The Spatial Pattern of Transition (Spot): Linking Pattern, Process, and Scale to State-And-Transition Models

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Field implementation of conceptual state-and-transition models will benefit from explicit representations of spatial patterns of vegetation, soils and topography and the hydrological/eolian processes that link them. Here, we introduce the concept "spatial pattern of transition" (SPOT) as a means to understand the interrelationships and feedbacks among vegetation and soil spatial patterns, changes in those patterns over time, and the ecological processes governing that change. Patterns can vary with spatial scale and include vegetation patches in a matrix of bare ground or mosaics of alternative states or plant communities. Key concurrent processes include those affecting surface and subsurface hydrology, eolian transport, resource availability and plant response to stress and disturbance. We review the literature and our own work to establish general approaches to and insights from SPOT. First, we show that SPOT can be observed at multiple scales from remotely-sensed imagery and has been experimentally investigated and mathematically modeled. Second, we argue that SPOT is a consequence of three interacting factors: a) inherent, relative stable heterogeneity in soils, topography and geomorphology, b) disturbance processes such as grazing or fire, and c) feedbacks among plant attributes, surface soil properties, and material fluxes. Third, we show general classes of SPOT that are reliably associated with soil-geomorphic settings and climate zones. Finally, we demonstrate the consequences of SPOT for the development and practical use of state-and-transition models. In particular, we show that differences in SPOT influence (i) the scale at which state-and-transition models should defined, (ii) the ecosystem attributes we need to measure to define thresholds and monitor change, and hence, (iii) the appropriate spatial scale and frequency of observation.

2009. 62nd Society for Range Management Annual Meeting. Paper No. 06-11.