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Local patterns of biological N fixation and N-to-P limitations along steep atmospheric deposition gradients

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A major challenge facing biogeochemists is being able to predict how environmental changes alter the functioning of forest ecosystems. In particular, atmospheric N deposition (AND) from fossil fuel combustion is fertilizing forest ecosystems worldwide at an unprecedented rate. While much attention has been paid to regional and continental-scale AND patterns, very little is known about local scale patterns resulting from human activities. For example, busy roads have recently been identified as hotspots for AND, with steep gradients occurring within 100–400 m margins along busy roadsides. It was previously found that such gradients along boreal forest roadsides correlated negatively with changes in biological N fixation (BNF) by moss dwelling cyanobacteria. Here, we present data from a recent experiment designed to answer specific questions regarding this phenomenon, namely: (1) Can AND lead to shifts from N to P limitation of BNF in mosses? (2) Can AND shift the stoichiometry of P and Mo (i.e. nitrogenase enzyme cofactor) limiting BNF in mosses? (3) Do roadside BNF patterns occur because of a down regulation in nitrogenase enzyme activity, or as the result of changes in moss biomass? (4) Do roadside AND and BNF patterns correlate predictably with the relative N-to-P limitation of trees? Preliminary results confirm that roadside BNF gradients are site specific, with moisture and light availability as major environmental controls. P-limitations of BNF were observed along roadside gradients on some sites, as were changes in spruce needle N and P concentrations. Decreases in BNF due to high AND may partly be due to changes in moss biomass. Collectively, our project provides important insights that improve our knowledge of site-specific stoichiometric gradients due to AND, which can be used to improve the precision of biogeochemical models required to predict ecosystem responses to global changes.