Rangeland Soil Quality – Indicators for Assessment and Monitoring

What Are Rangeland Indicators?

Rangeland indicators are key soil and plant community characteristics that are sensitive to change in the environment. They reflect complex ecosystem processes that are often too difficult to be measured directly. They provide information about the current status of rangeland ecosystems. Trends from indicators assessed regularly provide clues about the response of the system to management. Soil quality indicators complement vegetation indicators and may be qualitative or quantitative.

How Are Rangeland Indicators Selected?

The indicators chosen depend on the functions to be assessed or monitored and the scale (e.g. management unit, ranch, watershed, or region) at which the information is needed. Rangeland ecosystem functions include maintaining soil and site stability; distributing, storing and supplying water and plant nutrients; and supporting a healthy plant community. Good indicators are:

- Strongly related to the function and scale of interest
- Sensitive to change
- Compatible with time, resource availability, and technical expertise, and
- Relatively easy to observe or measure in a reliable manner.

What Soil Quality Indicators Are Used On Rangeland?

- **Soil Properties** Soil properties, such as bulk density, reflect limitations to root growth, seedling emergence, and water infiltration. Other properties, such as the diversity and activity of soil biota, reflect the availability of both water and nutrients to plants. Soil organic matter and soil aggregate stability reflect a combination of physical, biological, and chemical processes.
- **Soil surface features** – Pedestals, exposed plant roots, rills, gullies, wind scours, and soil deposition reflect such processes as runoff and erosion. These indicators are commonly assessed qualitatively.

Pedestalled plant with exposed roots

Spatial patterns and variability – The distribution and cycling of water and nutrients in rangeland soils are affected over both short and long distances by such processes as erosion and deposition. The kinds, amounts, and spatial distribution of living plants and decaying residue on the soil also affect nutrients and water. Accordingly, as the distribution of soil organic matter becomes less uniform, resource availability declines in some patches and increases in others.

The following qualitative assessment indicators and the attributes they reflect are from *Interpreting Indicators of Rangeland Health*, Version 4, 2005 R-1734-6, BLM
http://www.blm.gov/nstc/library/pdf/1734-6rev05.pdf

Rangeland Health Indicator	Rangeland Health Attribute		
	Soil/Site Stability	Hydrologic Function	Biotic Integrit
1. Rills	X	X	
2. Water-flow patterns	X	X	
3. Pedestals and/or	X	X	
4. Bare ground	X	X	
5. Gullies	X	X	
6. Wind-scoured, blowouts, and/or deposition areas	X		
7. Litter movement	X		
8. Soil surface resistance to erosion	X	X	X
9. Soil surface loss or degradation	X	X	X
10. Plant community composition and distribution relative to infiltration		X	
11. Compaction layer	X	X	X
12. Functional/structural groups			X
13. Plant mortality or decadence			X
14. Litter amount		X	X
15. Annual production			X
16. Invasive plants			X
17. Reproductive capability of perennial plants			X

Assessment

Indicator assessments estimate the functional status of ecological processes. The assessment must start with an understanding of the standard to be used for comparison. For rangeland assessments, the ecological site description is used as a standard at the site scale. A reference sheet, associated with each ecological site description, describes a range for each indicator based on the expected variability within each ecological site. The reference sheet serves as the primary reference for the assessment.

The optimum time and location for making assessments depend on the objectives. Potential objectives include:

- Selection of sites for monitoring
- Gathering of inventory data used in making decisions,
- Identification of areas at risk of degradation, and
- Targeting of management inputs

The timing of assessments also depends on seasonal cycles. Some soil properties are highly variable on a daily, seasonal, or yearly basis in response to changes in both temperature and moisture. For example, the total amount of organic matter in a soil is relatively insensitive to seasonal changes, whereas rills can become less apparent, depending on the length of time and conditions since the most recent major storm.

Careful site selection helps to ensure that the assessment sites are truly representative of the area of interest. The sites should be on the same soil and in the same landscape position as the area they represent. Offsite features, such as roads, homesteads, and other areas of recent or historic disturbances, can have significant impacts and should either be avoided or noted. The management history of the site can aid in interpretation.

Monitoring

Monitoring identifies changes in the resource through the orderly collection, analysis, and interpretation of quantitative data. It must be conducted over time at permanently marked locations and include baseline data if it is to ascertain the functional status of the resource. Monitoring is often designed so that measurements can be made consistently by more than one observer. Reference data or standards may be used to establish management goals and aid in interpretation of the monitoring results.

Site selection for monitoring depends primarily on the objectives, which include:

- Evaluation and documentation of the progress toward management goals,
- Detection of changes that may be an early warning of future degradation, and
- Determination of the trend for areas in desired condition, at risk, or with potential for recovery.

If the objective is to determine progress or trend, the sites that are representative of the management unit should be selected. If the objective is to provide an opportunity to modify management before degradation occurs, the sites that are most vulnerable should be selected. The detected changes must be real and must occur rapidly enough for land managers to correct problems before undesired and perhaps irreversible loss of soil quality occurs. The monitoring plan should include the proper measurement frequency, which either limits or captures seasonal variability, as dictated by the objectives.