# An Analysis of Street Tree Benefits for

Yellow Springs


## By

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THE OHIO STATE UNIVERSITY EXTENSION

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## EXECUTIVE SUMMARY

An inventory of street trees was conducted by Greene County Extension, Yellow Springs Tree Committee, and citizen volunteers to allow an analysis of environmental benefits to be run. A total of 1,646 street trees were inventoried but did not include park trees. A common bid price for this service is $3.00 per tree and thus the inventory represents a savings of $4,938 for Yellow Springs taxpayers had the inventory been bid. More importantly however, is that the Village of Yellow Springs now has a tree inventory that can be used to better manage the street tree resource. Benefits mentioned above do not include the subsequent analysis which was performed by The School of Environment and Natural Resources at The Ohio State University.

Analysis of the inventory data was done using iTree, a software suite distributed by the USDA Forest Service. The specific program in the iTree suite used to identify benefits was Street Tree Resource Analysis Tool for Urban forest Managers (STRATUM). This program allows individuals to make informed decisions about the community tree resource and to evaluate costs and benefits of some management decisions such as whether to increase biodiversity in the village.

A long-standing rule of thumb for biodiversity is the 10–20–30 guideline which suggests that no more than 10 percent of village trees should be from the same species, no more than twenty percent should be from the same genera, and no more than thirty percent should be from the same family. In Yellow Springs, maple at 27% exceeds the genera limit of 20% and is approaching the family limit of 30%. Many communities in Ohio have maple in the 30-40% range. This suggests that Yellow Springs is likely to have a more difficult time dealing with Asian longhorned beetle (ALB) should it reach central Ohio than it has at present with the emerald ash borer (EAB). The problem with emerald ash borer, now established in central Ohio, is well known. We recommend planting no additional maples in Yellow Springs until the percentage of maples in the community drops below 20% in order to maintain a diverse tree canopy and limit potential problems with exotic pests such as EAB and ALB. The potential for losses from EAB is likely to be modest as Yellow Springs has only 86 ashes but 450 maples which are sensitive to ALB.

Under ideal conditions, tree numbers among size classes of larger growing trees such as oaks and maples should remain somewhat constant to 24-inch diameter then decline as tree size increases and trees die from old age (Table 2). Younger plantings have been skewed toward maples (Table 3). Consider other large trees for the future to minimize the risk of another exotic pest and to increase environmental benefits for the community as larger trees yield greater environmental benefits. Many of Yellow Springs' trees are now reaching sizes where environmental benefits per tree are high (24 to 36-inch trees).

Larger growing broadleaved deciduous trees such as catalpa have importance values greater than their respective percentages in the inventory because of their larger size. For example catalpa represents 4% of the trees but constitutes 18% of the leaf area, 12% of the canopy cover, and has an importance value of 11 (Table 4). Further this demonstrates Yellow Springs' need for larger statured trees whenever possible as the importance value is a measure of the overall contribution of the species.

A major benefit of urban trees is their ability to intercept rainfall and reduce storm water runoff (Table 5). Storm water runoff is a major cost for many communities. Columbus is about to embark on a multi-billion dollar sewer and storm water upgrade for the community. Yellow Springs' street trees intercept 2,677 CCF (20,025 gallons) of storm water annually at a savings of $52,265 per year to the community.

Carbon sequestration, as reported here, represents the carbon removed from the air and stored in Yellow Springs' trees (Table 6) over time. More than 6 million pounds or more than 3,000 tons of carbon have been stored by the community's 1,641 trees over time. Additionally, Yellow Springs' trees annually sequester and avoid more than 775,221 lbs of $CO_2$ (Table 8) and could represent carbon credits worth $5,664 per year if a carbon trading system were in place and if a system for accounting for them were available for community trees. These are net gain figures and include deductions for tree losses and maintenance. Annual $CO_2$ benefits vary by species but are confounded by size as larger trees would produce more benefits. Larger, longer lived species and species requiring less maintenance would also produce greater benefits (Table 8).

Energy savings by trees are exceptionally important in view of the citizenry's increasing concern over the nation's energy dependency. Planting trees in our communities may well be more cost effective than building power plants as an alternative to meeting some of our energy needs. Energy is saved by shading structures, evaporating water (evapotranspiration) and reducing wind speed around structures (Table 7). Community-wide, Yellow Springs saves $17,600 in electricity and $31,900 in natural gas for a total savings of nearly $49,600 or more than $30 per tree with larger trees resulting in greater savings.

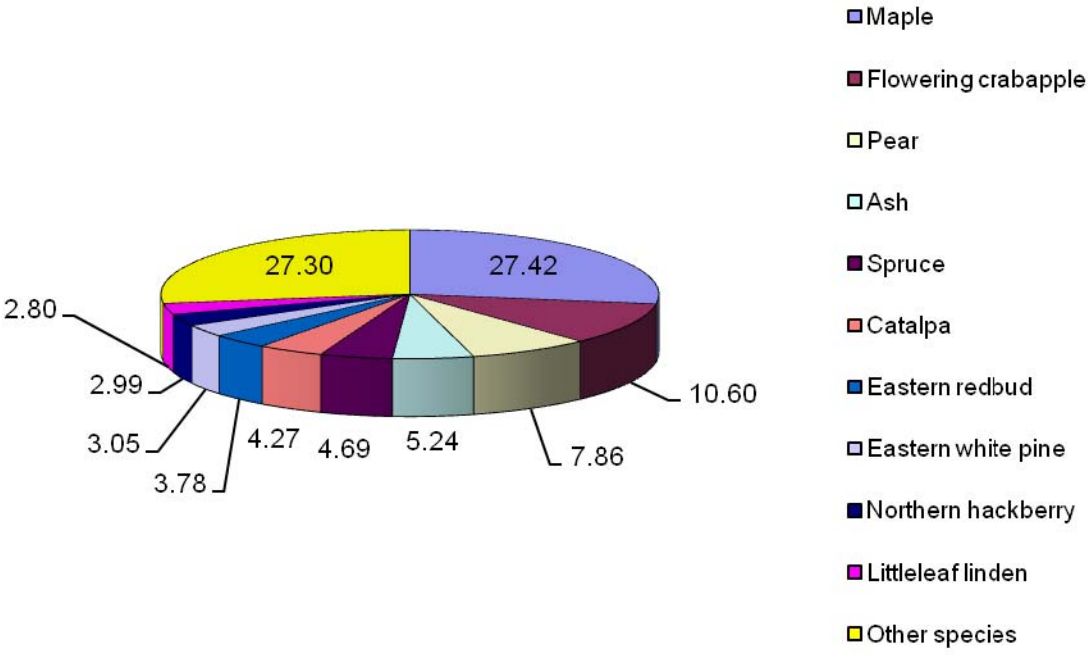
Annual air quality savings (reduced ozone, nitrous and sulfur oxides as well as particulate matter) for Yellow Springs' trees are $8,366 (Table 9). This includes both direct savings ($1,975) from the trees and avoided pollution which is even greater ($6,936). Avoided pollution is pollution not generated at power source because energy was not required by the community. The total annual air quality benefits are discounted by $545 for the volatile emissions given off by the trees themselves.

Aesthetic and miscellaneous benefits from trees contribute $43,266 annually to the community in the form of increased property values and enhanced community identity among other things (Table 10). Research in public housing has shown that areas with trees lead to reduced domestic violence and more sociable environments. Customer surveys suggest that customers prefer to spend their money and time in commercial streetscapes with trees and are willing to spend up to 11% more in such settings.

When all benefits are included the average tree in Yellow Springs contributes $98.18 per tree annually to the community (Tables 11 & 12). Species vary in their annual benefits. Mature size, longevity, and maintenance costs are but some of the factors determining annual benefits. Thus Yellow Springs' 1,646 trees contribute $161,107. This would be well in excess of their maintenance and planting costs.

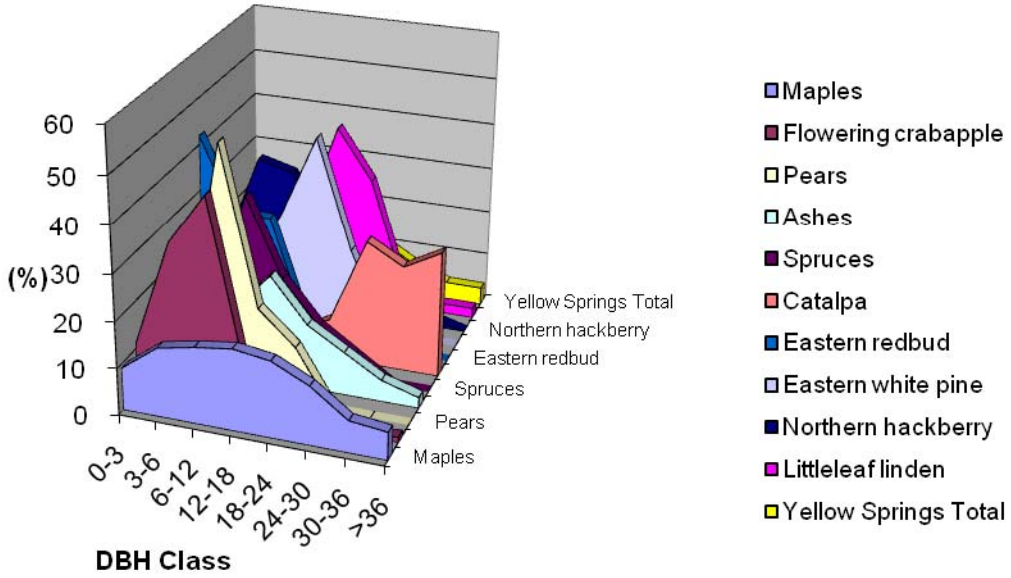
The Village of Yellow Springs does not have a specific budget for tree care but if we use the Tree City guideline suggesting a minimum expenditure of $2 per capita yields an $8,000 budget estimate. Dividing benefits by costs yields a 2000% return on the community's investment. Trees are truly a contributing part of Yellow Springs. Unlike most community infrastructure, tree benefits per tree continue to increase over a tree's lifetime and peak between 24 and 36 inches in diameter.

## Table 1 Distribution of Yellow Springs' Ten Most Commonly Planted Street Trees (%)




| Species | Percent |
|---|---|
| Maples | 27.42 |
| Flowering crabapple | 10.60 |
| Pears | 7.86 |
| Ash | 5.24 |
| Spruces | 4.69 |
| Catalpa | 4.27 |
| Eastern redbud | 3.78 |
| Eastern white pine | 3.05 |
| Northern hackberry | 2.99 |
| Littleleaf linden | 2.80 |
| Other species | 27.30 |
| **Total** | **100.00** |

# Table 2. Relative Age Distribution (%) of the Top 10 Most Commonly Planted Street Trees in Yellow Springs




| Species Name | DBH class (in) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 0-3 | 3-6 | 6-12 | 12-18 | 18-24 | 24-30 | 30-36 | >36 |
| **Maples** | 9.1 | 14.9 | 16.4 | 17.6 | 16.4 | 12.7 | 6.9 | 6.0 |
| **Flowering crabapple** | 10.9 | 33.9 | 44.8 | 8.6 | 0.6 | 0.0 | 0.0 | 1.1 |
| **Pears** | 6.2 | 9.3 | 52.7 | 19.4 | 12.4 | 0.0 | 0.0 | 0.0 |
| **Ashes** | 11.6 | 19.8 | 15.1 | 23.3 | 14.0 | 9.3 | 4.7 | 2.3 |
| **Spruces** | 18.2 | 10.4 | 36.4 | 19.5 | 10.4 | 5.2 | 0.0 | 0.0 |
| **Catalpa** | 5.7 | 2.9 | 1.4 | 4.3 | 8.6 | 27.1 | 22.9 | 27.1 |
| **Eastern redbud** | 41.9 | 25.8 | 25.8 | 3.2 | 1.6 | 1.6 | 0.0 | 0.0 |
| **Eastern white pine** | 6.0 | 10.0 | 24.0 | 42.0 | 18.0 | 0.0 | 0.0 | 0.0 |
| **Northern hackberry** | 12.2 | 32.7 | 30.6 | 16.3 | 6.1 | 0.0 | 2.0 | 0.0 |
| **Littleleaf linden** | 0.0 | 6.5 | 17.4 | 39.1 | 28.3 | 4.3 | 2.2 | 2.2 |
| **Yellow Springs Total** | **11.5** | **17.9** | **26.5** | **17.6** | **11.6** | **7.1** | **3.9** | **3.8** |

## Table 3. Inventory of Yellow Springs Trees by Common Name and Size

| Species | DBH Class (in) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 0-3 | 3-6 | 6-12 | 12-18 | 18-24 | 24-30 | 30-36 | >36 | Total |
| **Broadleaf Deciduous Large (BDL)** | | | | | | | | | |
| Maples | 41 | 67 | 74 | 79 | 74 | 57 | 31 | 27 | 450 |
| Catalpa | 4 | 2 | 1 | 3 | 6 | 19 | 16 | 19 | 70 |
| Northern hackberry | 6 | 16 | 15 | 8 | 3 | 0 | 1 | 0 | 49 |
| Black walnut | 7 | 5 | 12 | 11 | 6 | 0 | 1 | 0 | 42 |
| Hybrid elm | 0 | 10 | 15 | 3 | 5 | 4 | 0 | 2 | 39 |
| Sweetgum | 1 | 3 | 6 | 10 | 3 | 1 | 0 | 0 | 24 |
| Oaks | 5 | 5 | 6 | 4 | 0 | 1 | 0 | 0 | 21 |
| Large Unknowns | 5 | 3 | 6 | 4 | 9 | 6 | 3 | 3 | 39 |
| **Total** | **69** | **111** | **135** | **122** | **106** | **88** | **52** | **51** | **734** |
| | | | | | | | | | |
| **Broadleaf Deciduous Medium (BDM)** | | | | | | | | | |
| Ashes | 10 | 17 | 13 | 20 | 12 | 8 | 4 | 2 | 86 |
| Littleleaf linden | 0 | 3 | 8 | 18 | 13 | 2 | 1 | 1 | 46 |
| Zelkova | 2 | 4 | 13 | 14 | 6 | 0 | 1 | 1 | 41 |
| Osage-Orange | 0 | 1 | 10 | 8 | 6 | 4 | 1 | 2 | 32 |
| Black locust | 2 | 0 | 8 | 3 | 3 | 7 | 3 | 2 | 28 |
| Honeylocust | 5 | 2 | 4 | 8 | 1 | 1 | 1 | 0 | 22 |
| Ginkgo | 6 | 3 | 8 | 3 | 1 | 0 | 0 | 0 | 21 |
| Medium Unknowns | 3 | 5 | 3 | 3 | 0 | 0 | 1 | 0 | 15 |
| **Total** | **28** | **35** | **67** | **77** | **42** | **22** | **12** | **8** | **291** |
| | | | | | | | | | |
| **Broadleaf Deciduous Small (BDS)** | | | | | | | | | |
| Flowering crabapple | 19 | 59 | 78 | 15 | 1 | 0 | 0 | 2 | 174 |
| Pears | 8 | 12 | 68 | 25 | 16 | 0 | 0 | 0 | 129 |
| Eastern redbud | 26 | 16 | 16 | 2 | 1 | 1 | 0 | 0 | 62 |
| Mulberry | 5 | 13 | 12 | 7 | 4 | 0 | 0 | 1 | 42 |
| Common chokecherry | 1 | 9 | 7 | 3 | 3 | 1 | 0 | 0 | 24 |
| Serviceberry | 4 | 11 | 6 | 0 | 0 | 0 | 0 | 1 | 22 |
| Small Unknowns | 8 | 9 | 2 | 0 | 0 | 1 | 0 | 0 | 20 |
| **Total** | **71** | **129** | **189** | **52** | **25** | **3** | **0** | **4** | **473** |
| | | | | | | | | | |
| **Conifer Evergreen Large (CEL)** | | | | | | | | | |
| Spruces | 14 | 8 | 28 | 15 | 8 | 4 | 0 | 0 | 77 |
| Eastern white pine | 3 | 5 | 12 | 21 | 9 | 0 | 0 | 0 | 50 |
| Large Unknown Conifers | 0 | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 5 |
| **Total** | **17** | **16** | **42** | **36** | **17** | **4** | **0** | **0** | **132** |
| | | | | | | | | | |
| **Conifer Evergreen Small (CES)** | | | | | | | | | |
| Small Unknown Conifers | 6 | 4 | 3 | 1 | 2 | 0 | 0 | 0 | 16 |
| **Total** | **6** | **4** | **3** | **1** | **2** | **0** | **0** | **0** | **16** |
| | | | | | | | | | |
| **Yellow Springs Total** | **191** | **295** | **436** | **288** | **192** | **117** | **64** | **63** | **1,646** |

# Table 4. Importance Values for Yellow Spring's Most Abundant Street Tree Species Ordered by Importance Value

| Species | Number of Trees | % of Total Trees | Leaf Area (ft2) | % of Total Leaf Area | Canopy Cover (ft2) | % of Total Canopy Cover | Importance Value |
|---|---|---|---|---|---|---|---|
| Maple | 450 | 27.42 | 1,126,616 | 36.03 | 393664 | 37.68 | 33.71 |
| Catalpa | 70 | 4.27 | 548,452 | 17.54 | 123621 | 11.83 | 11.21 |
| Ash | 86 | 5.24 | 176,342 | 5.64 | 61140 | 5.85 | 5.58 |
| Other trees | 90 | 5.48 | 182,366 | 5.83 | 52017 | 4.98 | 5.43 |
| Flowering crabapple | 174 | 10.60 | 35,797 | 1.14 | 43484 | 4.16 | 5.30 |
| Pear | 129 | 7.86 | 62,200 | 1.99 | 55191 | 5.28 | 5.04 |
| Spruce | 77 | 4.69 | 149,322 | 4.78 | 22227 | 2.13 | 3.87 |
| Littleleaf linden | 46 | 2.80 | 114,145 | 3.65 | 32294 | 3.09 | 3.18 |
| Osage-Orange | 32 | 1.95 | 109,958 | 3.52 | 31747 | 3.04 | 2.84 |
| Eastern white pine | 50 | 3.05 | 108,539 | 3.47 | 18043 | 1.73 | 2.75 |
| Black locust | 28 | 1.71 | 95,068 | 3.04 | 28694 | 2.75 | 2.50 |
| Hybrid elm | 39 | 2.38 | 74,477 | 2.38 | 27998 | 2.68 | 2.48 |
| Black walnut | 42 | 2.56 | 67,786 | 2.17 | 23791 | 2.28 | 2.33 |
| Northern hackberry | 49 | 2.99 | 46,103 | 1.47 | 24714 | 2.37 | 2.28 |
| Zelkova | 41 | 2.50 | 68,788 | 2.20 | 21754 | 2.08 | 2.26 |
| Eastern redbud | 62 | 3.78 | 9,108 | 0.29 | 10171 | 0.97 | 1.68 |
| Honeylocust | 22 | 1.34 | 47,956 | 1.53 | 17469 | 1.67 | 1.52 |
| Mulberry | 42 | 2.56 | 17,136 | 0.55 | 14678 | 1.41 | 1.50 |
| Sweetgum | 24 | 1.46 | 45,051 | 1.44 | 16181 | 1.55 | 1.48 |
| Oak | 21 | 1.28 | 20,774 | 0.66 | 7852 | 0.75 | 0.90 |
| Common chokecherry | 24 | 1.46 | 11,106 | 0.36 | 9000 | 0.86 | 0.89 |
| Ginkgo | 21 | 1.28 | 6,231 | 0.20 | 4944 | 0.47 | 0.65 |
| Serviceberry | 22 | 1.34 | 3,450 | 0.11 | 3956 | 0.38 | 0.61 |
| **Yellow Springs Totals** | **1641** | **100.00** | **3,126,772** | **100.00** | **1044630** | **100.00** | **100.00** |

## Table 5. Annual Stormwater Benefits of Yellow Springs' Street Trees by Common Name and Ordered by Average Benefit per Tree

| Species | Total Rainfall Interception (CCF) | Total ($) | % of Total Tree Numbers | % of Total $ | Avg. $/tree |
|---|---|---|---|---|---|
| Catalpa | 408 | $8,271 | 4.3 | 15.2 | $118.16 |
| Black locust | 82 | $1,668 | 1.7 | 3.1 | $59.57 |
| Osage-Orange | 90 | $1,831 | 2.0 | 3.4 | $57.22 |
| Maples | 969 | $19,634 | 27.4 | 36.2 | $43.63 |
| Littleleaf linden | 97 | $1,961 | 2.8 | 3.6 | $42.64 |
| Ashes | 162 | $3,283 | 5.2 | 6.1 | $38.17 |
| Eastern white pine | 90 | $1,826 | 3.0 | 3.4 | $36.53 |
| Hybrid elm | 68 | $1,378 | 2.4 | 2.5 | $35.33 |
| Sweetgum | 41 | $828 | 1.5 | 1.5 | $34.50 |
| Honeylocust | 37 | $751 | 1.3 | 1.4 | $34.12 |
| Other street trees | 150 | $3,047 | 5.5 | 5.6 | $33.85 |
| Zelkova | 61 | $1,238 | 2.5 | 2.3 | $30.20 |
| Spruces | 113 | $2,285 | 4.7 | 4.2 | $29.67 |
| Black walnut | 61 | $1,231 | 2.6 | 2.3 | $29.32 |
| Northern hackberry | 48 | $975 | 3.0 | 1.8 | $19.89 |
| Oaks | 19 | $390 | 1.3 | 0.7 | $18.58 |
| Pears | 73 | $1,472 | 7.9 | 2.7 | $11.41 |
| Common chokecherry | 12 | $249 | 1.5 | 0.5 | $10.36 |
| Mulberry | 20 | $397 | 2.6 | 0.7 | $9.45 |
| Ginkgo | 8 | $165 | 1.3 | 0.3 | $7.86 |
| Flowering crabapple | 51 | $1,039 | 10.6 | 1.9 | $5.97 |
| Serviceberry | 5 | $96 | 1.3 | 0.2 | $4.37 |
| Eastern redbud | 12 | $249 | 3.8 | 0.5 | $4.02 |
| **Yellow Springs Totals** | **2677** | **$54,265** | **100.0** | **100.0** | **$33.07** |


## Table 6. Stored CO2 Benefits of Yellow Springs' Street Trees by Common Name and Ordered by Average Benefits per Tree

| Species | Total stored CO2 (lbs) | Total ($) | % of Total Tree Numbers | % of Total $ | Avg. $/tree |
|---|---|---|---|---|---|
| Catalpa | 1401621 | $10,512 | 4.3 | 22.8 | $150.17 |
| Black locust | 214909 | $1,612 | 1.7 | 3.5 | $57.56 |
| Osage-Orange | 245331 | $1,840 | 2.0 | 4.0 | $57.50 |
| Littleleaf linden | 241256 | $1,809 | 2.8 | 3.9 | $39.34 |
| Ash | 385940 | $2,895 | 5.2 | 6.3 | $33.66 |
| Maple | 1884745 | $14,136 | 27.4 | 30.6 | $31.41 |
| Hybrid elm | 156603 | $1,175 | 2.4 | 2.5 | $30.12 |
| Sweetgum | 84640 | $635 | 1.5 | 1.4 | $26.45 |
| Zelkova | 144208 | $1,082 | 2.5 | 2.3 | $26.38 |
| Black walnut | 130506 | $979 | 2.6 | 2.1 | $23.30 |
| Honeylocust | 59586 | $447 | 1.3 | 1.0 | $20.31 |
| Pear | 247794 | $1,858 | 7.9 | 4.0 | $14.41 |
| Common chokecherry | 44052 | $330 | 1.5 | 0.7 | $13.77 |
| Oak | 37655 | $282 | 1.3 | 0.6 | $13.45 |
| Mulberry | 68249 | $512 | 2.6 | 1.1 | $12.19 |
| Eastern white pine | 57938 | $435 | 3.0 | 0.9 | $8.69 |
| Spruce | 81784 | $613 | 4.7 | 1.3 | $7.97 |
| Northern hackberry | 46887 | $352 | 3.0 | 0.8 | $7.18 |
| Flowering crabapple | 147354 | $1,105 | 10.6 | 2.4 | $6.35 |
| Ginkgo | 13616 | $102 | 1.3 | 0.2 | $4.86 |
| Serviceberry | 14201 | $107 | 1.3 | 0.2 | $4.84 |
| Eastern redbud | 37289 | $280 | 3.8 | 0.6 | $4.51 |
| Other street trees | 187169 | $3,095 | 5.5 | 6.7 | $34.39 |
| **Yellow Springs Totals** | **6158800** | **$46,191** | **100.0** | **100.0** | **$28.15** |

# Table 7. Annual Energy Benefits of Yellow Springs' Street Trees by Common Name and Ordered by Numbers of Trees

| Species | Total Electricity (MWh) | Electricity ($) | Total Natural Gas (MBtu) | Natural Gas ($) | Total ($) | % of Total Tree Numbers | % of Total $ | Avg. $/tree |
|---|---|---|---|---|---|---|---|---|
| Maples | 85 | $6,436 | 1152 | $11,287 | $17,723 | 27.4 | 35.8 | $39.4 |
| Flowering crabapple | 11 | $797 | 170 | $1,668 | $2,465 | 10.6 | 5.0 | $14.2 |
| Pears | 13 | $996 | 205 | $2,005 | $3,000 | 7.9 | 6.1 | $23.3 |
| Ashes | 14 | $1,094 | 206 | $2,019 | $3,113 | 5.2 | 6.3 | $36.2 |
| Spruces | 6 | $430 | 78 | $767 | $1,197 | 4.7 | 2.4 | $15.5 |
| Catalpa | 23 | $1,727 | 315 | $3,091 | $4,818 | 4.3 | 9.7 | $68.8 |
| Eastern redbud | 2 | $182 | 39 | $387 | $569 | 3.8 | 1.1 | $9.2 |
| Eastern white pine | 5 | $367 | 62 | $608 | $975 | 3.0 | 2.0 | $19.5 |
| Northern hackberry | 6 | $452 | 86 | $846 | $1,298 | 3.0 | 2.6 | $26.5 |
| Littleleaf linden | 8 | $639 | 115 | $1,127 | $1,765 | 2.8 | 3.6 | $38.4 |
| Black walnut | 6 | $443 | 77 | $750 | $1,194 | 2.6 | 2.4 | $28.4 |
| Mulberry | 3 | $264 | 54 | $526 | $791 | 2.6 | 1.6 | $18.8 |
| Zelkova | 6 | $447 | 80 | $784 | $1,231 | 2.5 | 2.5 | $30.0 |
| Hybrid elm | 6 | $449 | 81 | $792 | $1,241 | 2.4 | 2.5 | $31.8 |
| Osage-Orange | 7 | $528 | 94 | $921 | $1,449 | 2.0 | 2.9 | $45.3 |
| Black locust | 6 | $470 | 91 | $894 | $1,364 | 1.7 | 2.8 | $48.7 |
| Sweetgum | 4 | $313 | 53 | $515 | $827 | 1.5 | 1.7 | $34.5 |
| Common chokecherry | 2 | $157 | 33 | $319 | $476 | 1.5 | 1.0 | $19.8 |
| Serviceberry | 1 | $68 | 15 | $150 | $218 | 1.3 | 0.4 | $9.9 |
| Honeylocust | 4 | $298 | 51 | $496 | $794 | 1.3 | 1.6 | $36.1 |
| Ginkgo | 1 | $99 | 17 | $170 | $269 | 1.3 | 0.5 | $12.8 |
| Oak | 2 | $151 | 26 | $253 | $404 | 1.3 | 0.8 | $19.2 |
| Other street trees | 11 | $836 | 156 | $1,529 | $2,365 | 5.5 | 4.8 | $26.3 |
| **Yellow Springs Totals** | **232** | **$17,643** | **3255** | **$31,903** | **$49,546** | **100.0** | **100.0** | **$30.2** |

# Table 8. Annual Carbon Dioxide Benefits of Yellow Springs' Street Trees by Species and Ordered by Average Benefits per Tree

| Species | Sequestered (lb) | Sequestered ($) | Decomp. Release (lb) | Maint. Release (lb) | Total Release ($) | Avoided (lb) | Avoided ($) | Net Total (lb) | Total ($) | % Total Tree Numbers | % of Total $ | Avg. $/tree |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Catalpa | 55062 | $412.96 | -6728 | -13.7 | -$50.56 | 38172 | $286.29 | 86492 | $648.69 | 4.3 | 11.4 | $9.27 |
| Osage-orange | 15940 | $119.55 | -1178 | -6.2 | -$8.88 | 11674 | $87.55 | 26430 | $198.22 | 2.0 | 3.5 | $6.19 |
| Littleleaf linden | 23719 | $177.89 | -1158 | -9.0 | -$8.75 | 14113 | $105.85 | 36665 | $274.99 | 2.8 | 4.8 | $5.98 |
| Sweetgum | 8767 | $65.75 | -406 | -4.7 | -$3.08 | 6908 | $51.81 | 15264 | $114.48 | 1.5 | 2.0 | $4.77 |
| Honeylocust | 7165 | $53.74 | -286 | -4.3 | -$2.18 | 6588 | $49.41 | 13463 | $100.97 | 1.3 | 1.8 | $4.59 |
| Zelkova | 15113 | $113.34 | -692 | -8.0 | -$5.25 | 9869 | $74.02 | 24282 | $182.11 | 2.5 | 3.2 | $4.44 |
| Black locust | 6960 | $52.20 | -1032 | -5.5 | -$7.78 | 10389 | $77.92 | 16313 | $122.35 | 1.7 | 2.2 | $4.37 |
| Maples | 121441 | $910.80 | -9047 | -87.8 | -$68.51 | 142239 | $1,066.79 | 254545 | $1,909.09 | 27.4 | 33.7 | $4.24 |
| Black walnut | 12711 | $95.33 | -626 | -8.2 | -$4.76 | 9799 | $73.49 | 21875 | $164.06 | 2.6 | 2.9 | $3.91 |
| Hybrid elm | 10631 | $79.73 | -752 | -7.6 | -$5.69 | 9919 | $74.40 | 19791 | $148.43 | 2.4 | 2.6 | $3.81 |
| Ashes | 20909 | $156.82 | -1853 | -16.8 | -$14.02 | 24176 | $181.32 | 43216 | $324.12 | 5.2 | 5.7 | $3.77 |
| Oaks | 4275 | $32.06 | -181 | -4.1 | -$1.39 | 3341 | $25.06 | 7431 | $55.74 | 1.3 | 1.0 | $2.65 |
| Pears | 22614 | $169.61 | -1189 | -25.2 | -$9.11 | 22002 | $165.02 | 43402 | $325.52 | 7.9 | 5.8 | $2.52 |
| Northern hackberry | 4869 | $36.52 | -225 | -9.6 | -$1.76 | 9994 | $74.95 | 14628 | $109.71 | 3.0 | 1.9 | $2.24 |
| Common chokecherry | 3386 | $25.39 | -211 | -4.7 | -$1.62 | 3474 | $26.05 | 6643 | $49.83 | 1.5 | 0.9 | $2.08 |
| Mulberry | 5690 | $42.68 | -328 | -8.2 | -$2.52 | 5835 | $43.76 | 11189 | $83.92 | 2.6 | 1.5 | $2.00 |
| Eastern white pine | 4845 | $36.34 | -278 | -9.8 | -$2.16 | 8104 | $60.78 | 12661 | $94.96 | 3.0 | 1.7 | $1.90 |
| Spruces | 5923 | $44.43 | -393 | -15.0 | -$3.06 | 9493 | $71.20 | 15009 | $112.57 | 4.7 | 2.0 | $1.46 |
| Flowering crabapple | 15779 | $118.34 | -707 | -33.9 | -$5.56 | 17617 | $132.12 | 32654 | $244.90 | 10.6 | 4.3 | $1.41 |
| Ginkgo | 1151 | $8.63 | -65 | -4.1 | -$0.52 | 2193 | $16.45 | 3274 | $24.56 | 1.3 | 0.4 | $1.17 |
| Eastern redbud | 3669 | $27.51 | -179 | -12.1 | -$1.43 | 4014 | $30.10 | 7491 | $56.19 | 3.8 | 1.0 | $0.91 |
| Serviceberry | 1135 | $8.51 | -68 | -4.3 | -$0.54 | 1511 | $11.33 | 2574 | $19.31 | 1.3 | 0.3 | $0.88 |
| Other street trees | 23449 | $175.87 | -1981 | -17.6 | -$14.99 | 18476 | $138.57 | 39927 | $299.45 | 5.5 | 5.3 | $3.33 |
| **Yellow Springs Totals** | **395202** | **$2,964.02** | **-29562** | **-320.0** | **-$224.12** | **389901** | **$2,924.25** | **755221** | **$5,664.15** | **100.0** | **100.0** | **$3.45** |

# Table 9. Annual Air Quality Benefits of Yellow Springs' Street Trees by Species and Ordered by Average Dollars per Tree

| Species | Deposit O3 (lb) | Deposit NO2 (lb) | Deposit PM10 (lb) | Deposit SO2 (lb) | Total Deposition ($) | Avoid NO2 (lb) | Avoid PM10 (lb) | Avoid VOC (lb) | Avoid SO2 (lb) | Total Avoided ($) | BVOC Emitted (lb) | BVOC Emitted ($) | Net Total (lb) | Total ($) | % Total Tree Numbers | Avg. $/tree |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Maple | 173.4 | 29.5 | 81.0 | 7.7 | $924 | 403.5 | 58.8 | 56.1 | 384.1 | $2,516 | -58.1 | -$218 | 1136 | $3,222 | 27.4 | $7.16 |
| Flowering crabapple | 8.2 | 1.4 | 4.4 | 0.4 | $45 | 52.5 | 7.5 | 7.1 | 47.6 | $321 | 0.0 | $0 | 128.8 | $366 | 10.6 | $2.10 |
| Pear | 15.3 | 2.5 | 7.4 | 0.7 | $82 | 64.8 | 9.3 | 8.8 | 59.4 | $398 | -0.1 | $0 | 168.2 | $480 | 7.9 | $3.72 |
| Ash | 23.2 | 4.0 | 11.6 | 1.0 | $126 | 69.7 | 10.1 | 9.6 | 65.4 | $432 | -5.6 | -$21 | 189.1 | $537 | 5.2 | $6.25 |
| Spruce | 9.1 | 1.8 | 7.9 | 1.1 | $61 | 27.0 | 3.9 | 3.8 | 25.6 | $168 | -36.0 | -$135 | 44.1 | $94 | 4.7 | $1.22 |
| Catalpa | 42.7 | 6.8 | 19.5 | 1.9 | $225 | 109.0 | 15.8 | 15.1 | 103.1 | $678 | 0.0 | $0 | 314.0 | $903 | 4.3 | $12.90 |
| Eastern redbud | 2.1 | 0.3 | 1.1 | 0.1 | $11 | 12.0 | 1.7 | 1.6 | 10.8 | $73 | 0.0 | $0 | 29.8 | $85 | 3.8 | $1.37 |
| Eastern white pine | 7.3 | 1.4 | 6.3 | 0.9 | $49 | 22.6 | 3.3 | 3.2 | 21.9 | $142 | -26.2 | -$98 | 40.8 | $93 | 3.0 | $1.86 |
| Northern hackberry | 3.4 | 0.6 | 2.2 | 0.2 | $20 | 28.9 | 4.2 | 4.0 | 27.0 | $179 | 0.0 | $0 | 70.4 | $199 | 3.0 | $4.06 |
| Littleleaf linden | 11.1 | 1.9 | 5.7 | 0.5 | $61 | 40.2 | 5.9 | 5.6 | 38.2 | $251 | -5.6 | -$21 | 103.4 | $290 | 2.8 | $6.31 |
| Black walnut | 3.9 | 0.6 | 2.2 | 0.2 | $22 | 27.6 | 4.0 | 3.9 | 26.5 | $173 | 0.0 | $0 | 68.8 | $194 | 2.6 | $4.62 |
| Mulberry | 4.2 | 0.7 | 2.0 | 0.2 | $23 | 17.1 | 2.5 | 2.3 | 15.8 | $105 | 0.0 | $0 | 44.8 | $128 | 2.6 | $3.05 |
| Zelkova | 6.5 | 1.1 | 3.4 | 0.3 | $36 | 28.1 | 4.1 | 3.9 | 26.7 | $175 | -3.4 | -$13 | 70.7 | $198 | 2.5 | $4.83 |
| Hybrid elm | 6.1 | 1.0 | 3.3 | 0.3 | $34 | 28.2 | 4.1 | 3.9 | 26.8 | $176 | 0.0 | $0 | 73.7 | $210 | 2.4 | $5.37 |
| Osage-Orange | 7.4 | 1.2 | 3.7 | 0.3 | $40 | 33.1 | 4.8 | 4.6 | 31.5 | $207 | 0.0 | $0 | 86.8 | $247 | 2.0 | $7.71 |
| Black locust | 12.9 | 2.2 | 6.3 | 0.6 | $70 | 30.2 | 4.4 | 4.1 | 28.1 | $187 | -3.0 | -$11 | 85.9 | $245 | 1.7 | $8.76 |
| Sweetgum | 2.5 | 0.4 | 1.4 | 0.1 | $14 | 19.3 | 2.8 | 2.7 | 18.7 | $121 | 0.0 | $0 | 48.0 | $135 | 1.5 | $5.64 |
| Common chokecherry | 2.7 | 0.4 | 1.3 | 0.1 | $14 | 10.3 | 1.5 | 1.4 | 9.4 | $63 | 0.0 | $0 | 27.1 | $77 | 1.5 | $3.22 |
| Serviceberry | 0.8 | 0.1 | 0.4 | 0.0 | $4 | 4.6 | 0.6 | 0.6 | 4.1 | $28 | 0.0 | $0 | 11.2 | $32 | 1.3 | $1.45 |
| Honeylocust | 4.8 | 0.8 | 2.3 | 0.2 | $26 | 18.5 | 2.7 | 2.6 | 17.8 | $116 | -3.3 | -$12 | 46.3 | $129 | 1.3 | $5.86 |
| Ginkgo | 0.9 | 0.2 | 0.5 | 0.0 | $5 | 6.2 | 0.9 | 0.9 | 5.9 | $39 | -0.4 | -$1 | 15.2 | $43 | 1.3 | $2.03 |
| Oak | 1.1 | 0.2 | 0.6 | 0.0 | $6 | 9.4 | 1.4 | 1.3 | 9.0 | $59 | 0.0 | $0 | 23.0 | $65 | 1.3 | $3.09 |
| Other street trees | 14.4 | 2.4 | 7.4 | 0.7 | $79 | 53.1 | 7.7 | 7.3 | 49.9 | $329 | -3.7 | -$14 | 139.2 | $394 | 5.5 | $4.38 |
| **Yellow Springs Totals** | **364.0** | **61.7** | **182.1** | **17.6** | **$1,975** | **1115.8** | **162.0** | **154.4** | **1053.4** | **$6,936** | **-145.3** | **-$545** | **2966** | **$8,366** | **100.0** | **$5.10** |

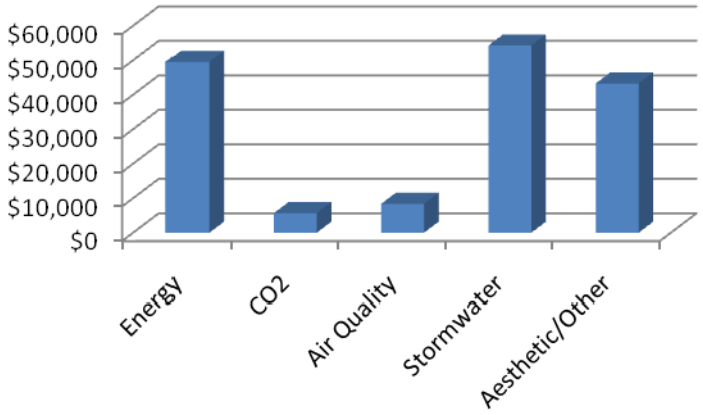
## Table 10. Annual Aesthetic or Other Benefits of Yellow Springs' Street Trees by Common Name and Ordered by Average Benefit per Tree

| Species | Total ($) | Tree Numbers | % Total Tree Numbers | % of Total $ | Avg. $/tree |
|---|---|---|---|---|---|
| Maples | $15,974 | 451 | 27.42 | 36.9% | $35.50 |
| Flowering crabapples | $882 | 174 | 10.60 | 2.0% | $5.07 |
| Pears | $1,308 | 129 | 7.86 | 3.0% | $10.14 |
| Ashes | $2,139 | 86 | 5.24 | 4.9% | $24.87 |
| Spruces | $1,534 | 77 | 4.69 | 3.5% | $19.92 |
| Catalpa | $4,059 | 70 | 4.27 | 9.4% | $57.98 |
| Eastern redbud | $196 | 62 | 3.78 | 0.5% | $3.16 |
| Eastern white pine | $1,339 | 50 | 3.05 | 3.1% | $26.78 |
| Northern hackberry | $1,107 | 49 | 2.99 | 2.6% | $22.59 |
| Littleleaf linden | $2,544 | 46 | 2.80 | 5.9% | $55.31 |
| Black walnut | $1,370 | 42 | 2.56 | 3.2% | $32.63 |
| Mulberry | $327 | 42 | 2.56 | 0.8% | $7.79 |
| Zelkova | $1,713 | 41 | 2.50 | 4.0% | $41.79 |
| Hybrid elm | $1,057 | 39 | 2.38 | 2.4% | $27.11 |
| Osage-Orange | $1,467 | 32 | 1.95 | 3.4% | $45.84 |
| Black locust | $682 | 28 | 1.71 | 1.6% | $24.36 |
| Sweetgum | $918 | 24 | 1.46 | 2.1% | $38.25 |
| Common chokecherry | $196 | 24 | 1.46 | 0.5% | $8.18 |
| Serviceberry | $61 | 22 | 1.34 | 0.1% | $2.78 |
| Honeylocust | $1,548 | 22 | 1.34 | 3.6% | $70.37 |
| Ginkgo | $118 | 21 | 1.28 | 0.3% | $5.64 |
| Oaks | $520 | 21 | 1.28 | 1.2% | $24.78 |
| Other street trees | $2,204 | 90 | 5.48 | 5.1% | $24.49 |
| **Yellow Springs Totals** | **$43,266** | **1646** | **100.00** | **100.0%** | **$26.29** |

## Table 11. Average Annual Benefits of Yellow Springs' Community Trees by Species ($/tree)

| Species | Energy | CO2 | Air Quality | Stormwater | Aesthetic /Other | Total |
|---|---|---|---|---|---|---|
| Catalpa | $68.83 | $9.27 | $12.90 | $118.16 | $57.98 | $267.14 |
| Osage-orange | $45.28 | $6.19 | $7.71 | $57.22 | $45.84 | $162.25 |
| Honeylocust | $36.10 | $4.59 | $5.86 | $34.12 | $70.37 | $151.04 |
| Littleleaf linden | $38.38 | $5.98 | $6.31 | $42.64 | $55.31 | $148.61 |
| Black locust | $48.73 | $4.37 | $8.76 | $59.57 | $24.36 | $145.79 |
| Maples | $39.38 | $4.24 | $7.16 | $43.63 | $35.50 | $129.92 |
| Sweetgum | $34.46 | $4.77 | $5.64 | $34.50 | $38.25 | $117.62 |
| Zelkova | $30.02 | $4.44 | $4.83 | $30.20 | $41.79 | $111.29 |
| Ashes | $36.20 | $3.77 | $6.25 | $38.17 | $24.87 | $109.26 |
| Hybrid elm | $31.81 | $3.81 | $5.37 | $35.33 | $27.11 | $103.43 |
| Black walnut | $28.42 | $3.91 | $4.62 | $29.32 | $32.63 | $98.90 |
| Eastern white pine | $19.50 | $1.90 | $1.86 | $36.53 | $26.78 | $86.56 |
| Northern hackberry | $26.50 | $2.24 | $4.06 | $19.89 | $22.59 | $75.28 |
| Oaks | $19.24 | $2.65 | $3.09 | $18.58 | $24.78 | $68.34 |
| Spruces | $15.54 | $1.46 | $1.22 | $29.67 | $19.92 | $67.81 |
| Pears | $23.26 | $2.52 | $3.72 | $11.41 | $10.14 | $51.05 |
| Common chokecherry | $19.82 | $2.08 | $3.22 | $10.36 | $8.18 | $43.66 |
| Mulberry | $18.82 | $2.00 | $3.05 | $9.45 | $7.79 | $41.11 |
| Ginkgo | $12.83 | $1.17 | $2.03 | $7.86 | $5.64 | $29.53 |
| Flowering crabapple | $14.16 | $1.41 | $2.10 | $5.97 | $5.07 | $28.72 |
| Serviceberry | $9.92 | $0.88 | $1.45 | $4.37 | $2.78 | $19.39 |
| Eastern redbud | $9.17 | $0.91 | $1.37 | $4.02 | $3.16 | $18.63 |
| Other street trees | $26.27 | $3.33 | $4.38 | $33.85 | $24.49 | $92.32 |

# Table 12. Totals for Five Benefit Categories and Grand Total for Yellow Springs' Street Tree Benefits




| Benefits | Total ($) | $/tree |
|---|---|---|
| Energy | $49,546 | $30.19 |
| CO2 | $5,664 | $3.45 |
| Air Quality | $8,366 | $5.10 |
| Stormwater | $54,265 | $33.07 |
| Aesthetic/Other | $43,266 | $26.37 |
| **Total Benefits** | **$161,107** | **$98.18** |
| *This is a savings in benefits of more than $40 per person in Yellow Springs.* | | |