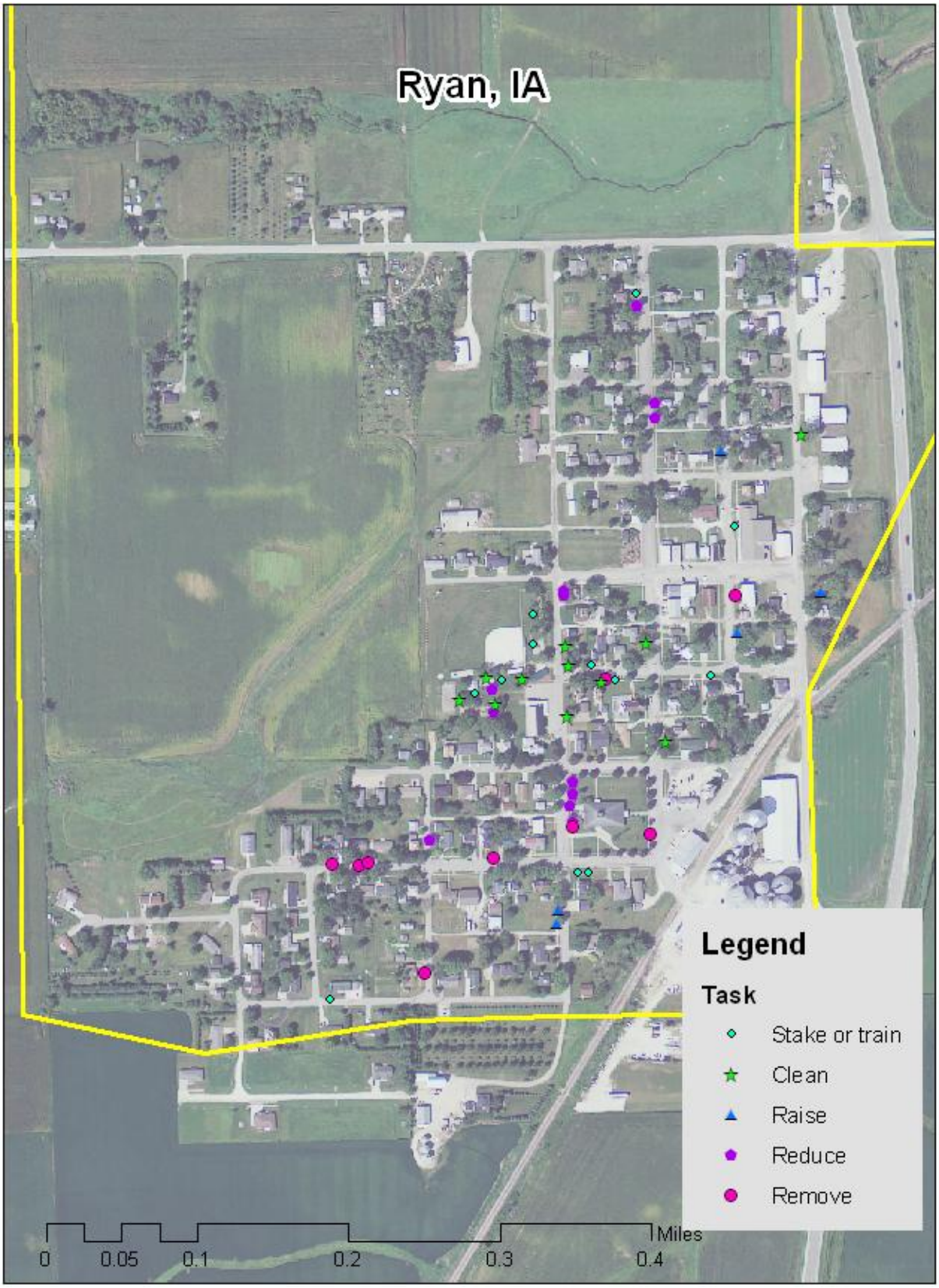



**Figure 5: Maintenance Tasks *City ownership of the trees recommended for removal should be verified prior to any removal***

# Appendix C: *CITY* Tree Ordinances

3-2-1 DEFINITIONS. For use in this Ordinance, the following terms are defined:

1. The term "nuisance" means whatever is injurious to health, indecent, or unreasonably offensive to the senses or an obstacle to the free use of property, so as essentially to unreasonably interfere with the comfortable enjoyment of life or property. The following are declared to be nuisances:

(Code of Iowa, Sec. 657.1)

h. Cotton-bearing cottonwood trees and all other cotton-bearing poplar trees in the City.

(Code of Iowa, Sec. 657.2(8))

m. Trees infected with Dutch elm disease.

(Code of Iowa, Sec. 657.2(13))

3-2-3 OTHER CONDITIONS REGULATED. The following actions are required and may also be abated in the manner provided in this Ordinance:

1. The removal of diseased trees or dead wood, but not diseased trees and dead wood outside the lot and property lines and inside the curb lines upon the public street.

(Code of Iowa, Sec. 364.12(3)(b))

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If you need accommodations because of disability to access the services of this Agency, please contact the Director at 515-281-5918.