Do Nutrient Limitation Patterns Shift from Nitrogen Toward Phosphorus with Increasing Nitrogen Deposition Across the Northeastern United States?

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Atmospheric nitrogen (N) deposition is altering biogeochemical cycling in forests and interconnected lakes of the northeastern US, and may shift nutrient limitation from N toward other essential elements, such as phosphorus (P). Whether this shift is occurring relative to N deposition gradients across the northeastern US has not been investigated. We used datasets for the northeastern US and the Adirondack sub-region to evaluate whether P limitation is increasing where N deposition is high at two geographic scales, based on N:P mass ratios. Using a model-selection approach, we determined that foliar N for dominant tree species and lake dissolved inorganic N (DIN) increased coincident with increasing N deposition, independent of relationships between foliar N or lake DIN and precipitation or temperature. Foliar P also increased with N deposition across the northeastern US for seven of eight deciduous species, but changed less across the Adirondacks. Foliar N:P therefore declined at the highest levels of N deposition for most deciduous species across the region (remaining nearly constant for most conifers and increasing only for black cherry and hemlock), but increased across all species in the Adirondacks. Ratios between DIN and total P (DIN:TP) in lakes were unrelated to N deposition regionally but increased across the Adirondacks. Thus, nutrient limitation patterns shifted from N toward P for dominant trees, and further toward P for predominantly P-limited lakes, at the sub-regional but not regional scale. For the northeastern US overall, accumulated N deposition may be insufficient to drive nutrient limitation from N toward P; alternatively, elements other than P (for example, calcium, magnesium) may become limiting as N accumulates. The consistent Adirondack foliar and lake response could provide early indication of shifts toward P limitation within the northeastern US, and together with regional patterns, suggests that foliar chemistry could be a predictor of lake chemistry in the context of N deposition across the region.