Diversity and Carbon Content of University of Richmond Campus Trees

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Abstract

Located in Richmond VA, the university offers two campuses divided by the Westhampton Lake. The goal was to create a high-resolution map of the distribution of trees and forest patches of the Westhampton Campus using Global Positioning System (GPS) and Geographic Information Systems (GIS) for web-based applications. The data were also used to quantify measures of species diversity and the amount of carbon stored in the trees and forests on campus. These metrics were then compared between the cultivated and less managed parts of campus.

Methods

Data Collection:

Cultivated Tree Logging – Individual trees were logged in the cultivated areas of campus using a Trimble Nomad GPS unit attached to a Trimble GEO-XT antenna which achieved sub meter accuracy in most areas. The main attributes recorded were species[1,2], diameter at breast height (DBH), and height. If a tree was found to be unhealthy or have abnormal attributes, those features were recorded. Only trees with a DBH greater than 5 cm were recorded.

Unmanaged Forest Parcels – Parcel data were obtained from the City of Richmond in order to have an accurate polygon of the forest area. For Westhampton forest, a dot density map was used to identify thirteen random points to be the corners of 13 ten meter by ten meter sample transects. Within each transect all trees with a DBH greater than 2.5 cm were recorded using the GPS unit.

Data Analysis:

Diversity – Dominance-diversity curves were generated for campus as a whole as well as separately for the Westhampton forest and the cultivated areas of campus.

Carbon – Allometric equations were used to calculate the biomass of the trees based upon DBH and tree species for 89% of the trees collected[3,4,5]. Then carbon content and CO_2 estimations were made using calculations from the Alabama Forestry Commission[6].

Tree allometry equation where *a* and *b* are species specific constants:

$$Biomass = a(DBH)^b$$

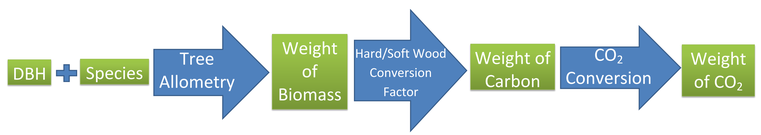

Figure 1. Flow chart showing how CO_2 equivalent was calculated from observations of tree DBH and species

Online Map:

The data were uploaded to ArcGIS Explorer Online to increase access by the University of Richmond community and to serve as a resource for other universities looking to create a similar database.

Works Cited and Acknowledgments

1. Hayden, John, Dr. "Key to Conifers on UR Campus." Print.
2. Hayden, John, Dr. "Key to Some Common Trees on UR Campus." Print.
3. Clark III, D. R. Phillips, and D. J. Frederick. "Weight, Volume, and Physical Properties of Major Hardwood Species in the Atlantic Coastal Plain."
4. Clark III, D. R. Phillips, and D. J. Frederick. "Weight, Volume, and Physical Properties of Major Hardwood Species in the Piedmont."
5. Ter-Mikaelian, M. "Biomass Equations for Sixty-five North American Tree Species." *Forest Ecology and Management* 97.1 (1997): 1-24. Print.
6. "How Much Carbon Have Your Trees Stored?" *How Much Carbon Have Your Trees Stored?* Web. June-July 2012. <http://www.forestry.state.al.us/howmuchcarbonhaveyourtreesstored.aspx?bv=5>.

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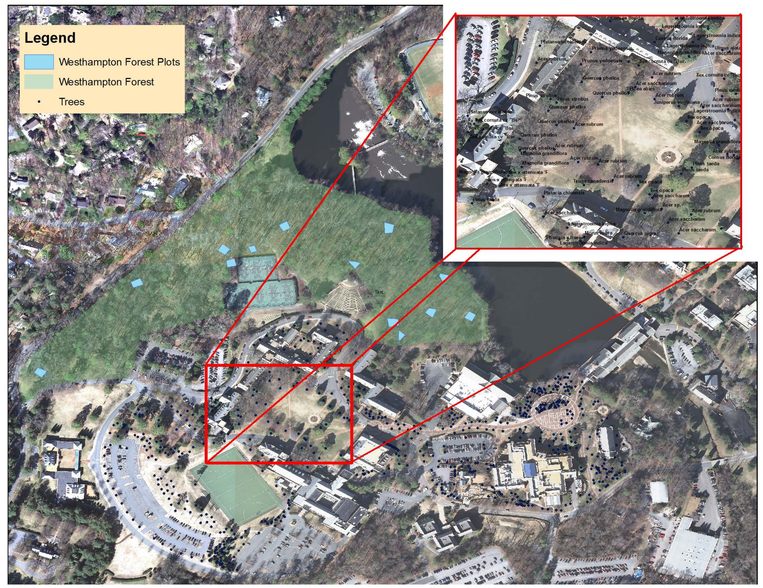

Figure 2. An ArcGIS map of the tree data collected on the Westhampton Campus

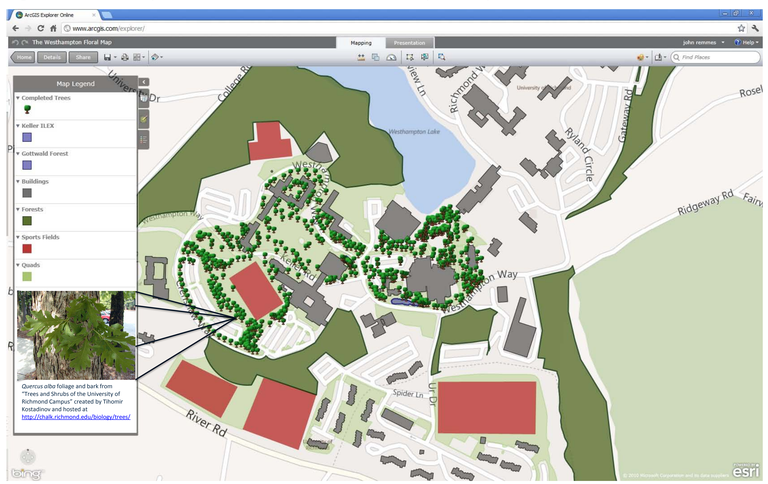

Figure 3. A map of the Westhampton Campus trees hosted at ArcGIS online (http://www.arcgis.com/explorer/)

Results and Discussion

Species Diversity

- 63 species total were observed in the mapped area of campus (845 individual trees)
  - 61 species in cultivated section (694 individuals)
  - 16 species in forest section (151 individuals)
- Forest area showed greater dominance by a few species

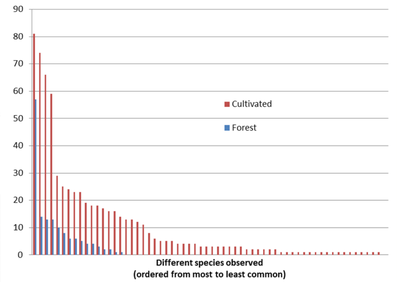

Table 1. Top 4 most prevalent species for the cultivated and forest areas

Cultivated Area			Forest Area		
Species	Number	Percentage	Species	Number	Percentage
Pinus taeda	81	11.7%	*Carya tomentosa*	57	37.7%
Acer rubrum	74	10.6%	*Fagus grandifolia*	14	9.3%
Quercus phellos	66	9.5%	*Quercus alba*	13	8.6%
Cornus florida	59	8.5%	*Ulmus alata*	13	8.6%
	Total %	40.3%		Total %	64.2%

Figure 4. Species dominance-diversity curves for cultivated and forest areas

Carbon Content

- Mean CO_2 Equivalent
  - Cultivated trees – 256.0 kg
  - Forest trees – 95.5 kg
- Top 5 Species Account for What Percent of CO_2?
  - Forest Trees – 88.6%
  - Cultivated Trees – 56.3%
- CO_2 per Square Meter
  - Cultivated Area – 4.6 kg/m^2
  - Forest Area – 38.3 kg/m^2
  - Total Campus Area – 11.8 kg/m^2
- CO_2 Estimate Whole Campus
  - Cultivated Area – 4,729,661 kg
  - Forest Area – 10,643,815 kg
  - Total Campus Area – 15,373,476 kg

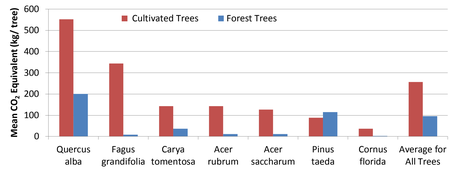

Figure 5. The mean stored CO_2 for common trees on campus

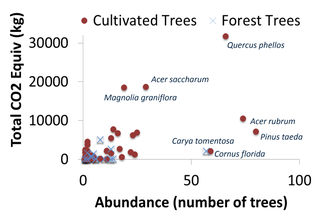

Figure 6. Total abundance and CO_2 equivalent estimates by species, which accounts for both the commonness and size distribution of recorded species.

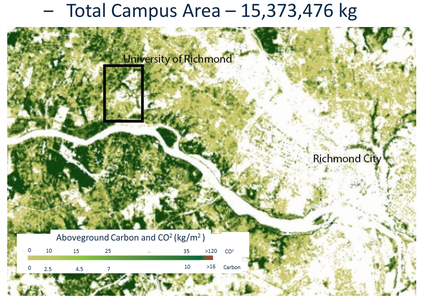

Figure 7. Carbon and CO_2 estimations for the region created by the Woods Hole Research Center using Landsat and US Forest Service data. http://www.whrc.org/mapping/nbcd/index.html