Surface Respiration in Developed, Forest and Park Landscapes of The Morton Arboretum

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Introduction

Due to disruptions in the carbon cycle, atmospheric CO_2 is on the rise. Surface respiration is one of the main sources of atmospheric CO_2 and is influenced by land use and change. Urbanization is rapidly increasing and more land is being altered to meet the needs of an increasing human population. Understanding and monitoring surface respiration and its drivers will help us better understand how urbanization may alter the carbon cycle. Primary controls on surface respiration include: vegetation and incoming litter; decomposers like earthworms and microbes; and, soil properties like texture, temperature and moisture. The objective of this study was to characterize the small-scale variability of surface respiration in three different land uses (park, developed, and forest) in The Morton Arboretum. These landscapes represent major types of land use and change associated with urbanization.

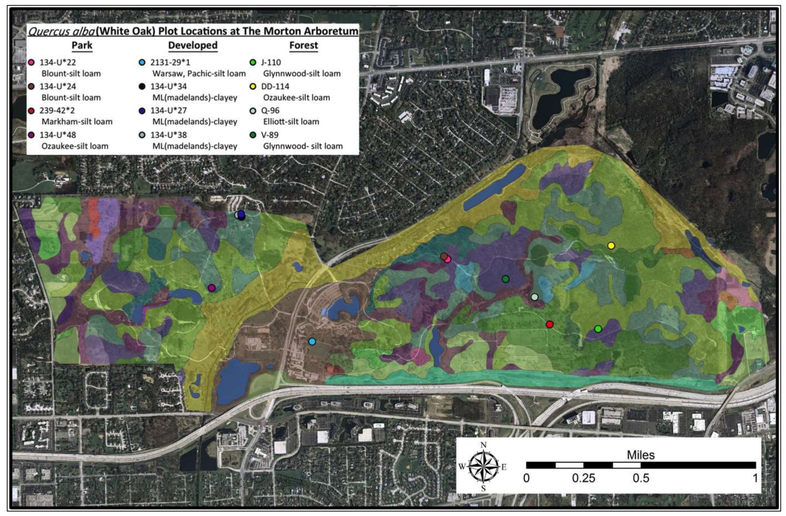

Figure 1. The Morton Arboretum soil map printed from ArcGIS. Plots marked by tree ID for park and developed, and grid map tree location for forest. Soil types given for plot locations.

Figure 2. White Oak (*Quercus Alba* 239-42*2) 4 m^2 plot.

Figure 3. Surface respiration with Licor 8100A.

Figure 4. Christina collecting earthworms from a 25 cm^2 plot.

Methods

Our study included 12 randomly located plots in each of three landscapes (developed, forest and park) at The Morton Arboretum (Fig. 1). Each plot was 4 m^2 surrounding the base of a *Quercus alba* tree (Fig. 2). Weekly measures were made at two 1 m^2 sub-plots (1 m from the tree base, 180° apart):

- Soil respiration - 8"x 4" SDR 35 sewer pipe Soil Collars placed 3 cm above soil surface in the center of each 1 m^2 with Licor 8100A (Fig. 3)
- Soil moisture, soil temperature – Licor 8100A probes were places 10 cm from the collar at a depth of 5.6 cm
- Leaf litter-collected in a 1 m^2 frame, dried 1 week, weighed with a scale

Earthworm data was collected during the first and last week of the research:

- 20g of Hot Mustard powder mixed in 50mL of water placed overnight in sealed canning jars, mixed with 2.5L of water right before extraction (Fig. 4)
- 25 cm^2 fiberglass lawn edging frame was placed 5 cm into the ground
- After 10 minutes poured mixture into frame until pooling, repeating every 4 minutes until solution was gone. Worms were collected, placed into jars during this time and during the 10 minutes after the last of the solution soaked in
- Earthworms were placed in a refrigerator overnight, cleaned, identified using a dissecting microscope and measured

Statistical analyses were conducted with R using one-way ANOVA. We also used Pearson's product moment to investigate correlations in the data.

Results

We found significantly greater surface respiration in park and developed sites compared to forest sites (Fig. 5 and Tab. 1). No differences were detected for soil moisture or temperature among the sites (Tab. 1). Leaf litter was greatest in the developed sites (Tab. 1). The park sites had the highest density and mass of earthworms (Tab. 1). Surface respiration was positively correlated with soil temperature (R=0.41), leaf litter (R= 0.30) and total earthworm biomass (R=0.49) (data not shown).

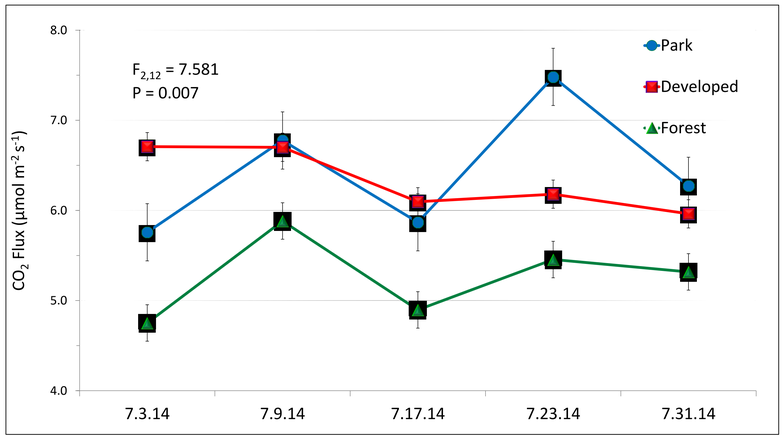

Figure 5. Mean surface CO^2 flux in developed, park and forested landscapes at The Morton Arboretum.

Table 1. Means of surface respiration, soil temperature, moisture, leaf litter, and total anecic, endogeic and epigeic earthworms in developed, forest, and park landscapes at The Morton Arboretum.

Variable	Developed	Forest	Park	P value
CO_2 Flux (µmol m^{-2} s^{-1})	6.33	5.26	6.43	0.007
Soil temperature (°C)	19.2	19.3	19.6	0.179
Soil moisture (%)	36.0	39.0	39.0	0.353
Leaf litter (Dry Mass g m^{-2})	3.12	2.07	1.29	0.018
Total earthworms (#) & (g m^{-2})	11.13 18.76	12.50 27.25	19.75 32.87	0.456 0.576
EW-anecic (#) & (g m^{-2})	5.00 15.05	2.75 12.48	6.63 22.77	0.536 0.641
EW-endogeic (#) & (g m^{-2})	6.25 3.45	3.38 2.96	10.13 3.82	0.302 0.902
EW-epigeic (#) & (g m^{-2})	0.38 0.27	6.38 11.81	3.00 6.29	0.142 0.155

Conclusions

- Overall, we found surface respiration to be greater in developed and park landscapes compared to forested sites at The Morton Arboretum.
- We suspect surface respiration is lowest in the forest, because these soils are less disturbed and buffered by the forest canopy cover.
- We expected to find larger litter layers in the forest also litter layer, which might also protect soil carbon and lead to lower surface respiration.
- Further research is needed monitor these parameters throughout the year and across more sites to give us a better understanding of the carbon dynamics of the landscapes of The Morton Arboretum.
- If our results hold true throughout the year, we may conclude that deforestation is leading to an increase in surface respiration.

Acknowledgements

I would like to The Morton Arboretum – Center for Tree Science for this great research opportunity. I would especially like to thank Margaret Bialecki and Dr. Bryant Scharenbroch for their wisdom and guidance; Christine Carrier, Dr. Andrew Schnabel and Dr. Deborah Marr for their support; Matthew Casali for his help making the arboretum soil map in ArcGIS ; and Erick Desotelle for his field assistance.

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