Detecting foliar nutrient status of northern hardwoods from the sky

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Introduction

Airborne remote sensing of forests would improve efficiency of collecting tree-level information across a landscape, but understanding how this remotely sensed vegetation information relates to nutrient availability in forests is difficult without experimental nutrient manipulation.

Methods and analysis workflow

Since 2011, annual additions of N (as NH4NO3; 30 kg/ha/yr) and P (as NaH2PO4; 10 kg/ha/yr) have been added to 9 forested stands at the Bartlett Experimental Forest to study nutrient limitation. In August 2017 the Airborne Observatory Platform of the National Ecological Observatory Network collected data for all 9 * 4 = 36 nutrient treatment plots. Here we test the ability to distinguish four nutrient treatment classes in an N*P factorial design.

Results

1. Treetop spectra from nutrient plots were readily grouped into nutrient addition using linear discriminant analysis.
2. Field measurements of resin-available P (gray numbers) support linkages of above and below ground processes.
3. The average reflectance in the visible (400-700 nm) increased with P (p = 0.001) and decreased with N addition (p < 0.001).
4. The photochemical reflectance index (530+570)/(530-570) was higher with N addition (p = 0.02) indicating higher photosynthetic efficiency.

Discussion

The spectral properties of nutrient addition in these forests were readily predicted, suggesting unique spectral signatures associated with small-scale gradients in resource availability.

Airborne imaging spectroscopy shows promise for better informed forest management.

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