Soils, Ecological Site Descriptions & State and Transition Models

Lecture Outline

• Soil function, quality and properties
• Soil surveys
• Ecological site descriptions
• State and transition models

What is Soil?

Foundation for Ecosystems

Soils & Ecosystems

Soil Functions  
Ecosystem Processes

- Capture, store, and supply WATER
  → Hydrologic cycling
- Capture, store, and supply NUTRIENTS
  → Nutrient cycling
- Habitat for SOIL ORGANISMS
  → Plant growth
- Competition
- Succession
- Growth medium for PLANTS

Soil Quality

The capacity of a specific kind of soil to perform functions that sustain plant and animal productivity and maintain water and air quality.

Soil Properties Affecting Function

Inherent Soil Properties:

- Depth
- Texture by depth
- Mineralogy / chemistry by depth
- Type of clay (expanding vs. nonexpanding)

Related to parent material, degree of profile development, and landscape position

Change relatively little in response to management & climate

Used to define soil series and ecological sites
Soil Properties Affecting Function

*Dynamic Soil Properties:*
- Aggregate stability
- Compaction (bulk density)
- Roughness
- Infiltration capacity or rate
- Organic-matter content
- Physical / chemical soil crusts
- Biological soil crusts
- Composition & abundance of soil organisms (e.g., mycorrhizal fungi)

Associated with soil biotic activity, vegetation, soil-surface disturbances, short-term erosion / deposition

Used to define relative quality, condition, or 'health' of soil

Platy structure from compaction

Inherent vs. Dynamic Properties

- Inherent properties: mapped by SOIL SURVEY
- Dynamic properties: key for ASSESSMENT & MONITORING

Soil Survey -- History

- Soil survey program has been active for over a hundred years
- Soil Erosion Service established in 1933 to support soil conservation efforts after Dust Bowl and other erosion concerns in the 1920s and 1930s
- Name later changed to Soil Conservation Service (SCS) then to Natural Resource Conservation Service (NRCS) in 1994

Soil Survey -- Background

- What is a soil survey?
  - The systematic examination, description, classification, and mapping of soils

Example: the Picante-Pecan soil map unit (#20)
Soil Map Unit

- Delineated by:
  - soil taxonomy
  - vegetative cover (ecological site)
  - climate/microclimate
  - parent material
  - topography

**Purpose:** delineate land into similar use and management units

More on Soil Map Units

- Some map units made of ≥ 2 major soils
  - An **ASSOCIATION** of two or more soils that occur in a repetitive and predictable pattern
    - Pattern and relative proportion of two soils is similar
    - Ex. ridges and swales
  - A **COMPLEX** of two or more soils that usually occur in an unpredictable pattern
    - Usually intricate patterns that are not easy to map
    - Ex. coarse and fine soils in river floodplain
  - An **UNDIFFERENTIATED GROUP** is mapped as one unit because uses and management are similar

Soil Map Units

- Includes:
  1. one or more dominant soil map unit components
  2. minor map unit components

- Minor soil components:
  - Non-contrasting/similar: similar to dominant soil in relation to use and management
  - Contrasting/dissimilar: properties that differentially affect use and management

Soil Survey

- Soils mapped at various scales, depending on the user’s needs
- Each soil component has a specific ecological site correlated to it

What is an Ecological Site?

- A group of land units (or soil series) that:
  - Share specific physical characteristics which determine the potential to produce distinctive kinds and amounts of vegetation
  - Respond similarly to drivers of ecosystem change, such as climate, land-use practices, and management activities

*Each soil component in a soil survey is attributed with an ecological site.*
What is an Ecological Site?

- Soil
  - Texture
  - Mineralogy
  - Depth
  - Horizon development
- Landscape / geomorphic setting
- Climate

Spatially explicit expression of ecosystem structure & function

Sites Differentiated on Basis of Climate, Soil & Plants

Upland 12-16"
Semidesert 9-12"
Desert 6-9"

Ecological Site Descriptions

- Contains information on:
  - Climate
  - Physiography
  - Hydrology
  - Soils
  - Plant community
  - Animal community
  - State and transition model
  - Rangeland Health Indicators

Soils & Ecological sites

1. A soil map unit can include more than one ecological site.
   - Soil map units often include many different soils, with different potentials to support plant communities
2. An ecological site can include more than one soil series, provided that the soils are similar
Soils & Ecological Sites – Key for Predicting and Understanding Change

Soil: Major determinant of ecosystem structure & dynamics -- including responses to drivers of change

Three Useful Tools

- Ecological sites
  - Land that has a similar potential to support certain plant communities based on soils and climates
  - Stratify landscape into similar units

- State and transition models
  - Evaluate current status of an area relative to its potential
  - Assess potential effectiveness of management options

- Qualitative indicators
  - Used with state and transition models to evaluate current status and identify critical processes
  - Provides preliminary evaluation of three attributes

Stable States

- Steady or stable state:
  - Inputs and outputs to the system show no trend with time
  - No long-term directional trend in ecosystem properties

State & Transition Models

- State – a complex of biotic and abiotic components, which may be transient or persisting, that occupy a site

- Transition – shift between states; includes a time dimension, a physical dimension and disturbance regime
  - May occur quickly or over a long period of time
  - Natural events or management actions
  - May be reversible or irreversible

- Threshold – transition boundary between states that once an ecosystem passes, it is irreversible without severe intervention (active restoration)
State & Transitions: Example

Reference State
Shrub - Native Perennial Grass

Invasive-dominated State
Invasive Annual Grass

Threshold?

Relatively Irreversible
Transition (Erosion & Fire)

After Stringham et al. 2003
J. Range Mgmt

State & Transition Models

- Developed for each ecological site
- Demonstrate possible changes in plant communities and soil properties
- Used to determine where and what to monitor

State A
State B
State C

Figure 26.1. Typical state and transition model structure. Based on Beestelmeier et al. 2005 and Stringham et al. 2005. Large boxes are states defined by relatively irreversible transitions. Small boxes within states represent plant communities. Transitions (dashed lines) are relatively reversible. Single-state systems are possible where non-thresholds have been identified.

Herrick et al. Vol. II 2009

Soils, Ecological Sites & the Integrated Management Framework

SOIL SURVEY provides the FOUNDATION

Interpreting Indicators Pellant manual

Herrick manual


Limits to ESDs

1. Based on previous range sites and not a systematic classification system
2. Does not account for physical and biological variability within ecological sites (better correlated with soil survey maps)
3. Define what is possible in long-term but does not talk about what is practical in the short-term
4. Does not account for important feedbacks
   - Soils-plants-animals and landscape elements
5. Infinite number of combinations of soils, plants, microbes, etc.