Case Study

Generalizing Ecological Site Concepts of the Colorado Plateau for Landscape-Level Applications

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On the Ground

- Numerous ecological site descriptions in the southern Utah portion of the Colorado Plateau can be difficult to navigate, so we held a workshop aimed at adding value and functionality to the current ecological site system.
- We created new groups of ecological sites and drafted state-and-transition models for these new groups.
- We were able to distill the current large number of ecological sites in the study area (ca. 150) into eight ecological site groups that capture important variability in ecosystem dynamics.
- Several inventory and monitoring programs and landscape scale planning actions will likely benefit from more generalized ecological site group concepts.

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The Colorado Plateau is an iconic landscape of the American West—containing dozens of national parks, monuments, historic sites, and several UNESCO World Heritage Sites—including some of the Nation's most recognizable landmarks, such as the Grand Canyon and the Arches National Park. The concentration of outdoor destinations has led to a rapid increase in recreational tourism on the Plateau—visitation to the Arches National Park has nearly doubled over the last 15 years.[1] Energy development (mostly oil and gas) has also accelerated in recent years, with a threefold increase in drilling rates in Utah between 2000 and 2008.[2] Agriculture has been an important activity in the region from the prehistoric ages to modern times, with irrigated agriculture carried out in locations with suitable soils and water and domestic livestock grazing (primarily cattle) occurring across the majority of the region.[3] Management of these co-occurring land uses are complicated by forecasts of a more arid and variable climate in the southwestern United States.[4]

Because of the variety of land-use pressures, extensive lands managed by federal and tribal entities, and concentration of areas of recreation and conservation concern (e.g., national parks and monuments), the Plateau has a large and diverse set of stakeholder groups—often with conflicting values and differing perspectives. Discussions among stakeholder groups regarding managing land uses and mitigating climate change impacts are often complicated by the large imprint of past land uses, droughts, highly heterogeneous landscapes, and disagreements about reference conditions and management objectives. Tools that clearly specify ecological potential and possible state changes should facilitate these discussions. These tools are made available to managers via the Natural Resources Conservation Service (NRCS) Ecological Site Descriptions (ESDs). As described earlier in this special issue by Bestelmeyer et al., the utility of ESDs could be improved by simplifying them for stakeholder groups interested in broader-scale interpretation of ecological information. One approach to ESD simplification is to group ecological sites into broader units and then construct state-and-transition models (STMs) and related interpretations for individual groups.

With the hope of improving ESD information to support stakeholder discussions, a group of scientists and managers with knowledge of existing ESDs (U.S. Geological Survey, Bureau of Land Management [BLM], National Park Service [NPS], Agricultural Research Service, the NRCS, and university and private consultants) met in April 2016 to develop Ecological Site Groups (ESGs) and to draft associated STMs for the Colorado Plateau. The focus of the

spatial scope of the workshop was on the Major Land Resource Area (MLRA) 35 within Utah (because of the existing data and experience), but allowed our work to extend beyond the MLRA 35 boundaries, where appropriate (Fig. 1). We limited our work to rangeland ecosystem types, including Woodlands but excluding Riparian and True Forestland types. Here, we report some of the outcomes of the workshop and follow-up analyses.

Landscape Attributes: Soils, Climate, Plant Communities, and Drivers of Change

The soil and geomorphic properties of the Plateau are strongly influenced by underlying geologic parent material, tectonic faulting, aeolian processes, and the relatively recent down-cutting by the Colorado River and associated drainages.[5] Geologic parent materials are predominantly sedimentary and include sandstones, silt/mudstones, limestones, and shales. Although well-known features of the Colorado Plateau are the exposed cliffs, rock outcrops, and thin soil deposits, landscape settings with deeper soil deposits tend to support plant communities that provide critical wildlife and livestock habitat (Grasslands and Shrublands). Key factors that appear to exert a strong influence on the distribution and resilience of Plateau plant communities include parent material salinity, mineralogy, and texture; landform; sand deposition; and soil depth.[6]

The Plateau is characterized as a cold desert ecosystem, with plant species assemblages adapted to low and variable precipitation, warm summers, and cold winters.[7] A strong gradient in summer (monsoonal)–winter (frontal) precipitation occurs, going from the southeast (~ 40% monsoonal) to the northwest (~ 20% monsoonal). Annual precipitation totals and average temperatures vary greatly across the region, mostly as a result of elevation, and both summer and winter precipitation are highly variable year to year.[7] This climate regime has resulted in a diverse plant community that is responsive to both cool season precipitation (often winter moisture stored in the soil profile) and summer monsoon events.[8] Plant communities comprise cool-season (C_3), warm-season (C_4), and succulent (CAM) functional types. Common Grassland species include Needle and Thread (*Hesperostipa comata* [C_3]), Indian Rice Grass (*Achnatherum hymenoides* [C_3]), James' Galleta (*Pleuraphis jamesii* [C_4]), Alkali Sacaton (*Sporobolus airoides* [C_4]), and Blue Gramma (*Bouteloua gracilis* [C_4]). Dominant shrub species include Big Sagebrush (*Artemisia tridentata* [C_3]), Blackbrush (*Coleogyne ramosissima* [C_3]), *Ephedra* species [C_3]), Shadscale Saltbrush

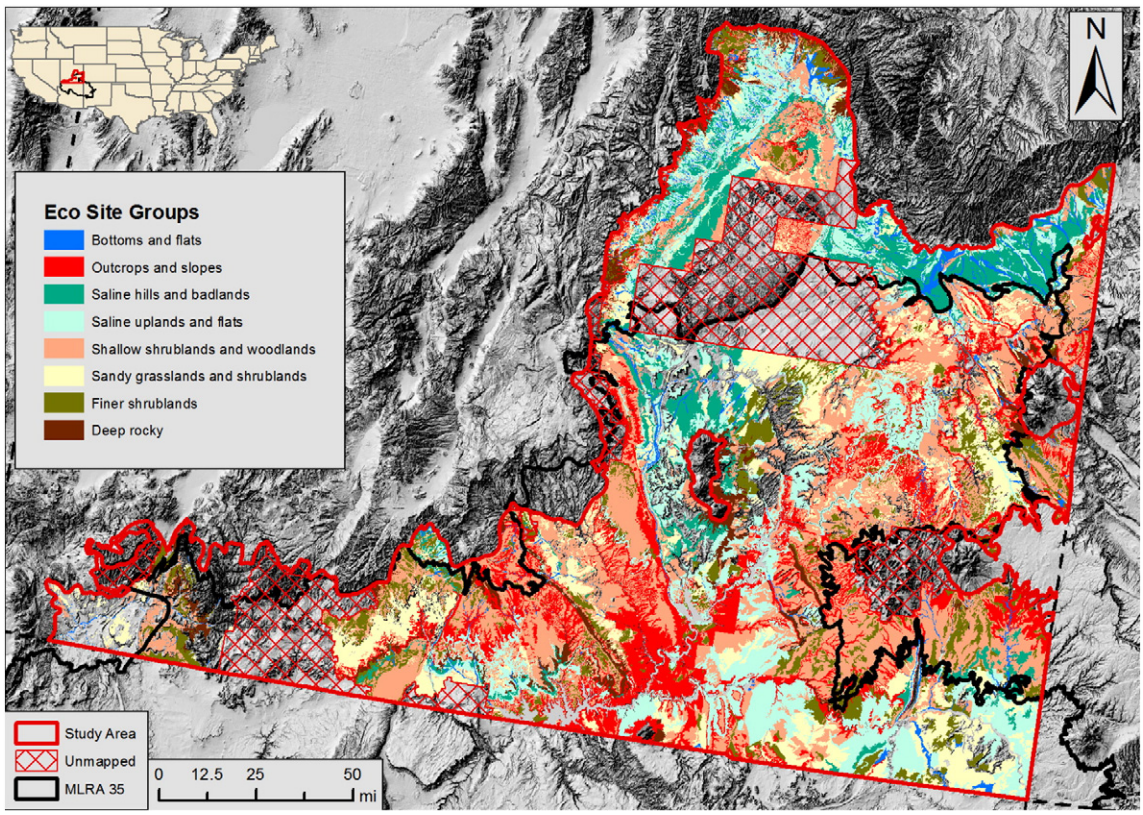

Figure 1. Map showing the study area used to query US soil survey geographic database (SSURGO) soil components *(thick red outline)*, and spatial correspondence to Major Land Resource Area (MLRA) 35 *(thick black outline)*. The study area was created by selecting Environmental Protection Agency (EPA) level 4 ecoregions, overlaying MLRA 35 within Utah, eliminating alpine and subalpine units, and then selecting SSURGO map units that overlapped highlighted ecoregions. Also shown are portions of study area where SSURGO has not been completed *(red crosshatch)*.