If a tree stands in the woods: Stem mapping and soil respiration

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**Introduction:**

There is more carbon held in the soils of the earth than in any other portion of the earth’s biosphere (Frey et al., 2013). The earth’s soils are not only carbon sinks, but they are also actors in a massive carbon exchange with the earth’s atmosphere. It is estimated that about 10% of all atmospheric CO­2 passes through the earth’s soil each year, more than is released by the burning of fossil fuels (Raich and Tufekciogul, 2000). It has been shown that increasing temperatures increase microbial soil respiration (Frey et al., 2013). The importance of such a large carbon sink cannot be underestimated with the threat of rising temperatures.

The composition of plants in an ecosystem greatly affects soil respiration (Levy-Varon, Schuster, and Griffin, 2012). The dominant species will define the soil respiration. Coniferous forests have about 10% less soil respiration than their broadleaf counterparts (Raich and Tufekciogul, 2000). Fungal communities go hand in hand with plant communities. One cannot exist without the other. The two major types of mycorrhizal fungi interact differently with their hosts. The most common type is Arbuscular Mycorrhizae (AM). AM fungi penetrate the cell walls of their plant host in order to mutualistically exchange nutrients. AM fungi are present in most plants that form mutualistic relationships with mycorrhizae such as Sugar Maples, *acer saccharum,* and Red Maples, *acer rubrum* (Phillips, Brzostek, and Midgley, 2013). AM fungi has also been found to promote the activity of decomposers in the soil by providing an easily accessible source of carbon (Bardgett, Mommer, and De Vries, 2014). Ectomycorrhizal (ECM) fungi are much less common. ECM fungi form sheaths around the roots of their host plant. They do not penetrate the cell walls of the plant but weave between the root cells to exchange nutrients. ECM fungal symbiosis is very common among birch and beech trees (Phillips, Brzostek, and Midgley, 2013). When interacting with the surrounding soils, ECM fungi will outcompete microbial decomposers for nitrogen which slows down decomposer activity (Bardgett, Mommer, and De Vries, 2014).

The Multiple Element Limitation in Northern Hardwood Ecosystems (MELNHE) project focuses on how nutrient addition, mainly nitrogen and phosphorous, will affect northern hardwood forests. Many of the MELHNE projects experimental stands at Bartlett Experimental Forest, Hubbard Brook Experimental Forest, and the Jeffers Brook Experimental Forest have both AM and ECM trees.

**Objectives and Hypothesis:**

 The first main objective of this project will be to produce an accurate map of all trees with a Diameter at Breast Height (DBH) >10 cm in the old aged plots at Bartlett Experimental Forest. The second main objective of this project is to determine how soil respiration is affected by the tree species composition in the surrounding soils. The plots which are dominated by trees with Arbuscular mycorrhizae (AM), like sugar and Red maple, will have a higher rate of soil respiration than those plots dominated by trees like birch and beech which have ectomycorrhizal (ECM) fungi. This increase in respiration would likely be due to the tendency of AM fungi to promote microbial activity in soils which in turn promotes turnover of plant-derived carbon (Phillips, Brzostek, and Midgley, 2013; Bardgett, Mommer, and De Vries, 2014).

**Methods:**

 The alphanumerically classified stakes in each plot were carefully measured in past years and their coordinates have been recorded in UTM coordinates. All trees with a DBH >10 cm in diameter in stands C7, C8, C9, Jeffers Brook Old, and Hubbard Brook Old will be located and, if untagged, given a tag with a unique identifier. The location of each tree with a DBH >10 cms will be determined relative to the lowest alphanumerical stake in each subplot. A hypsometer or rangefinder will be placed at the lowest alphanumeric stake in each subplot and will measure the distance between the stake and the tree. The angle of the tree from true north will be taken on a compass adjusted for declination. These relative tree coordinates will be used to triangulate the position of the tree in UTM coordinates. Any trees with a DBH lower than 10cm are not considered permanent members of these plots. Although a quick species inventory and diversity survey of trees with a DBH <10cm will be conducted to ascertain whether or not the trees with a DBH >10cm in diameter are representative of the entire tree population in the plot.

 The UTM coordinates for each tree will be entered into QuantumGIS (QGIS) and overlaid onto a map of the plot stake points. This data can be compared to inventory and stem mapping data from previous years.

**Expected Results:**

 It is expected that there will be more trees in the >10cm DBH size class. There will likely be a difference in soil respiration between each plot and each stand. Inter-plot differences will likely be largely affected by the nutrient addition treatment in each plot. Previous studies have shown that Nitrogen addition reduces soil respiration, therefore it is expected that no matter the dominant tree species, nitrogen addition plots would have lower respiration (Fisk and Fahey, 2001). Between stand difference will likely show a trend towards increased soil respiration in stands dominated by AM species like sugar maples and red maples.

**Implications:**

 The difference of the trees between the 2014 stem mapping initiative and the data that will be collected this summer will be important in measuring growth and the change in the MELNHE stands. If there is a difference in soil respiration rates between stands with different dominant mycorrhizae types, this will shed light on a new facet of soil respiration science. It will also open an avenue for studies of a broader scope to determine whether this difference in respiration is due to the mycorrhizae or to a difference in the microbial community. The results discovered will allow ecosystem scientists to produce more accurate ecosystem models. These more accurate models would be able to give insight into how Northern hardwood forests will react to warming temperatures. Since microbial respiration in the soil increases with warming these models will provide a more accurate view of how much carbon will be released from the soils as temperatures warm (Frey et al., 2013).

**References:**

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