# Locust Grove Nature Preserve Tree Survey
# Louisville, Kentucky

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**Abstract** – In June and July, 2012 a tree survey of Historic Locust Grove Nature Preserve forest was undertaken. Based on the size of Red Maple trees (*Acer rubrum*), the forest was determined to be less than 45 years old. Twenty-four species were identified in the forest preserve.

## Introduction

"Locust Grove is a National Historic Landmark situated on 55 acres of the original 694 acres farm established by William and Lucy Clark Croghan in 1790. The preserve consists of 24 acres within this remaining property. William Croghan was the brother-in-law and surveying partner of George Rogers Clark, founder of Louisville and Revolutionary War hero, who spent the last nine years of his life at Locust Grove, from 1809 until his death in 1818" (Locust Grove, 2012).

Locust Grove is owned by the city of Louisville. Louisville Metro Parks assists with the maintenance of the grounds, but their resources are limited. A 501C3 foundation, Historic Locust Grove employs museum staff and has a board of directors which overseas staff operations. The board of Historic Locust Grove is in the process of developing a Master Plan for the museum and grounds that will look to the next 20 years. Developing a management plan for the property includes a bush honey suckle survey, a trail map, a current tree survey to include maps (See Figures 1 – 5), a current list of tree species located in the preserve area (Figure 6) , and a wildlife survey.

Developing a tree map integrates trees of historical interest to Locust Grove like the Black Locust (*Robinia pseudoacacia*), the tree for which the property was named, and trees used for economic interest like Black Walnut (*Juglans nigra*) and Black Cherry (*Prunus serotina*). White Ash (*Faxinus americana*), Green Ash (*Faxinus pennsylvanica*), and the Tulip Poplar (*Lirdendorn tulipifera*) were used for construction of the mansion floors and trim. The Common Pawpaw (*Asimina triloba*) trees were used as a food source by settlers. The fruit of the Pawpaw is especially high in protein. For mapping, trees are identified in clusters, at the origin of an identified trail, along the foot path, and when possible at converging points of the trails.

Assimilating information on tree species density, diameter at breast height (DBH), and succession (comparing the number of pioneer species to climax species), of the forest helps determine forest age. The attained information is helpful in land management decisions to maintain a healthy, sustainable forest.

**Methods**

As part of the tree survey, the grid system provided from the bush honeysuckle survey data was used to assimilate tree data. Locust Grove was located using Google Earth and the preserve area was delineated using GE Path software (Haulter 2012). The total area surveyed was 94,718$m^2$, approximately 9.4 hectares. The grid was overlaid with quadrants and 60 random numbers were generated using Microsoft Excel to determine data survey points within the grid. Geographical coordinates (survey points) were determined for each of the grid quadrants.

A Garmin eTrex Venture HC GPS receiver was used to locate survey points. For each survey point, a five meter radius from the point was measured using a forestry tape measure and the trees were counted within the circle.

Each tree of sapling size or greater was identified using field guides (Petrides and Wehr 1998, Sibley 2009). Dead trees were not included. Diameter at breast height (DBH) of each tree was recorded in centimeters. These data were used to calculate age distribution (Magurran 1988). Trees determined to be of historical, economical, and larger than one meter in circumference (DBH) are also included in the data as non-random survey points and are mapped according to species.

The total area of sampling coverage was 4553 $m^2$ (~0.46 ha). The calculation represents 58 of 60 points surveyed and the sampled area was ~ 4.8 % of the total area of the preserve.

By dividing the number of trees sampled by the area of sample coverage (4553 $m^2$), density of the forest is determined. Multiplying the density by the total forest area gives the abundance of total trees and the abundance of each tree species identified (Magurran 1988): Abundance = Density X 94,718 $m^2$. (See Table 1.)

**Results**

The survey sample area contains 252 trees larger than seedlings and 24 species (Table 1). The most abundant species are the Red Maple (*Acer rubrum*) at 18%, and Black Locust (*Robinia pseudoacacia*) at 15% of the total trees recorded. The least common species represent a total of 1% of the trees surveyed and includes the Black Mulberry (*Morus nigra*), Honeylocust (*Gleditsia tiracanthos*), and Tulip Poplar (*Librodendron tulipifera*).

The estimated tree population of the study area based on calculations was 5241 trees, with an overall density of 553.48 trees/ha (Magurran 1988).

In determining the age of a forest, the size of the trees and the abundance of pioneer, also known as a succession species, to climax species, known as old growth, are compared. Initially, the fast-growing species that mature quickly and have a shorter life span inhabit the soils.

Eventually, pioneer species are replaced with climax species that grow more slowly, reproduce later in life, and have a much longer life span. In areas with temperate deciduous forests, the climax species of hardwoods comprise the canopy layer of the forest while the understory layer contains smaller trees and shrubs. During succession, the trees become larger as does their average DBH and the density (individuals / $m^2$) becomes smaller as individuals compete for space and soil sustenance.

Twenty-four species of trees were identified; two were pioneer species while twenty-two were transitional or climax species (Table 1). The Black Locust was the most abundant pioneer species, represents 15% of the forest, and was used to compare the relationship between the Black Locust DBH (cm) and abundance (N), (Figure 7). The most abundant trees were in the Maple family, with Red Maple and Boxelder occupying 32% of the forest. The Red Maple was used to compare the relationship between the Red Maple DBH (cm) and abundance (N), (Figure 8); as was a histogram to determine size class DBH (cm) and distribution (Figure 9). Age data from the Black Cherry trees DBH (cm) represent 10% of the forest and the data compares the relationship between the Black Cherry and reforestation (Figure 10), (Burns and Honkala 1990).

The pioneer species Black Locust showed that in the successional process of reforestation, these trees were the oldest. The Black Locust has been used for the reclamation of farmed fields and mining sites. The Black Locust at 40 years old has an average DBH of 27 (cm). The average DBH (cm) of the nature preserves Black Locusts is DBH 28.62 (cm) meaning that the Black Locusts are older than 40 years (Table 1). The relationship between the Black Locust and combined tree species abundance shows broad variation in DBH (cm) and density of the trees. The data indicates that competition for soil space and sustenance is low. The relationship between the Red Maple and combined tree species abundance shows that due to

variation, the Red Maple is not yet competing for soil space and nutrition (Packham and Harding, 1982). The average DBH (cm) size distribution is 18.8 (cm) DBH. Red Maples reach maturity between 70-80 years and 46-76 (cm) DBH. The data shows that the Red Maples are approximately 40 years old and younger (Burns and Honkala, 1990). Additionally, the Black Cherry shows that prior to reforestation, that 11 of the trees are nearly 60 years old and include four trees over 100 years old within the surveyed area. The data also shows that more of the Black Cherries germinated approximately 40 years ago than at ages 60 or 100 years ago (Figure 10), (Burns and Honkala 1990).

**Discussion**

Using a gridded plot of Locust Grove Nature Preserve, tree species were measured and mapped according to location. The preserve forest is approximately 40 years old and is a new forest. The Black Locust occupies 15% of the total surveyed area while the Red Maple occupies 18%. With continued ecological succession, the data suggest that the and Black Cherry at 10% will compose a significant portion of the canopy layer of the forest, while the Common Pawpaw at 5% and Flowering Dogwood at 4% of the total surveyed area, will compose the understory.

Based on the size of Red Maple and Black Cherry, the Locust Grove Nature Preserve is approximately 40 years old. The preserve forest is could play a role in site interpretation because the Black Locust, Tulip Poplar, Green and White Ash, and Pawpaw trees that are significant to the history of Locust Grove.

An additional component of the preserve forest is the invasive Amur Bush Honeysuckle (*Lonicera maackii*). Any management should take into account, not only composition of the native species, but the impact and control of invasive species.

| Location | | Total # | Density (trees/ha) | Abundance | Proportion | Average DBH (cm) |
|---|---|---|---|---|---|---|
| Red Maple | *Acer rubrum* | 45 | 98.84 | 936 | 18% | 19.75 |
| Black Locust | *Robinia pseudoacacia* | 39 | 85.66 | 811 | 15% | 28.62 |
| Boxelder | *Acer negundo* | 36 | 79.07 | 749 | 14% | 18.47 |
| Black Cherry | *Prunus serotina* | 26 | 57.11 | 541 | 10% | 34.03 |
| American Elm | *Ulmus americana* | 16 | 35.14 | 333 | 6% | 18.67 |
| Hackberry | *Celitis occidentalis* | 15 | 32.95 | 312 | 6% | 16.60 |
| Common Pawpaw | *Asimina triloba* | 12 | 26.36 | 250 | 5% | 7.64 |
| Flowering Dogwood | *Canus florida* | 10 | 21.96 | 208 | 4% | 12.14 |
| Eastern White Pine | *Pinus strobes* | 8 | 17.57 | 166 | 3% | 40.50 |
| Red Mulberry | *Morus rubra* | 6 | 13.18 | 125 | 2% | 19.43 |
| Eastern Red Cedar | *Junipers virginia* | 5 | 10.98 | 104 | 2% | 18.22 |
| Butternut | *Juglans cinerea* | 5 | 10.98 | 104 | 2% | 20.06 |
| Black Walnut | *Juglans nigra* | 5 | 10.98 | 104 | 2% | 28.45 |
| White Ash | *Faxinus americana* | 4 | 8.79 | 83 | 2% | 33.12 |
| American Holly | *Ilex opaca* | 3 | 6.59 | 62 | 1% | 6.85 |
| Ohio Buckeye | *Aesculus glabra* | 3 | 6.59 | 62 | 1% | 8.76 |
| Sugar Maple | *Acer saccharum* | 3 | 6.59 | 62 | 1% | 27.81 |
| Shellbark Hickory | *Carya ovata* | 2 | 4.39 | 42 | 1% | 14.01 |
| Silver Maple | *Acer saccharinum* | 2 | 4.39 | 42 | 1% | 14.49 |
| Slippery Elm | *Ulmus rubra* | 2 | 4.39 | 42 | 1% | 15.92 |
| Green Ash | *Faxinus pennsylvanica* | 2 | 4.39 | 42 | 1% | 18.31 |
| Tulip Poplar | *Lirodendron tulipifera* | 1 | 2.20 | 21 | < 10% | 35.03 |
| Honeylocust | *Gleditsia triacanthos* | 1 | 2.20 | 21 | < 10% | 38.22 |
| Black Mulberry | *Morus nigra* | 1 | 2.20 | 21 | < 10% | 101.91 |

Total Species = 24
Total # Trees = 252
Est. Total Population = 5241
Each sample plot = 0.0079 ha
Locust Grove study site = 9.47 ha

Density = 553.48 trees/ha
# Points measured = 58
Diversity Index = 0.901
Total Study Site = 0.4553 ha

Table 1. Forest Composition of Locust Grove Nature Preserve


Figure 1 Map of  Black Cherry (*Prunus serotina*) Tree Locations


Figure 2. Map of Common Pawpaw (*Asimina triloba*) Tree Locations


Figure 3. Map of White Ash (*Fraxinus americana*) and Green Ash (*F. pennsylvanica*)


Figure 4. Map of Black Walnut (*Juglans nigra*) Tree Locations


Figure 5. Map of Tuliptree (*Liriodendron tulipifera*) Tree Locations

## Existing Trees in 2012

- **Gymnosperms**
- Eastern White Pine (*Pinus strobes*)
- Eastern Red Cedar (*Juniper virginia*)
- **Angiosperms**
- Black Willow (*Salix nigra*)
- Black Walnut (*Juglans nigra*)
- Butternut (*J. cinerea*)
- Shagbark Hickory (*Carya ovata*)
- Shellbark Hickory (*C. laciniosa*)
- White Oak (*Quercus alba*)
- Northern Red Oak (*Q. rubra*)
- American Elm (*Ulmus americana*)
- Slippery Elm (*U. rubra*)
- Hackberry (*Celitis occidentalis*)
- Red Mulberry (*Morus rubra*)
- White Mulberry* (*M. alba*)
- Black Mulberry* (*M. nigra*)
- Tuliptree (*Lirodendron tuliifera*)
- Common Pawpaw (*Asimina triloba*)
- Sweetgum (*Liquidambar styracifua*)
- American Sycamore (*Platalnus occidentalis*)
- Black Cherry (*Prunus serotina)*
- Allegheny Serviceberry (*Amerlachier laevis*)
- Eastern Redbud (*Cercis candensis*)
- Kentucky Coffeetree (*Gymnocladus dioicus*)
- Honeylocust (*Gleditsia triacanthos*)
- Black Locust (*Robinia pseudoacacia*)
- Shining Sumac (*Rhus copallina*)
- American Holly (*Ilex opaca*)
- Sugar Maple (*Acer saccharum*)
- Red Maple (*A. rubrum*)
- Silver Maple (*A. saccharinum*)
- Boxelder (*A. negundo*)
- Ohio Buckeye (*Aesculus glabra*)
- American Basswood (*Tilia americana*)
- Flowering Dogwood (*Canus florida*)
- American Fringetree (*Chionanthus virginicus*)
- White Ash (*Faxinus americana*)
- Green Ash (*F. pennsylvanica*)
- *Non-native species

Figure 6. Identified Tree Species On Locust Grove Property

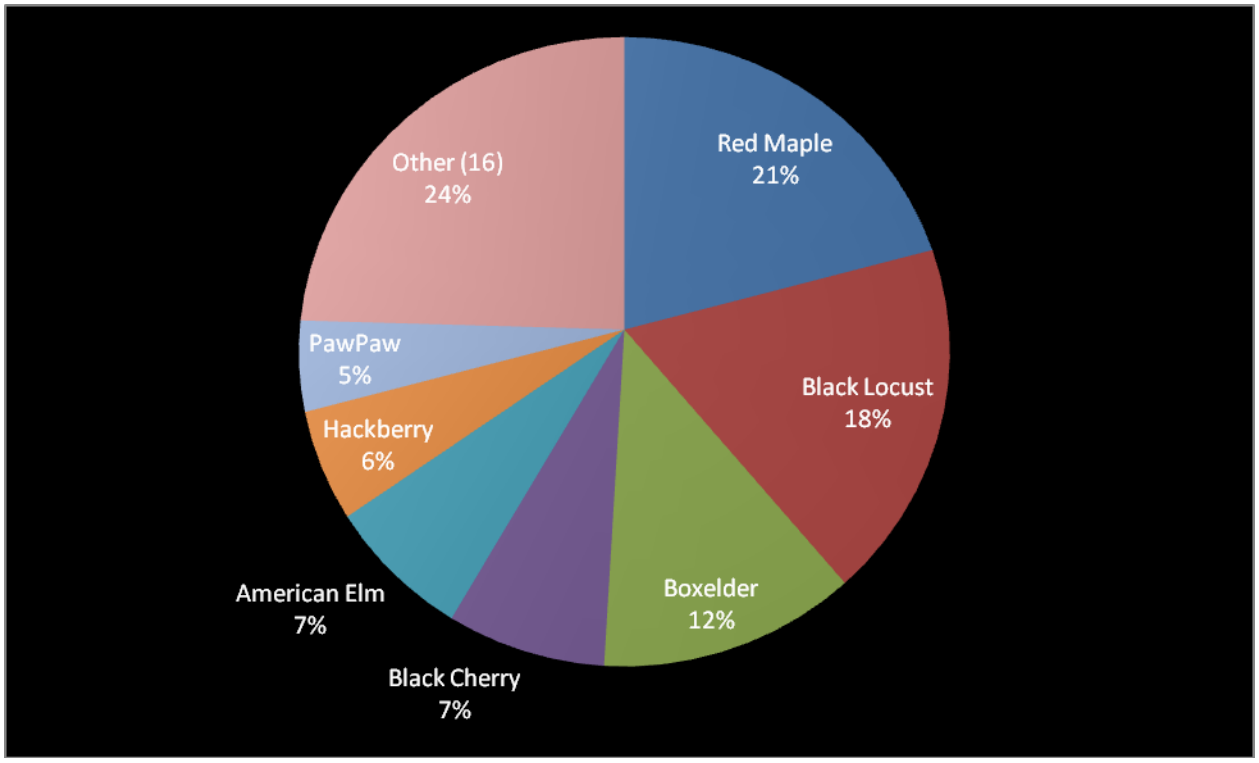


Figure 6a. Relative abundance of tree species.

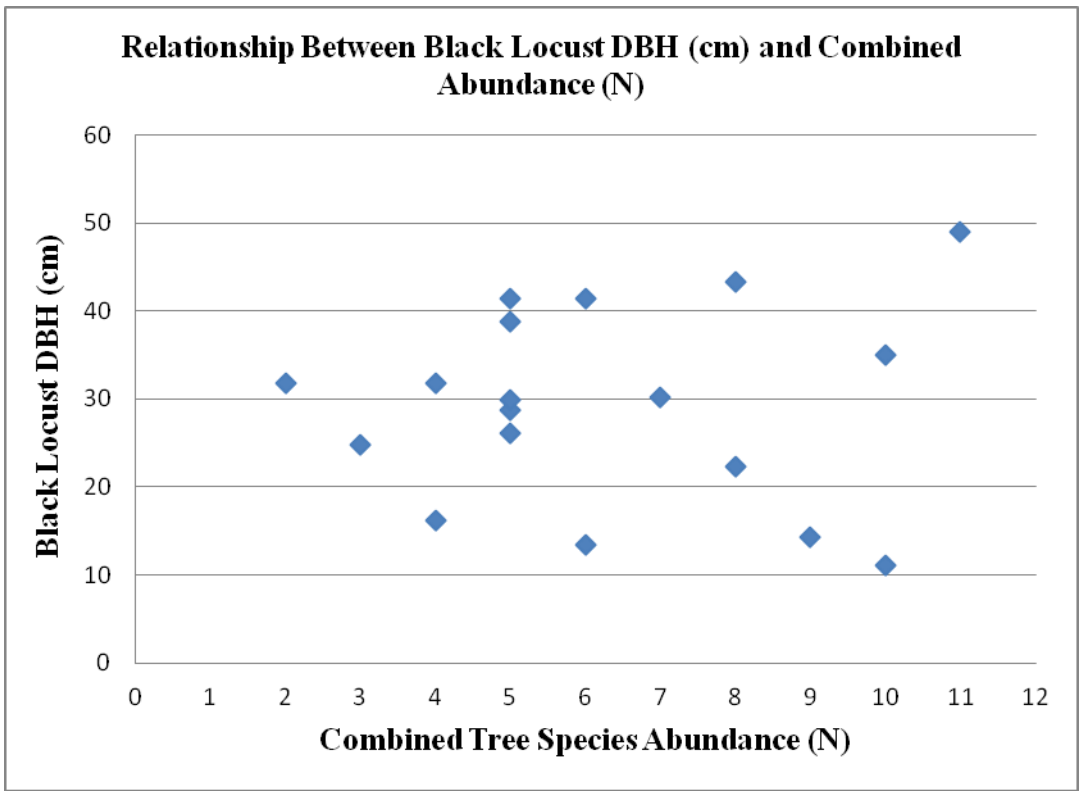


Figure 7. Relationship between the Black Locust (*Robinia pseudoacacia*) DBH (cm) and combined tree species abundance.

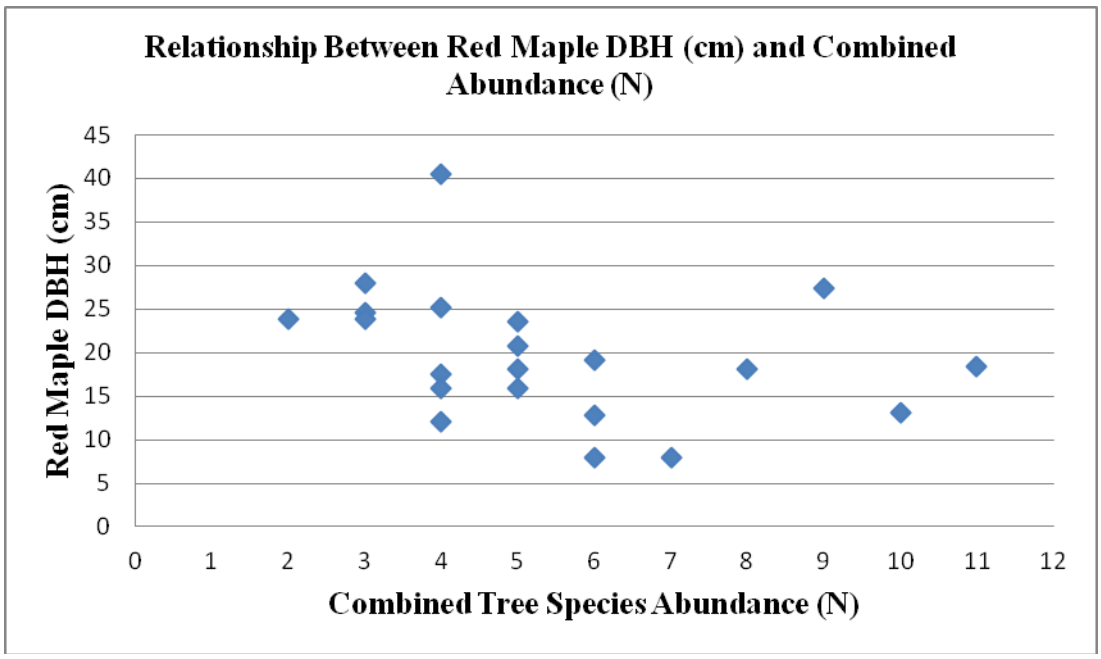


Figure 8. Relationship between the Red Maple (*Acer rubrum*) DBH (cm) and combined tree species abundance.

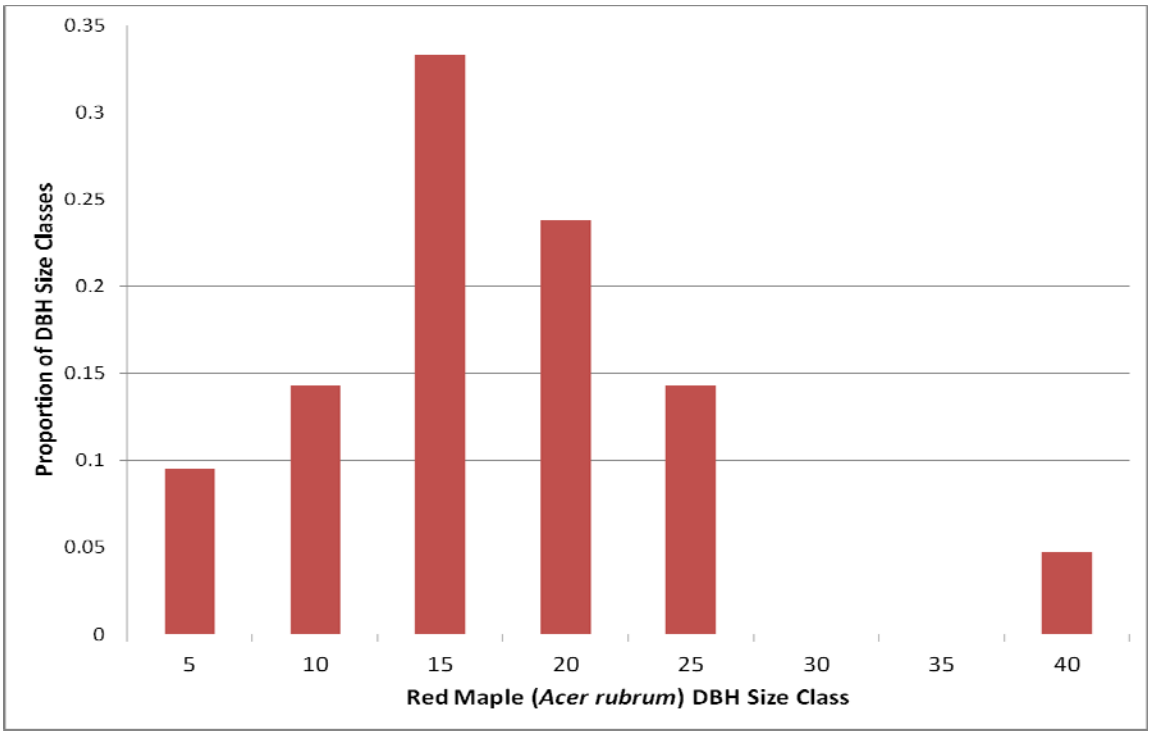


Figure 9. DBH Size Distribution of Red Maple (Acer rubrum)

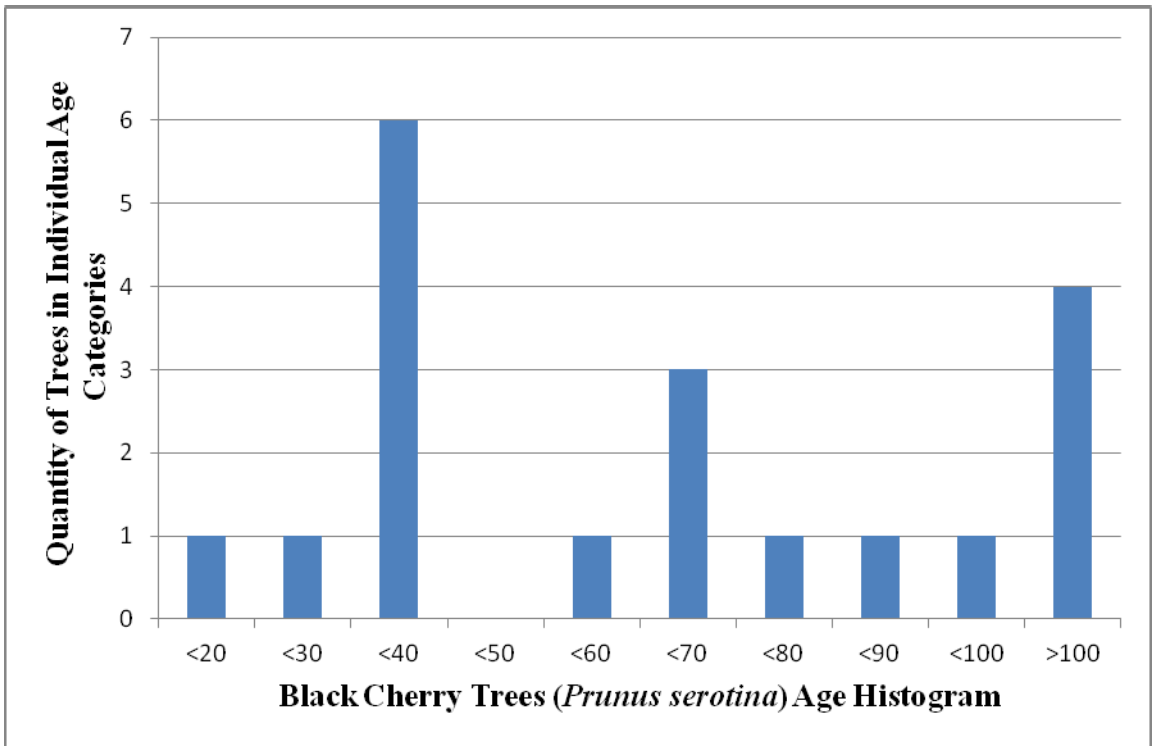


Figure 10. Black Cherry (*Prunus serotina*) Age Histogram

## Works Cited


BURNS, R.M. AND B.H. HONKALA, 1990. Silvics of North America: 1. Conifers; 2. Hardwoods. Agriculture Handbook 654. U.S. Department of Agriculture, Forest Service, Washington, DC.

HAULTER, P. 2012. *Amur Bush Honeysuckle Survey Data* (Department of Biology). New Albany, IN: Indiana University Southeast. Unpublished.

LOCUST GROVE, 2012. "Locust Grove." http://www.locustgrove.org/

MAGURRAN, A.E. 1988. Ecological Diversity and Its Measurement . Chapman and Hall, London.

PACKHAM, J.R. AND D.J.L. HARDING. 1982 Ecology of Woodland Processes. Edward Arnold Ltd. London.

PETRIDES, G. A. AND J. WEHR, 1998. A Field Guide to Eastern Trees. Houghton Mifflin Company, Boston.

SIBLEY, D.A. 2009. The Sibley Guide to Trees. Alfred A. Knopf, New York.


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