ABSTRACT

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Nitrogen cycling in 25-yr old postfire lodgepole pine: Who controls whom?

Monica G. Turner[1], Timothy G. Whitby[1], and William H. Romme[2]

[1]University of Wisconsin-Madison and [2]Colorado State University

Background/questions/methods

The extent of young postfire conifer forests is growing throughout western North America as high-severity fires increase, making it important to understand structure and function in early seral forests. Chronosequence studies in lodgepole pine (*Pinus contorta* var. *latifolia*) indicate recovery of nitrogen (N) stocks 40-70 years postfire, but N-cycling studies during early decades of succession are few. We re-sampled lodgepole pine stands in Yellowstone National Park (Wyoming, USA) that regenerated naturally after the 1988 fires to ask: (1) How have lodgepole pine foliage, litter, and soil N changed from 15 to 25 years postfire? (2) How do N pools and fluxes vary with lodgepole pine density and productivity? (3) Does evidence suggest N limitation in 25-yr old postfire lodgepole pine? In 14 plots (0.25-ha) that varied in postfire tree density (1,500-344,000 stems ha^{-1}), we measured N concentrations and pools in lodgepole pine foliage, annual litterfall, and forest-floor litter; soil total N and annual inorganic N availability; and $\delta^{15}N$ of lodgepole pine foliage, litter, and soil. Over time, we expected foliar N concentrations to decrease, foliar N pools to increase, and soil N pools to decrease. Among stands, we expected positive relationships between lodgepole pine productivity and soil N.

Results/conclusions

Lodgepole pine foliar N concentrations (1.33 and 1.11%N in current-year and composite needles, respectively) did not change between postfire years 15 and 25, but forest floor litter N concentration increased by 25% to 0.82%N. All measured ecosystem N pools increased substantially. Total foliar N increased to 89 kg N ha^{-1} (+85%), forest floor litter increased to 39.4 kg N ha^{-1} (+38%), and soil N increased to 0.08% (+33%). Inorganic N availability also increased to 0.69 μg N g-resin^{-1} day^{-1} (+165%). Thus, soil N pools did not decline as live biomass N pools increased over time. Among stands, foliar and litterfall N concentrations declined with stem density and productivity, whereas the foliar N pool increased. Lodgepole pine productivity was negatively correlated with annual resin-sorbed N, and there was no evidence of widespread N limitation. Soil $\delta^{15}N$ values were positive and declined as soil total N increased; foliar $\delta^{15}N$ values were negative and increased with foliar N concentration. These results cannot be explained by atmospheric deposition or presence of known N fixers. Rather, N dynamics in these young postfire stands are consistent with recent reports of N fixation in young lodgepole pine and facultative N fixation in early seral forests following disturbance.