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Remote spectral sensing of biological soil crust occurrence, Canyonlands National Park, USA

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Biologic soil crusts are important indicators of ecosystem health in arid and semiarid ecosystems. They reduce soil erosion and increase soil fertility by fixing organic C and N and biocycling mineral nutrients. Loss of the biological crust can be followed by soil loss and decreased ecosystem productivity. The species composition and degree of development of biological soil crusts vary with parent material, soil physical and chemical properties, and disturbance history. Therefore, remote sensing of biological crusts may be useful in digital soil mapping as environmental covariates and for soil and environmental assessments. The biological soil crusts in the Colorado Plateau region of North America are generally composed of cyanobacteria, lichen, and mosses. Cyanobacterial crusts contain phycobilin pigments, which along with chlorophyll-a, enable these organisms to photosynthesize. Unlike chlorophyll, phycobilins are not present in higher plants. Phycobilins increase reflectance in the blue spectral region (Karnieli et al., 1999), whereas chlorophyll has high reflectance in near infrared and absorbs radiation in red spectral regions. We hypothesized that these spectral properties can be exploited to predict the distribution of cyanobacteria-dominated biological soil crusts and facilitate the ongoing update soil survey project in the 137000-ha Canyonlands National Park, southern Utah, USA. A scaled model predicting biological soil crust distribution was developed for the Needles District of the Park based on the crust index suggested by Karnieli (1997), a normalized difference ratio of red and blue spectral regions, using Landsat 7 ETM+ data. The crust index map was evaluated qualitatively against digital color orthophotography, the Landsat-derived normalized difference vegetation index (NDVI), and ancillary data derived from digital elevation

models. The crust index had high values, presumably indicating high cover and/or degree of development of biological soil crusts, on stabilized sand dunes, in mid- to low-elevation sites where vegetation cover is lower, and on gentler slopes. Crust index values were low in disturbed areas which lacked biological soil crusts, higher elevation areas which normally have higher vegetation cover, and steeper slopes which are less stable. The crust index was not conclusively related to aspect. The crust index did not map the same features as the NDVI, indicating the utility of the crust index as a unique environmental covariate. We are currently validating the crust index with independent observations of crust, soil, and site characteristics made by the soil survey project team during the 2007 field season.