Preliminary Investigation of Orchards as Carbon Sinks: Do Trees Affect Soil Organic Matter Accumulation

Charlie Burroughs, Meghan Meloy, & Savannah Sullivan

Systems Ecology, Fall 2010

BACKGROUND

Soil is the largest terrestrial sink of atmospheric carbon. Underground root processes and leaf litter deposition are responsible for SOM accumulation around trees[1]. However, roots are the primary mechanism through which carbon enters the soil carbon pool[3]. The potential for using crop plants and crop management strategies to store carbon in the soil is recognized as one mechanism for addressing climate change. Woody crops sequester more carbon than annual crops[5]. Woody fruit trees are an increasingly important component of urban landscapes, but little is known about how these crops influence soil carbon sequestration of urban turf.

Our study was designed to determine whether apple trees in an established urban orchard had contributed to carbon sequestration relative to a traditional turf landscape. To do so, we analyzed the spatial distribution of soil organic matter (SOM) around dwarf apple trees in a ten-year-old Oberlin College orchard compared to a grass lawn. Because the spatial distribution of leaf litter is relatively equal in the orchard, we assumed that underground soil processes were primarily responsible for any variation in SOM accumulation.

Hypothesis: %SOM in orchard would be greater than %SOM in the lawn

We analyzed the effect of trees on SOM accumulation by examining %SOM at different soil depths and at different distances from trees.

- We predicted that %SOM would be greater in the surface layer than the bottom layer.
- We predicted that %SOM would decrease as the distance from each tree increased.

METHODS

We selected two groups of three trees within the Oberlin orchard. The distance between the trees within each group was partitioned into quarters, and soil samples were collected at these points (see diagram below). Control samples were collected at two points in the Oberlin lawn to act our control group. All soil samples were collected to a 15 cm depth using a standard soil corer. All samples were the same width, and were split in half[2]. %SOM was determined through the loss-on-ignition method[4].

SITE DESCRIPTION

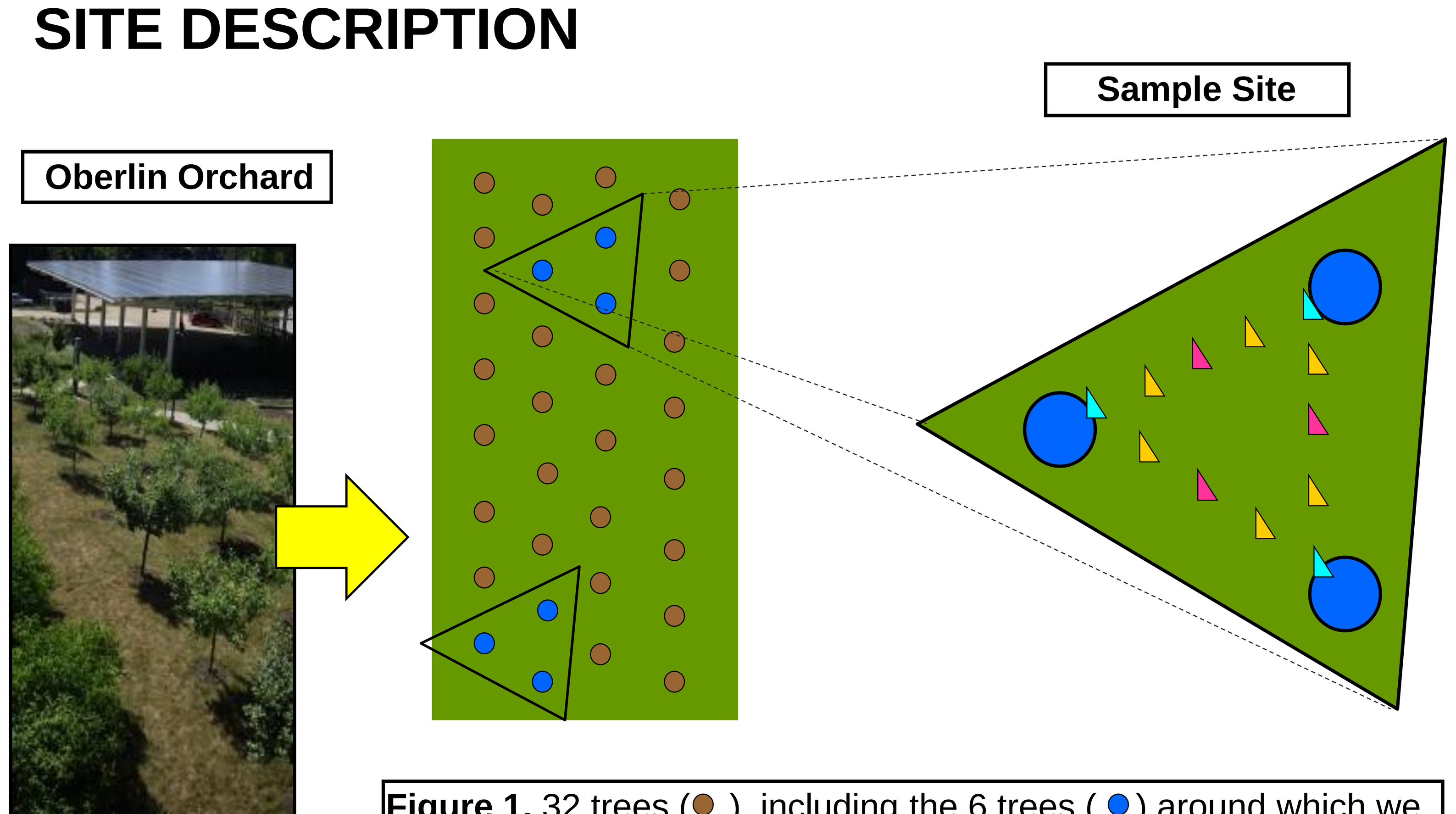


Figure 1. 32 trees (●), including the 6 trees (●) around which we collected soil samples. Sample locations marked by triangles: ◣ = sample nearest to the tree; ◣ = sample farthest from the tree; ◣ = sample between the nearest and farthest samples.

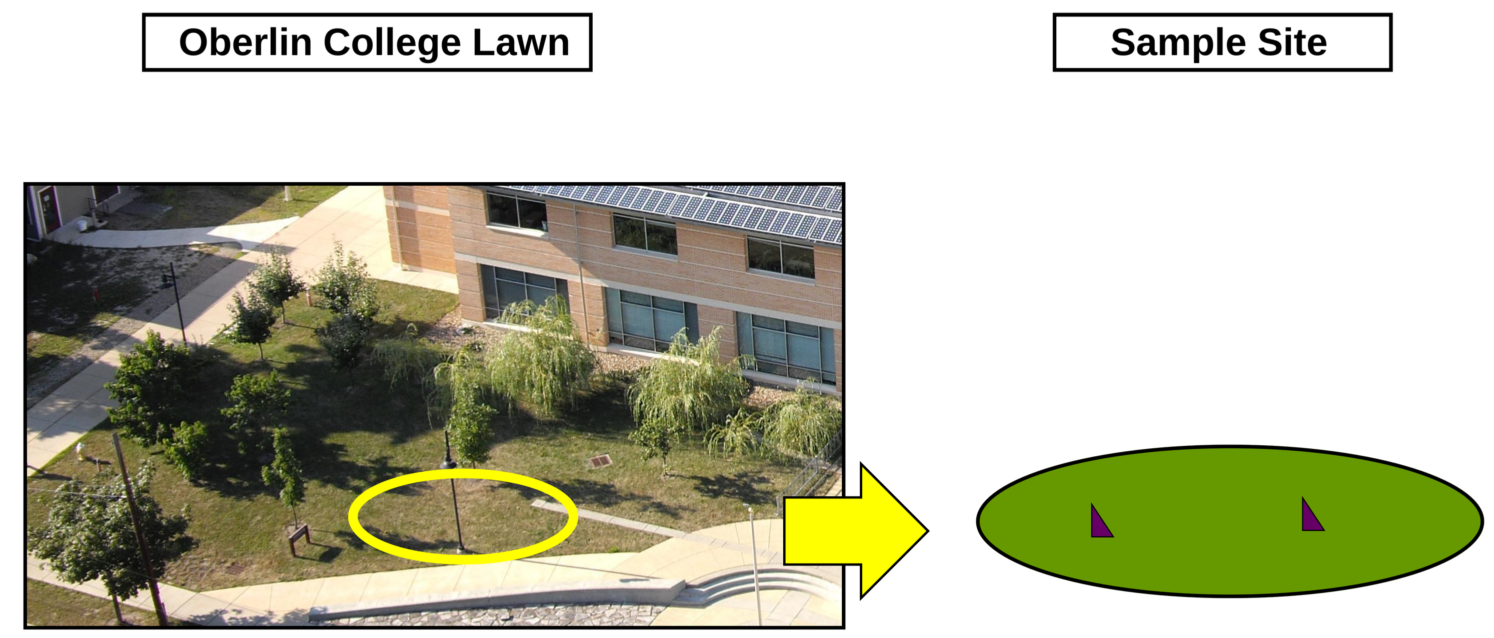
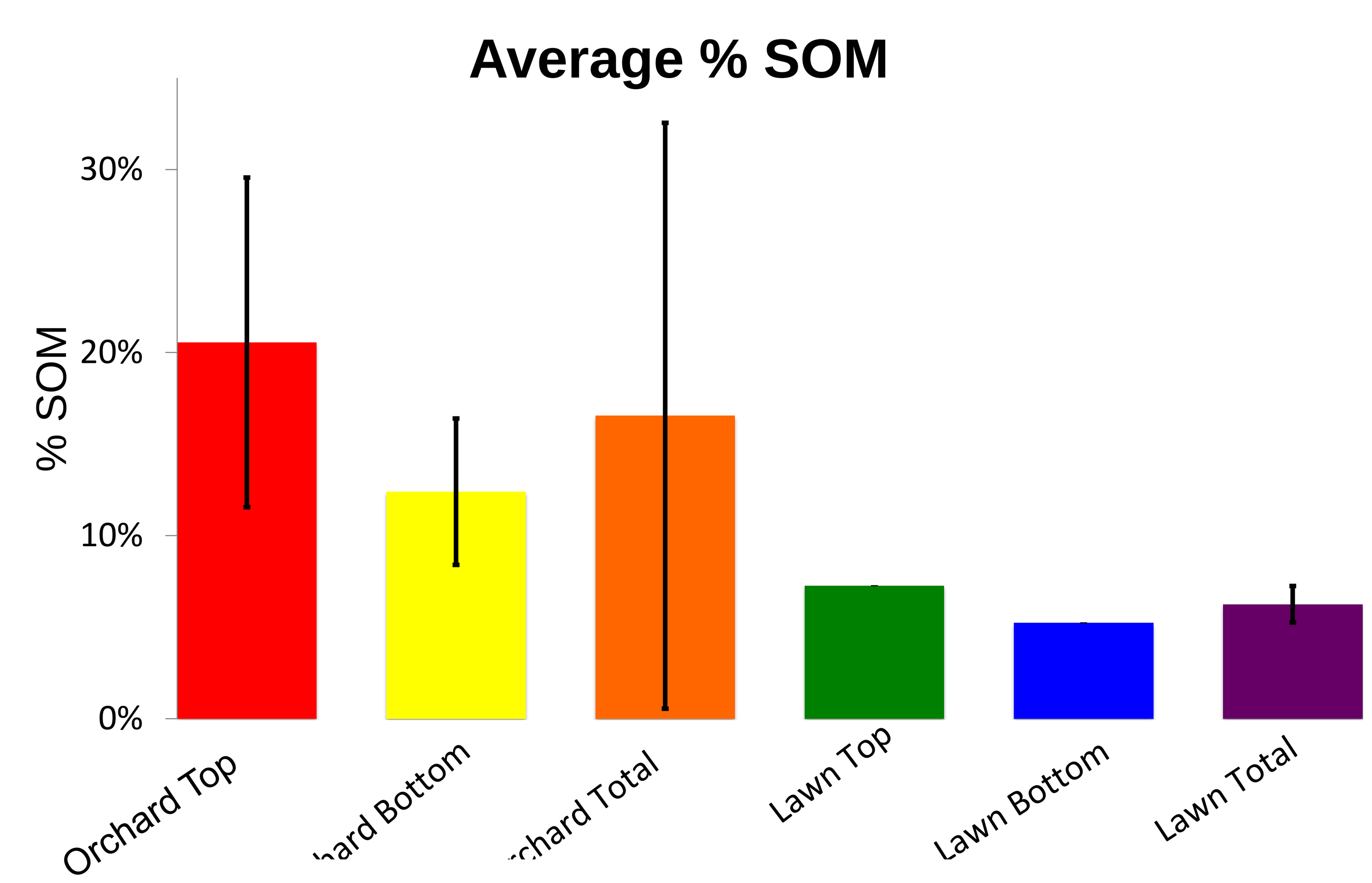


Figure 2. Sample site located away from trees on lawn. ◣ = control sample.

RESULTS



We found the average %SOM of orchard soil samples and lawn soil samples, as well as the top and bottom halves of the soil samples. Error bars show the standard deviation of %SOM.

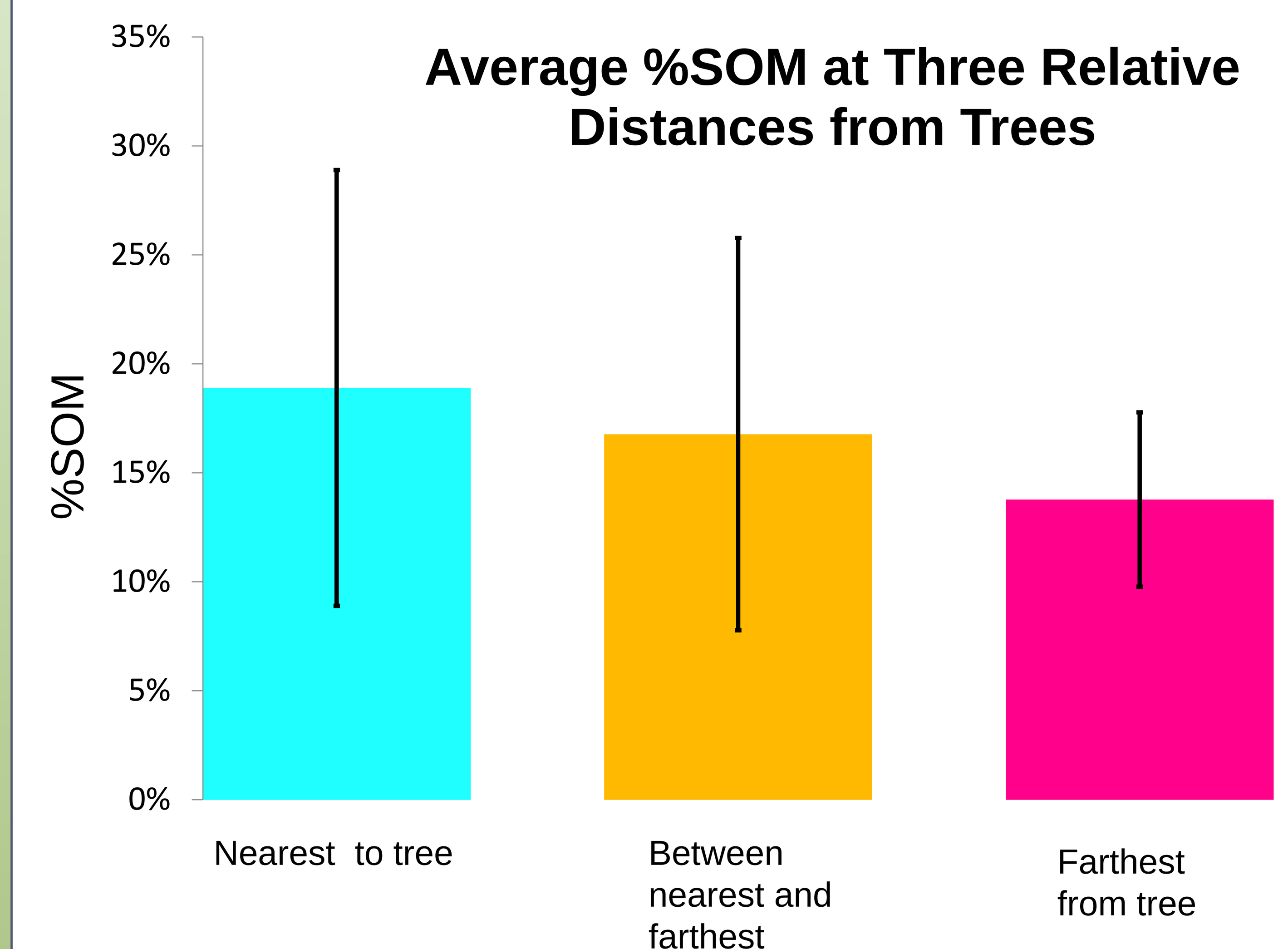
- %SOM of soil samples from the orchard was higher than the lawn, but the difference was not statistically significant.
- %SOM for top portions of the soil samples was higher than the bottom portions, but the difference was not statistically significant.

The results were not statistically significant due to the high variability of %SOM of the orchard soil samples.

ACKNOWLEDGEMENTS

We would like to thank Professor John Petersen for his input and support throughout this study; to Oberlin College for the use of the Adam Joseph Lewis Center orchard and the systems ecology lab; to Dr. Philip Rutter for his work on woody plants that inspired this project.

RESULTS CONTINUED



We grouped soil samples from the orchard based on their distance from the nearest tree. We then averaged the %SOM of these groups. The error bars show the standard deviation of %SOM. We found that %SOM decreased as distance from tree increased.

The results were not statistically significant due to the high variability of the orchard soil samples.

DISCUSSION

The data trends supported our hypotheses but no results were statistically significant.

Understanding the spatial accumulation patterns of SOM in orchards will inform planting schemes that optimize sequestration of atmospheric carbon.

A nut tree orchard has been proposed to be planted near the Adam Joseph Lewis Center of Oberlin College. To maximize the use of this orchard as a carbon sink, we recommend the following modifications to our study in future analyses:

- collect a greater number of samples in the analyzed tree groups
- resample different areas of the Oberlin orchard
- collect samples around trees of differing ages and species
- collect samples from an orchard with a different planting scheme.

WORKS CITED

[1] Chapin, F. S., P. A. Matson, and H. A. Mooney. 2002. Principles of terrestrial ecosystem ecology. Page 124. Springer Science+Business Media, LLC, New York, NY.

[2] Dick, P. Richard, David R. Thomas, Jonathan J. Halvorson. (1996) Standardized methods, sampling, and sample pretreatment. Methods for Assessing Soil Quality. Soil Science Society of America, Inc. Madison, Wisconsin.

[3] IPCC. 2007. Summary for Policymakers. *In* S. Solomon, D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M.Tignor and H.L. Miller (eds). Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

[4] Nelson, DW, and Sommers, LE. 1996. Total Carbon, Organic Carbon, and Organic Carbon. Pages 961-1010 *in* J.M. Bartels, editor. Methods of Soil Analysis Part 3- Chemical Analysis. Soil Science Society of America, Inc., American Society of Agronomy, Inc, Madison, Wisconsin, USA.

[5] Rutter, P.A. 1990. Woody agriculture: increased carbon fixation and co-production of food and fuel. Paper presented to the World Conference on Preparing for Climate Change, Cairo, Egypt, December 1989. The Climate Institute, Washington DC.