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Soil microbial communities vary with elevation and stand productivity in 27-yr-old postfire lodgepole pine forests of Yellowstone

Aisha K. Ba, Winslow D. Hansen, Monica G. Turner
Department of Zoology, University of Wisconsin, Madison, WI 53706

Background/Question/Methods

The frequency and size of high-severity forest fires are increasing across the US Rocky Mountains, expanding the extent of early-succession subalpine forests. Structure and function of young western conifer forests are not well studied but important to understand as their extent grows. Many forest ecosystem processes (e.g., carbon fluxes, nitrogen mineralization) are mediated by soil microbes, but how soil microbial communities vary in forests regenerating from fire remains poorly resolved. We sampled 27-yr-old postfire lodgepole pine (*Pinus contorta* var. *latifolia*) stands in Yellowstone National Park (Wyoming, USA) to ask: how do soil nutrients and soil microbial biomass and community structure vary with climate and stand productivity? We sampled 400-m^2 plots (n=20) using a 2x2 factorial design that crossed elevation (warm-dry low elevations and cool-wet high elevations) with stand-level aboveground net primary production (ANPP; low (2.2±0.5 Mg $ha^{-1}yr^{-1}$) and high (23.4±4.4 Mg $ha^{-1}yr^{-1}$)). In each plot, we collected soils within eight 1-m^2 quadrats using a 5-cm-diameter x 15-cm-deep soil core (n=160) and recorded understory cover. Soils were analyzed for total and inorganic nitrogen, extractable carbon, total organic matter, pH, and soil microbial biomass and community composition, measured by functional guilds. Effects of climate and stand productivity were evaluated with two-way ANOVAs.

Results/Conclusions

Microbial lipid abundance, a measure of total microbial biomass, was greater in stands of high vs. low ANPP (0.43±0.02 vs. 0.29±0.02 μmol/g soil) but did not vary with elevation. Fungal-to-bacterial ratio (an indicator of microbial-community stress) was greater at low vs. high elevations (2.2±0.09 vs. 1.5±0.08) and in stands of high vs. low ANPP (2.2±0.10 vs. 1.5±0.07). Indicators of soil-bacteria functional groups varied with ANPP but not elevation; e.g., the ratio of gram-positive to gram-negative bacteria (another indicator of community stress) was greater in stands of high vs. low ANPP (0.86±0.03 vs 0.71±0.20). Extractable soil carbon was double at high vs. low elevations (180±31 vs. 90±12 mg/kg soil) and in stands of high vs. low ANPP (172±31 vs. 98±18 mg/kg soil). Total percent soil nitrogen was greater at high- vs. low-elevation sites (0.15±0.01 vs. 0.11±0.013) but did not differ with ANPP. Our results suggest that high lodgepole pine ANPP, which is driven by early postfire lodgepole pine density, and warm-dry conditions increase stress on soil bacteria, and alter soil nutrient concentrations, particularly extractable carbon. Unraveling interactions among climate, postfire stand structure, soil microbes, and ecosystem processes could enhance understanding of subalpine forest dynamics.