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Anthropogenic deposition of heavy metals and phosphorus may reduce biological N2 fixation in boreal forest mosses

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A study was undertaken to test the effects of molybdenum (Mo) and phosphorus (P) amendments on biological nitrogen (N) fixation (BNF) by boreal forest moss-associated cyanobacteria. Feather moss (Pleurozium schreberi) samples were collected on five sites, on two dates and at different roadside distances (0–100 m) corresponding to an assumed gradient of reactive N deposition. Potential BNF of Mo and P amended moss samples was measured using the acetylene reduction assay. Total N, P and heavy metal concentrations of mosses collected at 0 and 100 m from roadsides were also measured. Likewise, the needles from Norway spruce trees (Picea abies) at different roadside distances were collected in late summer and analyzed for total N, P and heavy metals. There was a significant increase in BNF with roadside distance on 7-of-10 individual Site x Date combinations. We found no evidence of an N gradient across roadside distances; however, elemental analyses of feather moss and Norway spruce needle tissues suggested significant roadside gradients of heavy metals (Mo-Co-Cr-Ni-V-Pb-Ag-Cu) as well as P. The effects of Mo and P amendments on BNF were infrequent and inconsistent across roadside distances and across sites. One particular site, however, displayed greater concentrations of heavy metals near the roadside, as well as a steeper P fertility gradient with roadside distance, than the other sites. Here, BNF increased with roadside distance only when moss samples were amended with P. Also at this site, BNF across all roadside distances was higher when mosses were amended with both Mo and P, suggesting a co-limitation of these two nutrients in controlling BNF. In summary, our study showed a potential for car emissions to increase heavy metals and P, rather than reactive N, along roadsides. Our data further underscore the putative roles of these anthropogenic pollutants on BNF in northern latitudes.