Immediate response mechanisms to account for sustained tree growth following intensive biomass removal on Long-Term Soil Productivity (LTSP) sites

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Rationale

Using alternative sources of energy, such as forest residuals, are essential for America's energy independence; can intensive forest management remain productive while also harvesting residual biomass for fuels conversion?

Soil porosity and organic matter (OM) are two important factors that regulate biogeochemical processes and thus long-term soil productivity. These factors are impacted by the degree of compaction and organic matter removal.

In order to elucidate the mechanisms driving sustained productivity it is necessary to have a thorough understanding of the physical changes to the soil system.

QUESTIONS & HYPOTHESIS

The focus of this study is to examine the role of the O-horizon (including forest harvest residuals) in regulating soil physical and biologic processes.

Q1: What is the role of the O-horizon in moderating soil moisture and temperature in the soil profile?
H1: The O-horizon, and residual slash, act as a barrier from solar energy and can limit the amount of water that infiltrates the profile. Due to direct solar radiation and precipitation inputs, treatments with less residual organic matter will be warmer and have higher total moisture content throughout the profile.

Q2: What is the role of compaction in regulating temperature and moisture in the soil profile?
H2: Soil compaction increases bulk density and decreases total soil porosity. As a result of limited pore space, we expect compacted treatments to have higher soil moisture and temperature in the soil profile.

Q3: What is the role of soil temperature & moisture in regulating heterotrophic activity?
H3: Changes in soil moisture/temperature generally produce non-linear responses from biotic activity. We posit the treatments that are warmer and have more moisture will have higher heterotrophic respiration, also that maximum temperatures will be important drivers of these processes.

SUMMARY
Direct solar radiation and direct raindrop impact on the soil surface will increase soil temperature and moisture throughout the profile. This may promote a favorable environment for microbial activity leading to increased heterotrophic respiration. Eventually, mineralizing more nutrients for plant uptake producing an apparent resilience in tree growth following intensive biomass removals.

INITIAL RESULTS

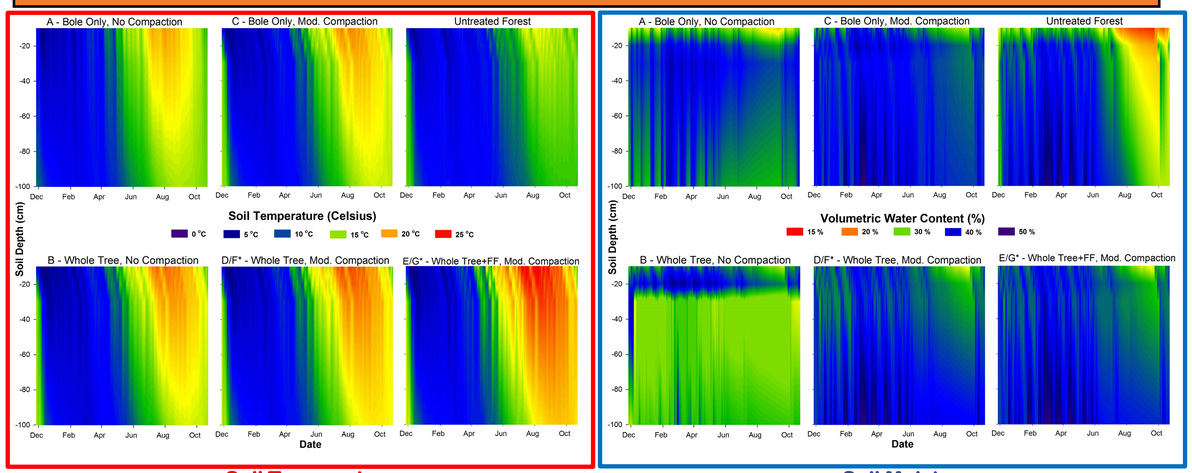


Figure 1A and 1B. Decagon soil temperature/moisture data at four depths (10, 20, 30, 100cm) at hourly intervals from December 2013 to October 2014. Soil moisture appears to be much lower in the untreated forest, however treated plots do not appear to differ. There appears to be significant trends with soil temperature and organic matter removal treatments. Figures produced with SigmaPlot v12.5.

METHODS

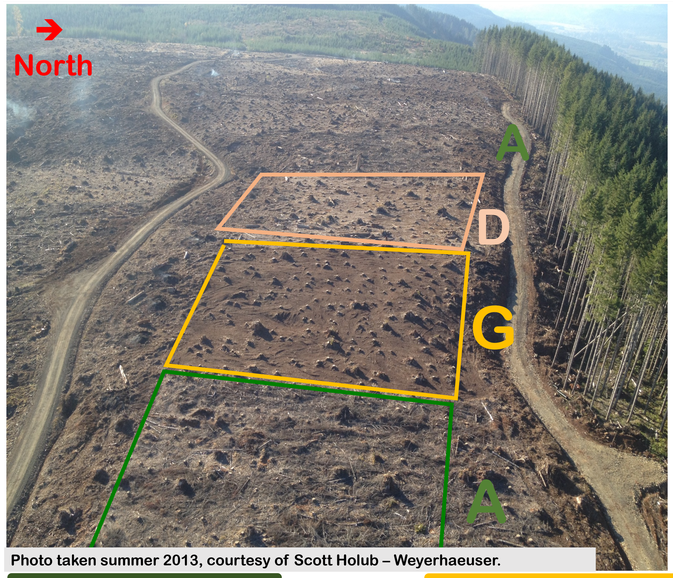


Photo taken summer 2013, courtesy of Scott Holub – Weyerhaeuser.

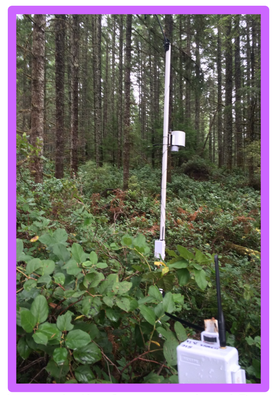
	No Compaction	Compaction	
Bole Only	A	C	Untreated Forest
Total Tree	B	D, F*	
Total Tree + Forest Floor	Not Conducted	E, G*	

In the summer of 2013 treatments were installed on Weyerhaeuser's Springfield tree farm as a LTSP affiliated site east of Eugene, OR. These treatments are not meant to be operational, they are only to provide end members allowing researchers to interpolate the effects of severe biomass removal.

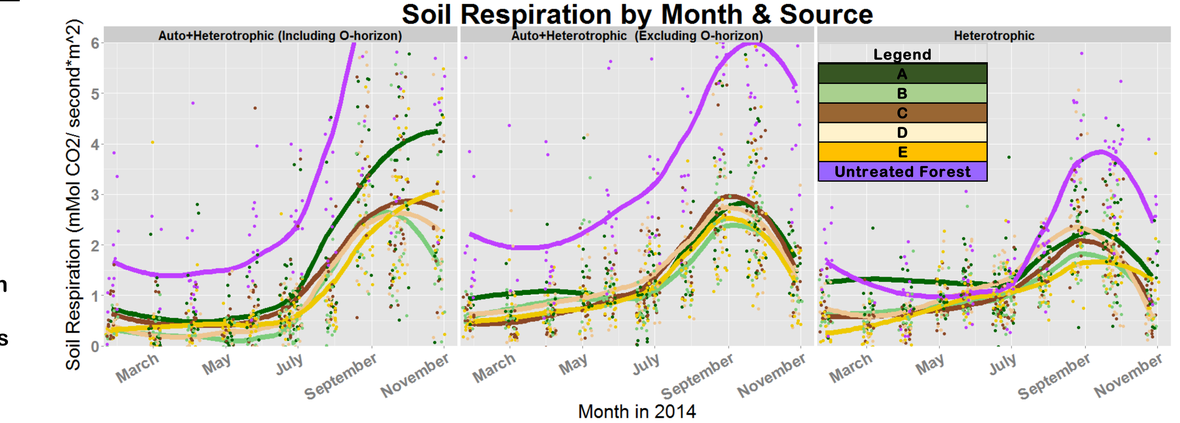
Each treatment has four replicate plots, each an acre in size on similar slopes (5-20%), aspect (140-240° south), and soil characteristics (coarse fragment %, C/N, depth, etc…).

Decagon data logger connected to soil moisture/temperature probes at 10, 20, 30, & 100cm depth. Air temperature and relative humidity also at 15cm above mineral surface. Data collected hourly on all plots. **Treatment A.**

LiCOR (yellow) infrared-CO_2 device placed on a PVC collar (white). Soil moisture probe (grey) and soil temperature probe (purple) used for each observation. Data collected monthly, on nine known locations per plot. Efforts were also made during summer to identify a diurnal pattern in soil respiration. **Treatment E.**



Decagon data logger in the foreground and Decagon weather station including an anemometer, solar radiation, leaf area wetness, relative humidity, air temperature, relative humidity sensors and a tipping bucket rain gauge. Data collected on the treated and reference stand every hour. **Untreated forest stand.**



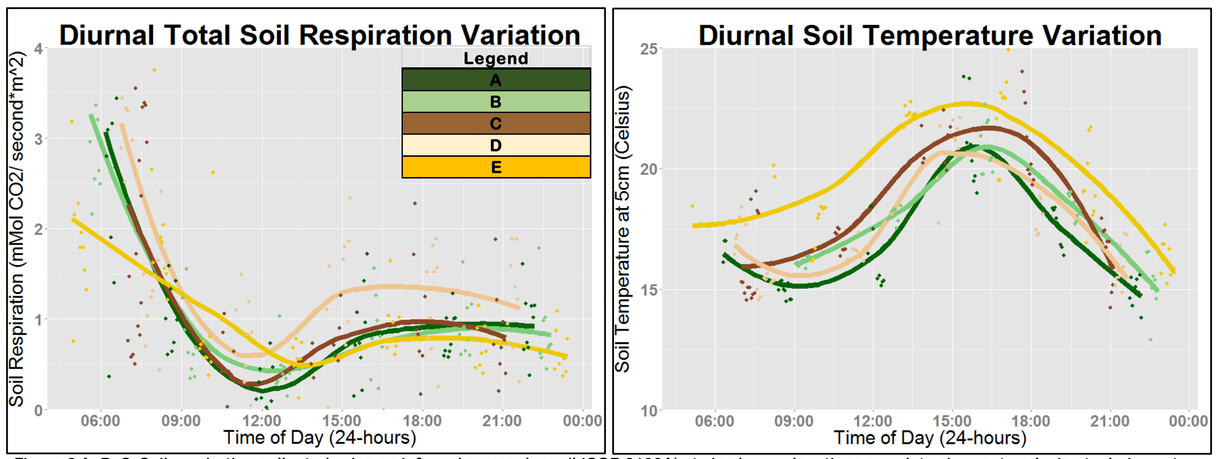


Figure 2 A, B, C. Soil respiration collected using an infrared gas analyzer (LiCOR 8100A) at nine known locations per plot using root exclusion techniques to partition auto/heterotrophic respiration. Observations are performed monthly (Fig. 2A), with the addition of two diurnal explorations in the summer of 2014 (Fig. 2B/C). Treated and untreated plots display similar trends on the seasonal scale (Fig. 2A). There is a severe lag in maximum soil temperature and maximum soil respiration over the diurnal period (Fig. 2B/C). Figures produced with RStudio v0.98 and the ggplot2 package.

Future Work

Throughfall collectors and zero-tension pan lysimeters are installed beneath the O-horizon/forest residuals and are analyzed for dissolved organic C/N and other cations. Density fractionation of soils will be performed to explore the dynamics of stable isotopes and biomarkers over two growing seasons.