Detection of Sugar Maple Condition Using Ground-Based Indicators and Hyperspectral Remote Sensing

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A major objective of the ***Bioindicators of Forest Sustainability Project*** is to develop optical indices from hyperspectral remote sensing data that are linked with ground-based physiological bioindicators of forest condition. In June and July of 1998, twelve Sugar Maple (*Acer saccharum*) sites located in the Algoma region of Ontario were assessed by collecting leaves for physiological analysis and using a compact airborne spectrographic imager (CASI) to acquire hyperspectral data. Reflectance, transmittance, chlorophyll fluorescence, chlorophyll *a* and *b*, total carotenoids, total anthocyanins, and nutrient levels were measured in the laboratory for individual leaves from five trees per site. Crown cover and leaf area index measurements were measured for all plots. Thirty-two optical indices from the following four categories were tested: i) Visible ratios; ii) Visible/NIR ratios; iii) Red edge reflectance-ratio indices; and iv) Spectral and derivative red edge indices. Single leaf reflectance data, infinite reflectance data (calculated from optically-thick leaf simulation formulae), and canopy reflectance (CR) models were the three scales used to calculate the optical indices which are expected to progressively more closely represent the observed above-canopy reflectance spectra of the sites. Leaf level analysis indicated that various red edge and visible ratios had the best correlation with chlorophyll, total carotenoids, and chlorophyll fluorescence. Leaf nutrients Ca, Mg, Mn, and P were correlated with chlorophyll and total carotenoid levels at the leaf level. Canopy level analysis using CASI derived indices calculated from leaf-level relationships scaled up through CR models showed that red edge reflectance-ratio indices and spectral and derivative red edge indices were best correlated with chlorophyll, total carotenoids, and chlorophyll fluorescence.

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