Soil Properties That Distinguish Ecological Sites

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Spokane, WA
January 31, 2012
Ecological Sites

Answer the questions: Why do sites across a landscape vary in kinds and amounts of vegetation? Why do sites differ in response to disturbance & management?
Ecological Sites & Soil Properties

- Within a climatic zone (e.g. MLRA), differentiation of ecological sites based on soil and landscape properties (not current vegetation)
  - Two areas that have same vegetation, not necessarily same site
  - Two areas that have different vegetation, not necessarily different sites
Ecological Sites & Soil Properties

• When dividing landscapes into ecological site units, we focus on those landscape and soil properties that control the inherent ecological potential.

• Properties that are relatively insensitive to common management & disturbance scenarios.
Soil Properties & Processes

Soil properties are features of a soil:
• e.g. soil texture, depth

Soil processes are a series of actions in the soil that bring about a result
• e.g. water percolating into the soil that determines soil water amounts.
Ecological Sites, Soil Properties & Soil Processes

• Although we use properties, it is the soil processes that are controlled by the properties that actually cause differences between ecological sites.

• Soil processes explain why ecological sites (and sometimes states) differ.
Measured relationships between soil properties and soil processes allow us to estimate soil processes given information on a set of soil properties and other variables.
Soil Properties That Distinguish Ecological Sites

• Primarily considering properties that have substantial control over four processes:
  – Soil water availability*
  – Soil nutrient availability
  – Plant rooting
  – Soil stability and redistribution

• These are the primary ecological mechanisms leading to differences in ecological potential
Soil Water Availability

Landscape Position → ? → Surface Soil Characteristics → Soil Profile

http://home.earthlink.net/~mplagens
Soil Water Availability

Landform and Landscape position

• Increased production where water and sediment collects, up to a point

Flooding 2 hours (2200 kg/ha of perennial grass)

Flooding 2 days (3900 kg/ha of perennial grass)

Flooding 2 weeks (0 kg/ha of perennial grass)
Soil Water Availability

Aspect:
South-facing aspects produce warmer conditions at the soil surface and increased rates of transpiration and evaporation compared with north-facing aspects.

South-facing  North-facing
Soil Water Availability

Surface texture: Sandy surface textures typically allow more rapid infiltration and less evaporation than clayey textures. Important in dry environments.

Sub-surface texture: Medium-textured (loamy) soils have greater plant-available holding water compared to very sandy and clayey soils.

*A sandy soil surface over a finer-textured horizon can improve water retention and productivity.
Soil Water Availability

Abrupt increase in sub-surface clay
Soil Water Availability

Surface coarse fragments
- Reduce infiltration capacity
- Can increase water capture

Sub-surface coarse fragments reduce water holding capacity.
Soil Water Availability

Water table depth
• Shallow water, woodland in the desert!
Soil Nutrient Availability

Differences in soil texture and mineralogy can cause important differences in plant nutrient availability.

- E.g. high amounts of gypsum in the soil profile tend to have imitations in mineral nutrients such as nitrogen, phosphorus, and potassium
- Few sites in west specifically related to nutrients availability
Plant Rooting

Depth to a root-limiting layer can determine the ability of different plant species to access water and other resources.

Restrictive horizons include
• petrocalcic (caliche)
• petrogypsic
• duripans
• fragipans
• bedrock
Plant Rooting

• Restrictive horizons stop or slow the elongation of roots and reduce the available rooting volume in the soil (i.e., “shallow” sites)

• Does not always correspond to reduced plant-available water
  • Several studies have illustrated the availability and utilization of water within rocks and rock-like soil

• Weathered granites (Jones and Graham, 1993)
• Limestones (Querejeta, J. I., et al. 2007.)
• Petrocalcics (Duniway et al. 2007)
Example from MLRA 42.2. Deep versus Shallow Sandy ecological sites, differing resilience to drought.
Plant Rooting

• The continuity of such horizons is also important.
  • Cracks and fissures can both trap water and facilitate access to water contained within the matrix of the restrictive horizon.
• Depth to the water table
  • Meadow sites
  • Florida
Soil Stability & Redistribution

- Erosion interrupts a plant’s ability to access resources
  - e.g. exposing roots or burying plants.
- Surface soils that form stable aggregates (clumps of soil particles glued together by organic matter or clay) are less erodible than non-aggregated soils.
Soil Stability & Redistribution

1970s-80s

2003

Sandy soils
(high erodibility)

Clayey soils
(low erodibility)
Soil Properties & Ecological Sites

- How do we go from a multivariate, continuum of soil properties to ecological site classes?
- How do we determine which soil properties and processes differ among ecological sites?
Soil Properties & Ecological Sites

• We observe relationships between soils and the plant communities occurring on them.
  – Inventory plant communities and soil properties within a climatic zone and look for statistical relationships among them.
  – Draw on research to infer the soil processes that occur and develop hypotheses about how those processes explain plant community patterns
### Soil Properties & Ecological Sites

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<th>Gravelly</th>
<th>Sandy</th>
<th>Loamy</th>
<th>Limy</th>
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<td>Petro-calcic</td>
<td>Calcic</td>
<td>Calcic w/ ~20% CaCO₃</td>
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<tr>
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*Four example from MLRA 42.2.*
Ecological Site Data Needs

• Where ES defined:
  – Refinement of soil surveys in areas with low precision mapping

• Where ES still in development (or refinement)
  – Soil property-plant community data sets (digital soil mapping)
Thanks!
Questions?
Comments?

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