Soil organic matter cycling in novel and natural boreal forest ecosystems

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Abstract

The western boreal forest of Canada, where the upland regions are dominated by stands of aspen (*Populus tremuloides* Michx.) and spruce (*Picea glauca* (Moench) Voss), is now home to novel ecosystems, i.e.; ecosystems composed of reclaimed stands formed from trees planted on constructed anthropogenic soils. This study set out to determine if soils from these natural and novel ecosystems differed in terms of their biogeochemical functioning. Using a multi-faceted approach this study examined several ecosystem function variables linked to soil organic matter composition, microbial communities and nitrogen fluxes. A survey of 42 sites showed that soil *n*-alkanes, biomarkers of vegetation inputs, were more concentrated and had distinct signatures in natural compared to novel ecosystems. Mineral soils from reclaimed stands, natural aspen and spruce stands showed a distinct microbial community structure as was demonstrated using phospholipid fatty acids (PLFAs) as microbial biomarkers following addition of 13C-glucose in a laboratory incubation. Further probing by compound specific analysis (CSA) of the 13C-enriched PLFAs determined that microbial incorporation of 13C-glucose was different among soils. Solid-state nuclear magnetic resonance characterization of double-labeled (13C, 15N) aspen leaves and roots generated for tracer studies confirmed that isotopic enrichment across biopolymers and tissues was time dependent. In a subsequent field incubation, where the labeled aspen leaf litter was added to the forest floors of aspen and spruce stands, soil microorganisms maintained an active nitrogen cycle between fresh litter and live vegetation at both stands, yet

remained structurally distinct. However, CSA indicated overlap in the 13C enrichment of some PLFA biomarkers between stands. Finally, the addition of 15N labelled aspen leaf litter to reclaimed and natural forest stands demonstrated the importance of vegetation inputs not only as a source of nitrogen for growing vegetation but also as a way to improve soil moisture and soil microbial biomass on all sites. Cumulatively, these results not only enhance our understanding of organic matter cycling in natural and novel boreal forest ecosystems but, more importantly, they also provide results on conceptual ideas to guide future research.