Title: A community-based approach to understanding fungal and bacterial responses to wildfire

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Project Goals: In this work, we aim to dissect the effects of microbes (fungal and bacterial) on carbon (C) and nitrogen (N) dynamics in post-fire forest soils. Our conceptual framework is rooted in systems biology and ecology, while our experimental approach combines genomics, transcriptomics, metabolomics, microbial community profiling, stable isotope techniques, small scale fire systems (pyrocosms), tightly controlled methods for producing labelled pyrogenic organic matter (PyOM), and high-throughput monitoring of C mineralization rates. We have three major research objectives: (1) To determine how dominant post-fire soil microbes affect the fate of PyOM; (2) To assess the interaction between N availability and PyOM mineralization by post-fire microbial communities and individual pyrophilous microbes; (3) To define the network of microbial interactions that facilitate PyOM breakdown over time and the key genes involved in this process.

Abstract Text: Forest wildfires in the western U.S. have been increasing in both frequency and size with each decade since the 1970s (Westerling, 2016). Understanding the effects of wildfires on microbial communities is required to predict their effects on processes such as biogeochemical cycling and plant recovery post-fire. We took a complementary field-laboratory approach to understanding how microbial communities respond to fire, and to probe the mechanisms controlling the effects of PyOM additions on soil organic carbon (SOC) cycling (often referred to as "priming") in a Californian mixed conifer forest.

For the field study, we undertook extensive field sampling of two controlled-burn plots (one high and one low-temperature burn) in parallel with two unburned control plots. Analysis of both the fungal and bacterial communities indicates non-neutral processes (*e.g.*, selection) play a key role in structuring the post-fire microbial community. For the laboratory study, we worked with soil from the same site, that was burned during the 2014 King Fire, adding PyOM to isolate the effects of PyOM addition on microbial communities and SOC cycling. To better elucidate the mechanisms of PyOM-SOC interaction, we exchanged water-extractable fractions of PyOM from ^{13}C-labelled and unlabelled PyOM, produced from pine biomass grown in our custom labelling chamber and charred at 350°C and 550°C in our "charcoalator". This exchange of isotopically-labelled fractions allowed us to trace the water-extractable PyOM separately from the non-water-extractable fraction. We found that the water extractable fraction was the most mineralizable in both 350°C and 550°C PyOM compared to the SOC and non-water-extractable fraction. The mineralizability of the 350°C water-extractable PyOM fraction was higher than the

mineralizability of the 550°C water-extractable PyOM fraction. We observed short-term positive priming upon addition of 350°C PyOM to soil, most likely due to co-metabolism of easily mineralizable PyOM-C and the SOC. On the other hand, addition of 550°C PyOM to soil induced negative priming which could be attributed to the physical protection of SOC through sorption of SOC on the PyOM surface. We also examine the effects of PyOM additions on bacterial and fungal communities, and compare PyOM-responsive taxa with those identified in the field study.

References/Publications

Westerling ALR. 2016. Increasing western US forest wildfire activity: sensitivity to changes in the timing of spring. *Phil. Trans. R. Soc.* B 371: 20150178.

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