TERRESTRIAL ECOSYSTEM FUNCTION DATA ANALYSIS LAB REPORT

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**Abstract**

Background research has previously concluded that CO2 is continually being cycled between the atmosphere and terrestrial ecosystems. Normally the main biological carbon fluxes occur from photosynthesis, autotrophic respiration and heterotrophic respiration. The majority of heterotrophic respiration is due to soil microbes which include bacteria and fungi. The specific objective of this experiment was to analyze the measurement of soil carbon stocks and fluxes in different land types. We tested different ecosystem types on NATL in the University of Florida. The different ecosystem types were the Forest, the Old Field, and the Lawn. The hypothesis was that the Lawn would have a higher soil average carbon stock, due to soil microbial activity, and the Forest would have the highest above ground biomass, since that area would be susceptible to an abundance of leaf litter. The methods we used included a chamber and infrared gas analyzer (IRGA) to measure the soil stocks and fluxes and an analytical scale to measure the above ground biomass. Microsoft Excel was also used to do final calculations on the rate of increase on CO2 concentrations in the chamber for the areas. It was concluded that there was no absolute correlation between above ground biomass and soil carbon stocks and fluxes that was measurable.

**Keywords**

CO2 exchange, CO2 fluxes, Carbon Cycle Components, Terrestrial Carbon Stocks and Fluxes, NATL of University of Florida, Above Ground Biomass

**Introduction**

The purpose of this experiment was to quantify how land use affects above ground biomass carbon stock, belowground soil respiration, and residence time of the belowground carbon pool. We concluded that the Lawn would have the highest carbon stock because it has an increase in soil microbial activity. The Forest should have the most aboveground biomass because it is a prime location for leaf litter. We also hypothesized that the Lawn would have the highest residence time because even though there is high soil microbial activity there is not a lot of contact with roots or fungi which greatly contribute to low residence times/turnover rate.

**Methods**

**Soil respiration methods**

In this experiment will estimate soil CO2 flux along a 50 m transect in each of three land uses: lawn, old field (~10-year old vegetation), and forest. To estimate soil CO2 flux, we will take measurements with a soil respiration chamber / IRGA system at five points (each in the middle of a 10 m interval, as in the figure below) along each transect. Because we want to measure soil respiration, we will clip and remove any aboveground plant biomass from the ground surface before positioning the chamber. We will also keep some of this biomass and use it to estimate aboveground C stocks.

When we analyze these data, we will treat each sample along the transect as a replicate. We will use the chamber and infrared gas analyzer (IRGA) to measure the soil respiration. Instructions on how to use the machine are located in its instruction manual.

**Aboveground biomass methods**

We will use the same 50 m transects described above to estimate aboveground biomass in the lawn, old field, and forest as follows:

**• Lawn and old field**: We will clip the aboveground live biomass within a 25 cm × 25 cm quadrat (625 cm2) at the center of each 10 m interval (same 5 locations as soil respiration sampling; see figure above). If any plants are present that are too large to clip, record their DBH. We will then put all of the clipped biomass in a labeled bag, and take it back to the lab where it will be dried and weighed.

**• Forest**: We will inventory tree DBHs within a 4 m × 50 m transect and later combine these data with allometric equations to estimate tree biomass. For every tree in the 4 m × 50 m transect with a DHB > 2.5 cm, record its DBH and if it is a pine or a hardwood. Later, when we analyze the data, we will use separate allometric equations for pines vs. hardwoods. Trees account for nearly all forest biomass, so it is not necessary to collect, dry, and weigh the clipped biomass (as we did in the lawn and old field). It **is** still necessary to clip and remove biomass from the area where the soil respiration chamber will be placed, so that no aboveground respiration contributes to the soil flux measurements.

Once the areas are measure we will use the data to calculate carbon soil fluxes. We accomplished this using the following steps:

**Calculate the rate of increase of CO2 concentration in the chamber.** For each sampling point (5 per transect), a linear regression of CO2 concentration (ppm) vs. time (0 to 120 seconds in 20-second increments) would provide a slope (ppm sec−1), which is the rate of change of the CO2 concentration. Your TA will show you how to quickly calculate a slope for each sampling point.

**Use the ideal gas law (PV = nRT; see box below) to calculate the number of moles of air in the chamber.** We will use this result to convert the slopes (from Step 1) from units of concentration to absolute amount.

**Convert the units of the slopes (Step 1) to absolute amounts.** For each soil respiration sampling point, multiply the slope (from Step 1) times the number of moles of air in the chamber (from Step 2) to yield the rate of CO2 increase in the chamber (μmol CO2 sec−1). Note that ppm units (number of CO2 molecules per million air molecules) are equivalent to μmol CO2 / mol air. Therefore, multiplying the slopes from Step 1 (μmol CO2 / mol air / sec) by the result from Step 2 (mol air) yields units of μmol CO2 sec−1.

**Convert the result from Step 3 to ha−1 units.** Although we have ignored area units until now, the ground area under the chamber is 531 cm2. So the actual units for the fluxes calculated in Step 3 are μmol CO2 / 531 cm2 / sec. To convert from cm−2 to ha−1 units, see the box below on Useful Conversions.

**Convert from units of** μ**mol CO2 to mg C** by first multiplying your result from Step 4 by (1 mol / 106 μmol) to convert to moles, then multiplying by (12.011 g C / mol CO2) to convert to g C, and finally multiplying by (1000 mg / g) to convert to mg.

**Convert to different time and mass units.** To practice converting units, you should also convert your results from Step 5 (mg sec−1) to g day−1, kg yr−1, and Mg yr−1 (1 Mg = 1 metric ton = 103 kg = 106 g).

**Results**

In Figure 1.1 the measurements of the soils carbon flux concluded that the Lawn had a higher soil carbon average MgC/ha/yr than the Old Field and the Forest.

In Figure 1.2 the above ground biomass measurements concluded that the Forest had more ton/ha than the Old Field and the Lawn. The Old Field had almost as much above ground biomass as the Forest. We can hypothesize that leaf litter entered the field possibly through wind through the Forest. The Forest of course had more above ground biomass since it is a prime location for leaf litter.

In the Table 1.3 the table summarizes the Soil C and Soil C flux, and the mean residence time in years in three different ecosystems in NATL in the University of Florida. The Lawn has the highest mean residence time and the Old Field has the lowest residence time. We can hypothesize that the Old Field has the lowest residence time because there is a lot of soil microbial activity as well as wildlife activity that will help the turnover rate. The Lawn is exposed so it would be hard for wildlife to improve its residence time.

**Discussion**

Our results concluded that the Lawn had the most soil carbon flux, the Forest had the most aboveground biomass, and the Lawn had the highest residence time. The data does prove our original hypothesis. We had hypothesized that the Lawn would have the most soil carbon flux because it seemed like the area with the most microbial activity. It seemed to look like this because it was an open area with exposed grass that was susceptible to high concentrations of microbes. Figure 1.1 shows the average soil carbon fluxes for the three areas. The Forest was hypothesized to have the highest aboveground biomass because the Forest has the only location that could development leaf litter naturally. Our hypothesis for the Forest was proven to be true as depicted in Figure 1.2. The Lawn was also hypothesized to have the longest residence time since there seemed to be a lack of fungi and availability of decomposers to shorten the residence time of carbon. Figure 1.3 displays the average residence times as calculated by the ANOVA Excel computations.

If we were to calculate the how much total carbon could be potentially stored in the whole state of Florida I added the average of the Lawn, Old Field and the Forest and timed it by the land area. The total carbon would be around 700,000 MgC/ha/yr. The aboveground biomass would be around 164,000 MgC/ha/yr. The difference, which is 536,0000 , would be the below ground biomass. Converting these lands into agriculture land would cause a huge amount of carbon to be released into the atmosphere. The agriculture land would also naturally develop carbon sinks, but it would not be enough to retain the carbon amount that is currently in the landscapes.

It would be detrimental if forests and lawns are converted into agricultural land. Lawns hold a large amount of soil carbon flux, so removing the lawns would lead to areas where carbon pools would be lessened. It would also cause a surplus of carbon to be released into the atmosphere if forests were removed for agriculture. Forest can contain relatively high amounts of soil carbon fluxes, high above ground biomass, and contribute to high residence times. The biodiversity of the forests and lawns would be drastically reduced. The animals in the forests would have to relocated, and normally when animals have to relocate very quickly their mortality rate increases. Insects would also suffer because they have mechanisms that allow them to come back to certain locations for food, and if those locations were to disappear they would have to spend more energy into locating new food sources. Plant diversity would lessen as well because not many wild plant species can be found in an agricultural area. As mentioned in the peer reviewed article “The effects of 11 yr of CO2 enrichment on roots in a Florida scrub-oak ecosystem”, the carbon flux exchange rates between fine root biomass and aboveground biomass is very important for the overall enrichment of the forest area.

**Acknowledgments**

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**Literature Cited**

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**Tables and Figures**

Figure 1.1- The soils carbon flux concluded that the Lawn had a higher soil carbon average MgC/ha/yr than the Old Field and the Forest.

Figure 1.2- The above ground biomass concluded that the Forest had more ton/ha than the Old Field and the Lawn. The Old Field had almost as much above ground biomass as the Forest.

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| Table2 |  |  |  |
|  | Soil C stock (kgC/m^2) | Soil C flux | Mean Residence Time (yr) |
| Lawn | 3.7 | 1.547 | 2.39 |
| Old Field | 2.2 | 1.65 | 1.33 |
| Forest | 3.5 | 1.746 | 2.00 |

Table 1.3- The table above summarizes the Soil C and Soil C flux, and the mean residence time in years in three different ecosystems in NATL in the University of Florida. The Lawn has the highest mean residence time, which the Old Field has the lowest residence time.