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Rapid response of soil fungal communities to low and high intensity fire

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Contemporary fires have created high-severity burn areas exceeding historical distributions in forests in the western United States. Until recently, the response of soil ecosystems to high intensity burns has been largely unknown. In complementary studies, we investigated the environmental effect of extreme soil heating, such that occurs with the complete combustion of large down wood during wildfires, on soil fungi and nutrients. We used TRFLP and next generation sequencing (Illumina MiSeq) to investigate the fungal communities. During the burning of large down wood, temperatures lethal to fungi were detected at 0-cm, 5-cm, and 10-cm depths in soils compared to 0-cm depth in soils receiving low intensity broadcast burns. We compared the soil fungal diversity in ten high intensity burned plots paired with adjacent low intensity burned plots before and one week after at 0-10 cm soil depth. Non-metric Multidimensional Scaling (NMS) ordinations and analyses of taxon frequencies reveal a substantial community turnover and corresponding near complete replacement of the dominant basidiomycetes by ascomycetes in high intensity burns. These coarse-level taxonomic responses were primarily attributable to a few fire-responsive (phoenicoid) fungi, particularly Pyronema sp. and Morchella sp., whose frequencies increased more than 100-fold following high intensity burns. Pinus ponderosa seedlings planted one week post-burn were harvested after four months for EMF root tip analysis. We found: a) greater differences in soil properties and nutrients in high intensity burned soils compared to low intensity burned and unburned soils; b) no differences in EMF richness and diversity; and c) weak differences in community composition based on relative abundance between unburned and either burn treatments. These results confirm the combustion of large downed wood can alter the soil environment directly beneath it. However, an EMF community similar to low burned soils recolonized high burned soils within one growing season. Community results from both burn treatments suggest an increase in patchy spatial distribution of EMF. The importance of incorporating mixed fire effects in fuel management practices will help to provide EMF refugia for dry forest regeneration. Our studies highlight the strong and rapid fungal community responses to fires and differences among fires of different severities. We theorize that quick initiation of EMF recolonization is possible depending on the size of high burn patches, proximity of low and unburned soil, and survival of nearby hosts.