

An Overview of Interpreting Indicators of Rangeland Health:



For More Information Visit:

<http://fresc.usgs.gov/products/rangehealth/>

Download Assessment Manual from:

http://fresc.usgs.gov/products/papers/1385_Pellant.pdf

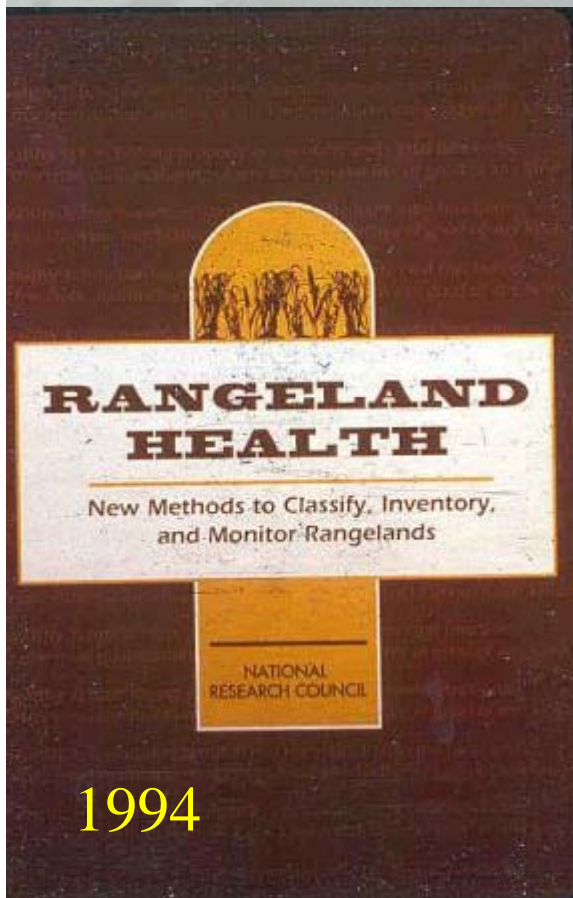


Rangeland Health

Focus Biological & Physical Processes

“The degree to which the integrity* of the soil, vegetation, water, & air as well as the ecological processes of the rangeland ecosystem are balanced and sustained.”

* “Integrity is the maintenance of the functional attributes characteristic of a locale including normal variability”



1994

Interpreting Indicators of Rangeland Health



Ecological Processes

- **Energy flow** – the conversion of sunlight to plant and then animal matter.
- **Nutrient cycle** – the movement of nutrients, such as carbon and nitrogen, through the physical and biotic components of the environment.
- **Water cycle** – the capture, storage, & safe release of precipitation.

Terminology Clarification

Inventory – *A record of land and enterprise resources. This information is used in planning.*

Monitoring - *The orderly and quantitative collection, analysis and interpretation of resource data to evaluate progress toward meeting management or conservation objectives.*

Assessment - *The process of estimating or judging the value or functional status of ecological processes. It is generally a “moment-in-time” evaluation that is not repeated in the future. In other words, it not a monitoring tool).*

Assessment

Determining Rangeland Health is an Assessment. The assessment of rangeland health may use inventory and monitoring data. However, range health is an assessment because it determines if something is “good” or “bad.”



Indicators



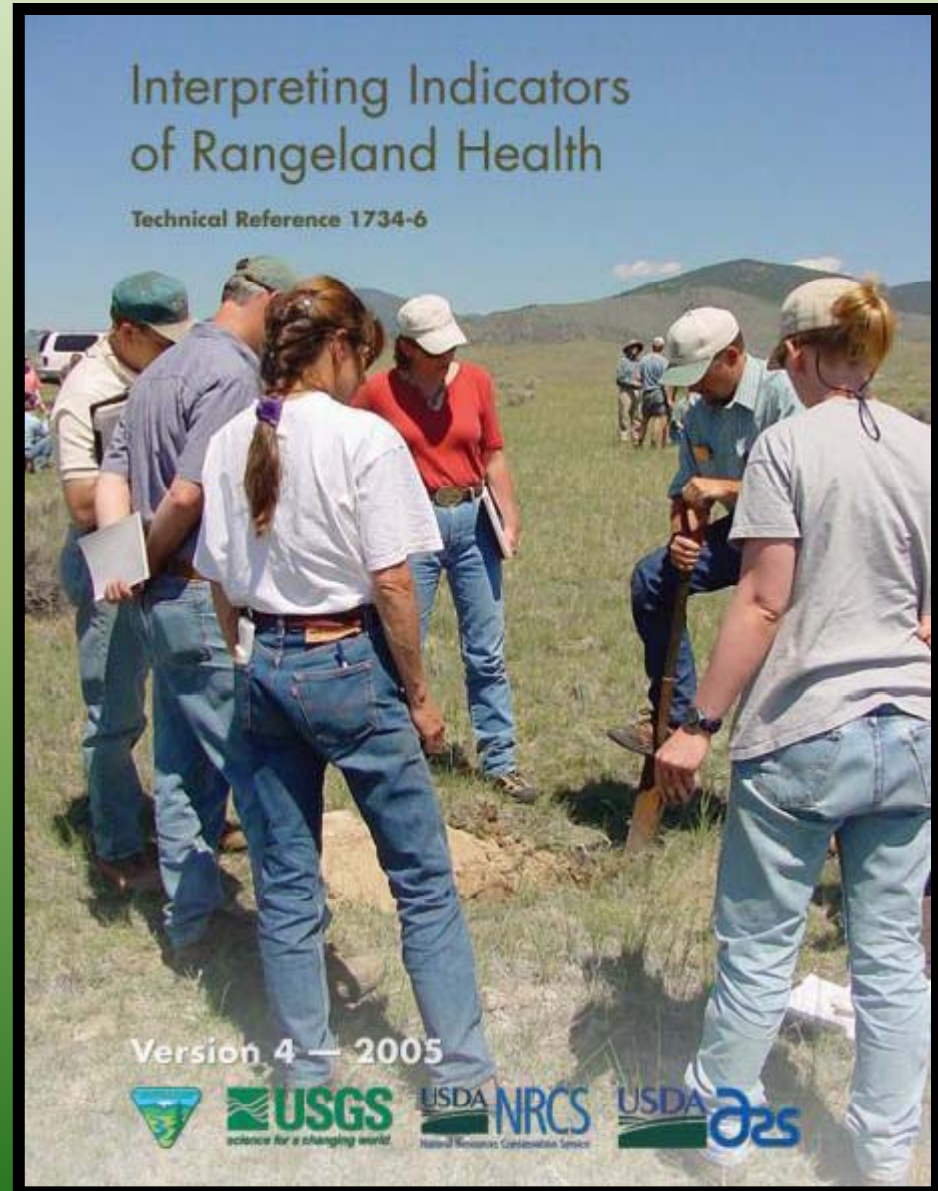
Attributes



Interpretations



Applications



Five Steps to Evaluating Rangeland Health

1. Verify soils
2. Obtain or develop Reference Sheet
3. Collect supplementary information
4. Rate the 17 indicators
5. Evaluate the 3 rangeland health attributes

Step 1 – Verify Soils to Identify Ecological Site at Evaluation Area

- Consider slope, aspect, elevation, & topographic position
- Verify soil with a shallow soil pit:
 - Surface Texture
 - Depth to restrictions
 - Diagnostic horizons
- Identify ecological site
- Document soil-ecological site information on Evaluation Sheet- Appendix 1 (page 66)



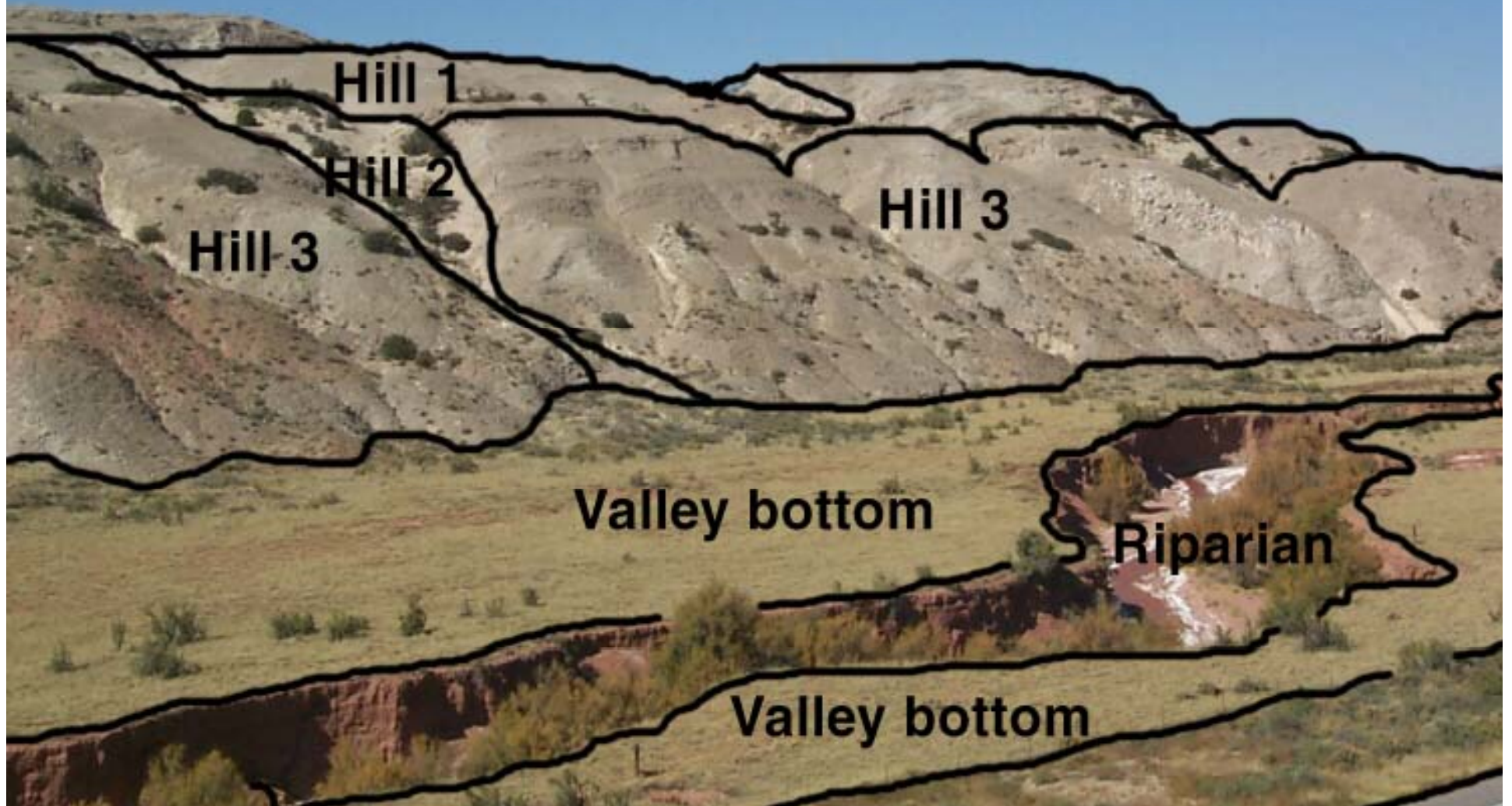
A unique reference is needed for each Ecological Site

- An ecological site is a kind of land with specific physical characteristics (soil, topography, climate) which differs from other kinds of land in its ability to produce distinctive kinds and amounts of vegetation in its' response to management.
- In other words, a kind of land with similar potential.
- Other stratification systems can also be used at a broader scale.

A unique reference is needed for
each Ecological Site



A unique reference is needed for
each Ecological Site

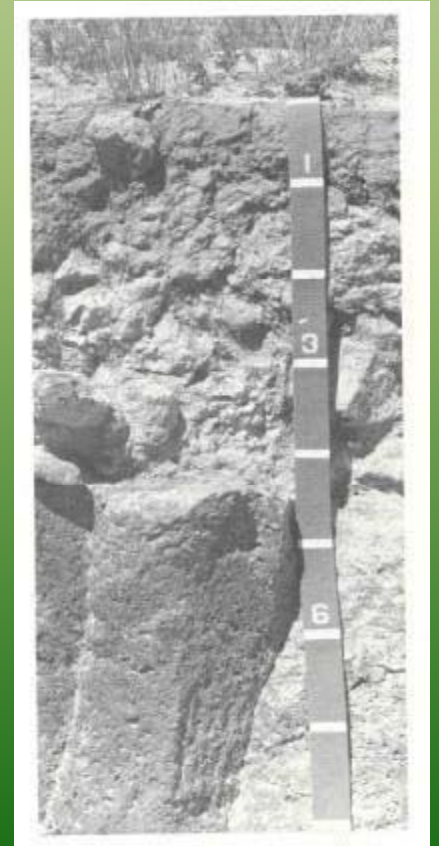


Using soils to identify ecological sites

The defining of an ecological site on the landscape begins with the soil type. It can be a bit complicated to link a specific soil series or soil map unit to a specific ecological site.

But... the point remains – when identifying ecological sites, begin with the **soil**.

A clear definition of “**ecological site**” allows development of the “**reference state**”



Reference State...

The state where the functional capabilities represented by soil and site stability, hydrologic function, and biotic integrity are performing at a near-optimum level under the natural disturbance regime.

From a clear idea of the “**Reference State**” comes the development of a “**Reference Worksheet**”

Generating the Reference Worksheet

- What do you need to define potential for an ecological site?
 - Ecological Site Descriptions

Data Proposed: 3/69
Author(s): RK/GKB
MLRA: 25

South Slope #-12" P.Z.
025XY01SNV
ARTRM/AGSP

Ecological Site Description

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

NEVADA
Range Site Description

A. PHYSICAL CHARACTERISTICS

1. PHYSIOGRAPHIC FEATURES

This site occurs on southerly facing sideslopes of hills, erosional fan remnants and rock-pediment remnants. Slopes range from 15 to 75 percent, but slope gradients of 30 to 50 percent are most typical. Elevations are 5500 to 6500 feet.

2. CLIMATIC FACTORS

Average annual precipitation is 8 to 12 inches. Mean annual temperatures is 45 to 50 degrees F. The average growing season is about 100 to 120 days.

3. SOIL FACTORS

The soils in this site are typically moderately deep and well drained. Surface soils are medium to moderately fine textured and are normally less than 10 inches thick. Subsoils are moderately fine to fine textured. Most of these soils are modified with 35 to 50 percent rock fragments through the soil profile. Available water capacity is low to moderate. On the southerly exposures of this site, more sunlight is received and the soils tend to warm and promote plant growth earlier in the spring than on adjacent sites. High evapotranspiration potentials on this site result in depletion of the available soil moisture supply early in the growing season. Runoff is medium to rapid. Potential for sheet and rill erosion is moderate to high depending on slope. A surface cover of gravel and/or cobbles on these soils provides a stabilizing affect on surface erosion conditions.

For a listing of soils correlated to this range site and representative pedon, see Appendix II.

4. VEGETATION FACTORS

a. Potential Native Vegetation

The plant community is dominated by bluebunch wheatgrass. Other plants of importance are Thurber needlegrass and Wyoming big sagebrush.

Potential vegetative composition is about 80% grasses, 5% forbs and 15% shrubs.

Technical Guide
Section III

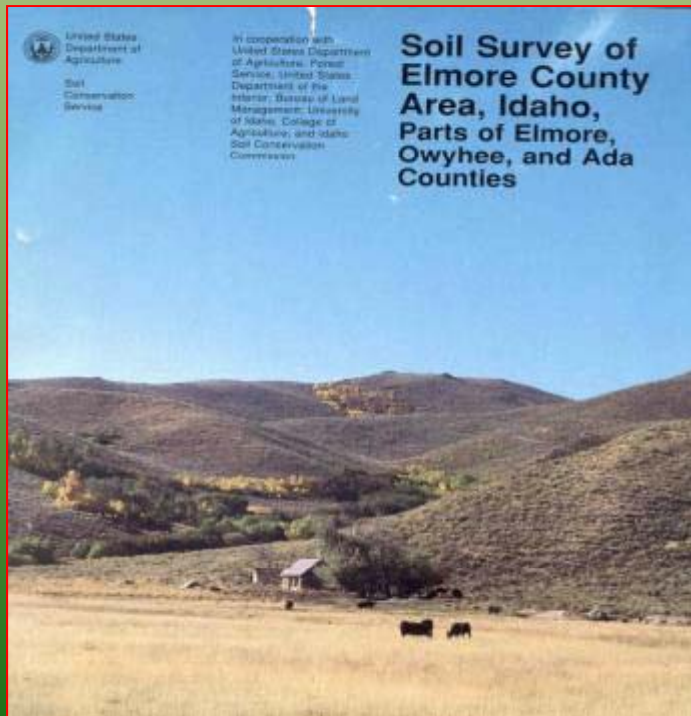
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USDA-SCS
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<http://esis.sc.egov.usda.gov>

Generating the Reference Worksheet

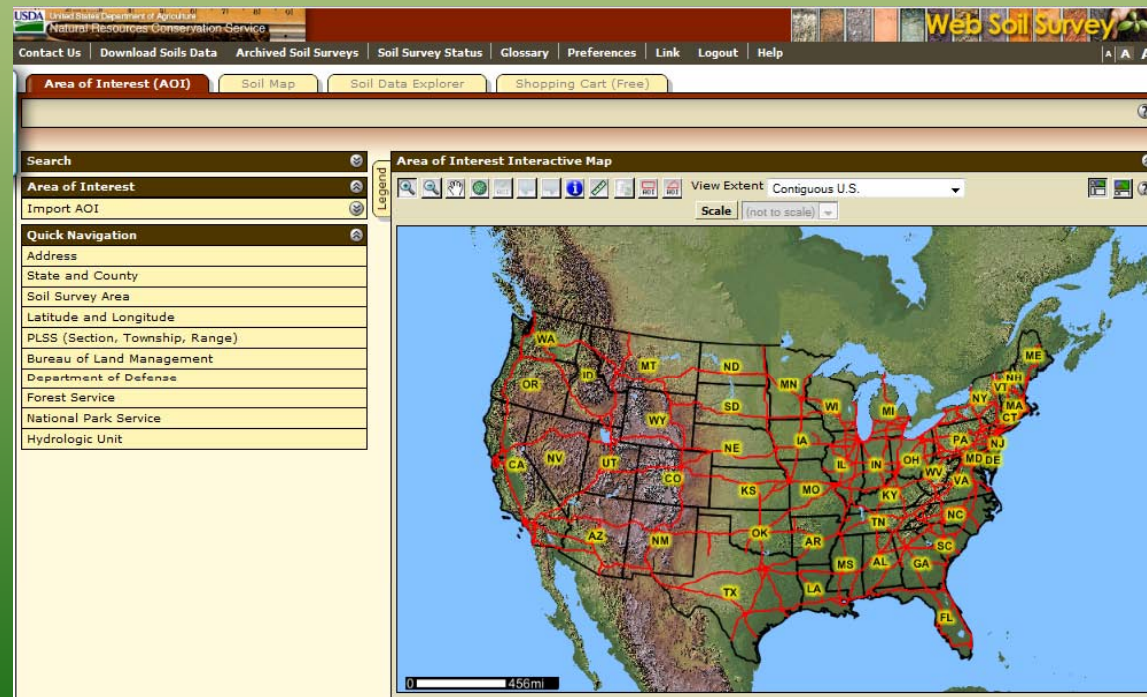
- What do you need to define potential for an ecological site?
 - Ecological Site Descriptions
 - Soil Survey Information



Generating the Reference Worksheet

- What do you need to define potential for an ecological site?
 - Ecological Site Descriptions
 - Soil Survey Information

Web Soil Survey



<http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm>

Generating the Reference Worksheet

- What do you need to define potential for an ecological site?
 - Ecological Site Descriptions
 - Soil Survey Information
 - Ecological Reference Areas = *“A landscape unit in which ecological processes are functioning within a normal range of variability and the plant community has adequate resistance to and resiliency from most disturbances”*



Generating the Reference Worksheet

- What do you need to define potential for an ecological site?
 - Ecological Site Descriptions
 - Soil Survey Information
 - Ecological Reference Site



Verify soils



Establish baseline studies



Communicate Ideas

Generating the Reference Worksheet

- What do you need to define potential for an ecological site?
 - Ecological Site Descriptions
 - Soil Survey Information
 - Ecological Reference Sites
 - Expert knowledge
(old timers and brilliant ecologists)

Generating the ecological reference worksheet

Capture
temporal and disturbance
variability!

REV. 12/15/02

Ecological Reference Worksheet (Example)

Author(s)/participant(s): J. Christensen, B. Call, B. Bestelmeyer, R. Placker, D. Trujillo, L. Hauser, D. Coalson, P. Smith, & J. Herrick

Contact for lead author: __jchristensen@web.com/334-556-7890__ **Reference site used? Yes/No: No**

Date: 03/23/2002 **MLRA:** __42__ **Ecological Site:** __Limy__ This must be verified based on soils and climate (see Ecological Site Description). Current plant community *cannot* be used to identify the ecological site.

Indicators. For each indicator, describe the potential for the site. Where possible, (1) use numbers, (2) include expected range of values for above- and below-average years for **each** community within the reference state, when appropriate & (3) cite data. Continue descriptions on separate sheet.

1. Number and extent of rills: *None*

2. Presence of water flow patterns: *None, except following extremely high intensity storms, when short (less than 1 m) flow patterns may appear; minimal evidence of past or current soil deposition or erosion.*

3. Number and height of erosional pedestals or terracettes: *None*

4. Bare ground from Ecological Site Description or other studies (rock, litter, lichen, moss, plant canopy are *not* bare ground): *20 – 30 % bare ground; bare patches should be less than 8-10 inch diameter; occasional 12 inch patches associated with shrubs. Larger bare patches also associated with ant mounds and rodent disturbances*

5. Number of gullies and erosion associated with gullies: *None*

6. Extent of wind scoured, blowouts and/or depositional areas: *None*

7. Amount of litter movement (describe size and distance expected to travel): *Minimal and short, associated with water flow patterns following extremely high intensity storms. Litter also may be moved during intense wind storms*

8. Soil surface (top few mm) resistance to erosion (stability values are averages – most sites will show a range of values): *Stability class (Herrick et al. 2001) anticipated to be 5-6 at surface and subsurface under vegetation and 4-5 at surface and subsurface in the interspaces. These values need verification at reference sites.*

9. Soil surface structure and SOM content (include type and strength of structure, and A-horizon color and thickness): *2-4 inch dark brown A horizon with medium granular structure (Otero County Armesa series description refers to platy structure; probably not from a true reference site).*

10. Effect of plant community composition (relative proportion of different functional groups) & spatial distribution on infiltration & runoff: *High grass canopy and basal cover and small gaps between plants should reduce raindrop impact and slow overland flow, providing increased time for infiltration to occur. High root density of blue grama can limit infiltration. High herbaceous vegetation on this site will result in less rain necessary to sustain this site because more water is retained.*

11. Presence and thickness of compaction layer (usually none; describe soil profile features which may be mistaken for compaction on this site): *None.*

12. Functional/Structural Groups (list in order of descending dominance by above-ground weight using symbols: >>, >, = to indicate much greater than, greater than, and equal to): *Blue grama > Black grama > warm season bunchgrasses > Yucca = shrubs >> sub-shrubs = succulents; Forbs 0 – 8 % depending on the year.*

13. Amount of plant mortality and decadence (include which functional groups are expected to show mortality or decadence): *Grasses will nearly always show some mortality and decadence*

14. Average percent litter cover (_____ %) and depth (_____ inches).
20 – 25 % litter cover and 0.25 inch depth

15. Expected annual production (this is TOTAL above-ground production, not just forage production):
_____ #/acre or t/ha (choose one) 650 to 1200 pounds/acre based on ecological site description. Could be even higher on particularly good years.

16. Potential invasive (including noxious) species (native and non-native). List species which characterize degraded states and which, after a threshold is crossed, “can, and often do, continue to increase regardless of the management of the site and may eventually dominate the site”: *Possibly creosote bush which is an invader on similar ecological sites; snakeweed is cyclical, so not regarded as an invasive plant on this ecological site.*

17. Perennial plant reproductive capability: *all species should be capable of reproducing*

Rev. 12/15/02

No Reference Worksheet---don't
bother going to the field!



Step 3 - Collect Supplementary Information

- Spatial and temporal variability
- Ecological reference areas
(as developed in step 2)
- Functional and structural groups sheet
- Quantitative Data

Step 4 - Rate 17 Indicators

THREE RANGELAND HEALTH ATTRIBUTES ASSESSED BY 17 INDICATORS

**Soil /Site
Stability**

**Hydrologic
Function**

**Biotic
Integrity**

Rills

Functional/Structural Groups

Water-Flow Patterns

Plant Mortality/Decadence

Pedestals and/or Terracettes

Annual Production

Bare Ground

Invasive Plants

Gullies

Reproductive Capability

Soil Surface Resistance to Erosion

Soil Surface Loss or Degradation

Compaction Layer

Wind-Scoured, Blowouts
&/or Deposition Areas

Litter Amount

Litter Movement

Plant Community Composition
Relative to Infiltration/Runoff

Indicators

Elements of an ecosystem used to assess processes that are too difficult or expensive to measure.

Due to the complexity of ecological processes a “suite” of indicators are recommended.



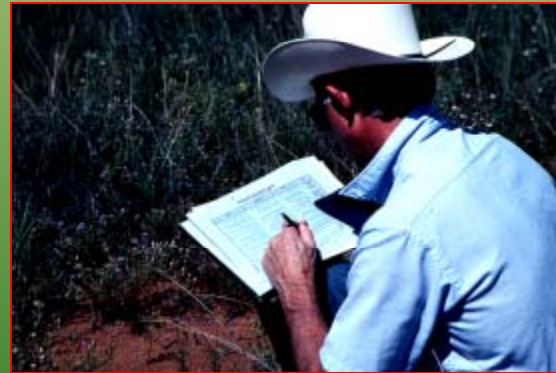
Quantitative & Qualitative Studies

- Quantitative
 - Objective
 - Measure attributes



“Cheatgrass cover is 85%”

- Qualitative
 - Observed
 - Describe or rate attributes



“Cheatgrass is rated as abundant”

The 17 Indicators

1. Rills
2. Water Flow Patterns
3. Pedestals/Terrecettes
4. Bare Ground
5. Gullies
6. Wind Scour Areas
7. Litter Movement
8. Resistance to Erosion
9. Loss of Soil Surface
10. Plant/Infiltration Effects
11. Compaction Layer
12. Functional/Structural Groups
13. Plant Mortality/Decadence
14. Litter Amount
15. Annual Production
16. Invasive Plants
17. Reproductive Capability

Optional Indicators

- Flexibility to add additional **ecological** indicators is provided.

- Biological crusts may be considered as an optional indicator:

- Colorado Plateau--important functional component
- Tall Grass Prairie--unimportant and rare component



Rills

Small erosional rivulets that are generally linear



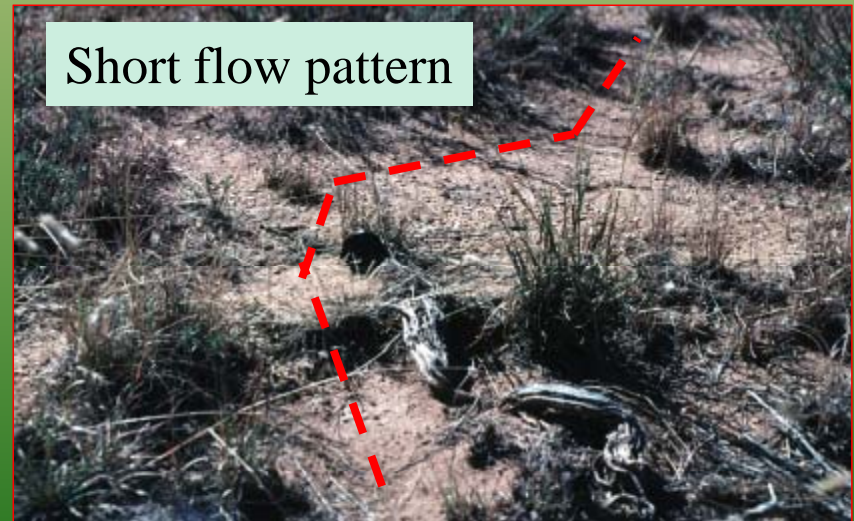
Water Flow Patterns

Path that water takes as it moves across the soil surface.

Large water flow path



Short flow pattern

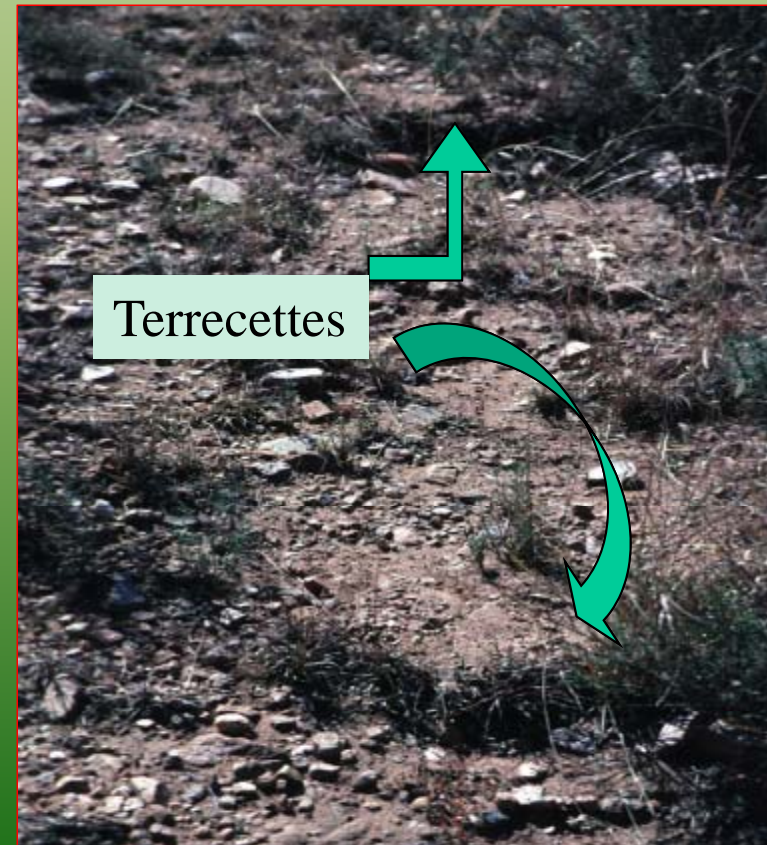


Pedestals/Terrecettes



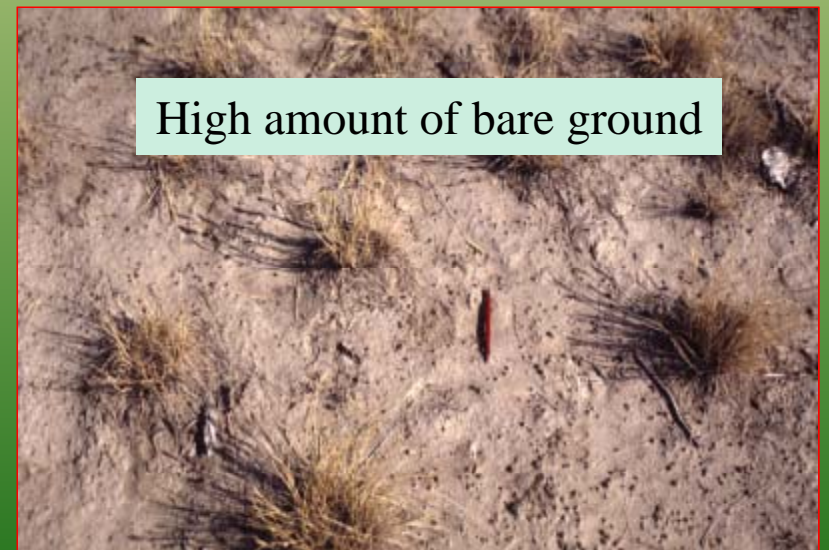
Plant on erosional pedestal

Do not evaluate frost-heaving



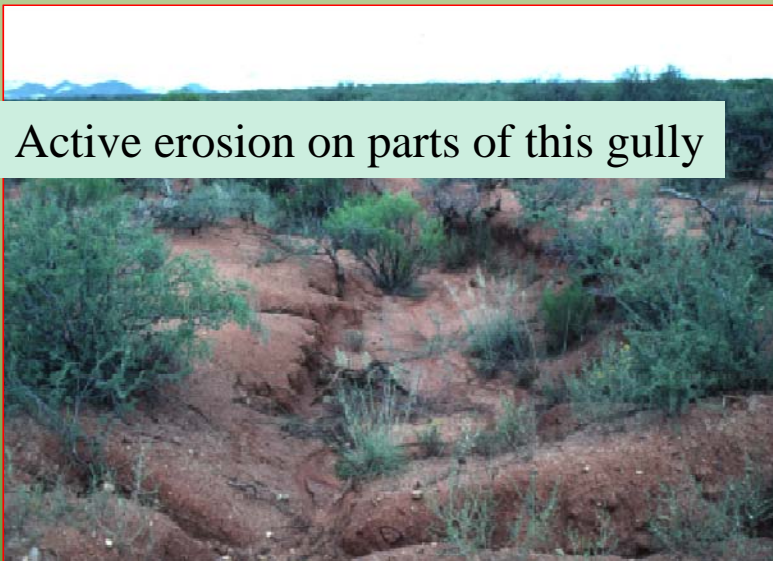
Bare Ground

Exposed mineral or organic soil not covered by vegetation, gravel/rock, litter, or biological crust.



Gullies

Channel that has been cut into the soil by moving water



Wind-Scoured, Blowout, and/or Depositional Areas

Finer soil particles have been redistributed from interspaces and deposited near obstructions

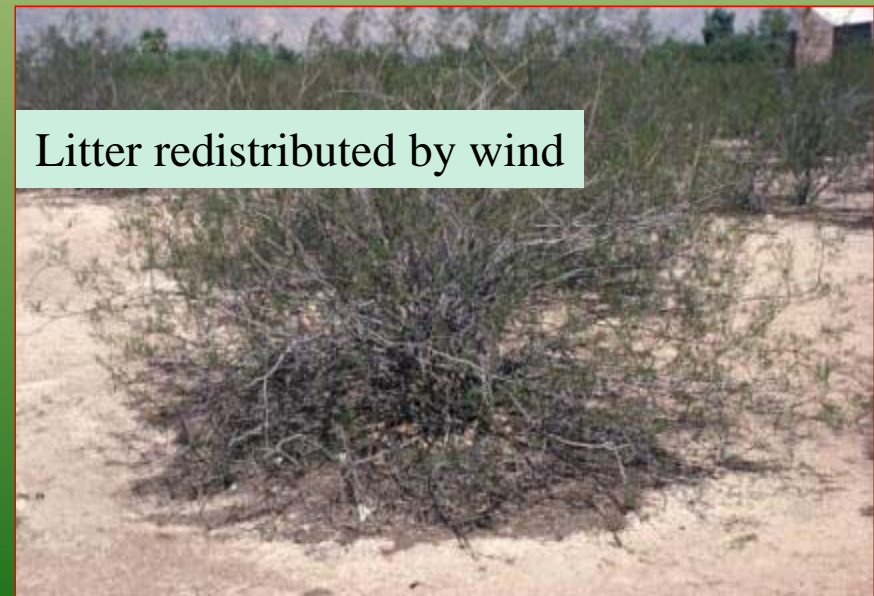


Wind-scoured area

Deposition area

Litter Movement

Redistribution of litter by water or wind



Soil Surface Loss or Degradation

Loss or degradation of soil surface (organic matter) affects site potential



Intact soil surface

Loss of soil surface



Upslope side



Downslope side



3 m upslope



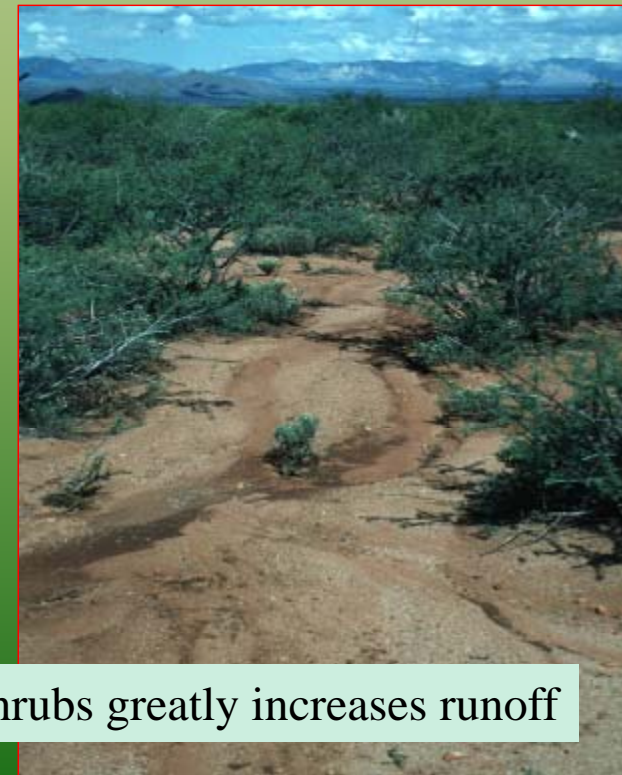
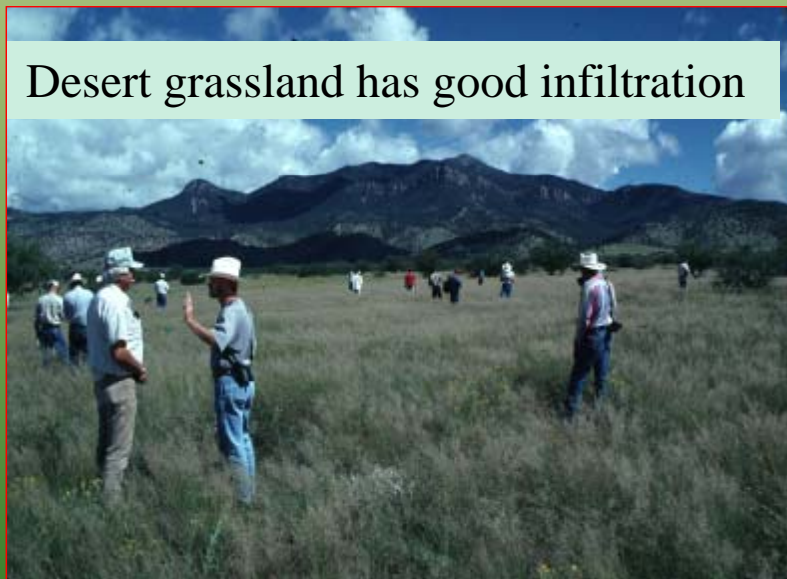
Under ironwood tree



3 m downslope

Plant Community Composition & Distribution Relative to Infiltration & Runoff

Vegetation growth form and composition affects infiltration and interrill erosion



Compaction Layer

Near surface layer of dense soil caused by repeated impact or disturbance of the soil surface

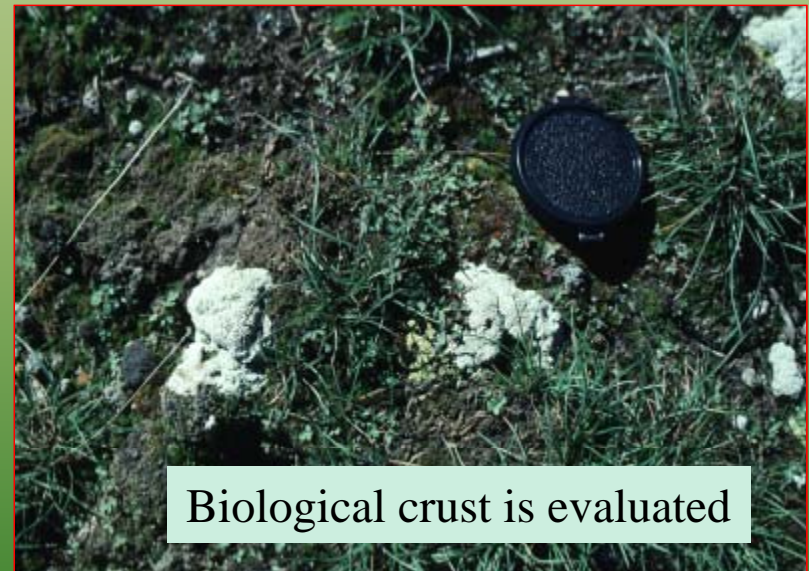


Functional/Structural Groups

A suite of species that because of similar morphology, photosynthesis pathways, nitrogen fixing ability, life cycle etc. are grouped together



Nitrogen fixing forb- *Astragalus*



Biological crust is evaluated

Cool vs. warm season, tall vs. short grass, sprouting vs. nonsprouting Shrub, fibrous vs. tap root, annual vs. perennial.....

Plant Mortality/Decadence

The proportion of dead/decadent plants expected for the site



Litter Amount

Litter is dead organic material in contact with the soil surface and it influences several ecological processes



Annual Production

Total above ground biomass is a measure of the vegetation available to harvest the sun's energy

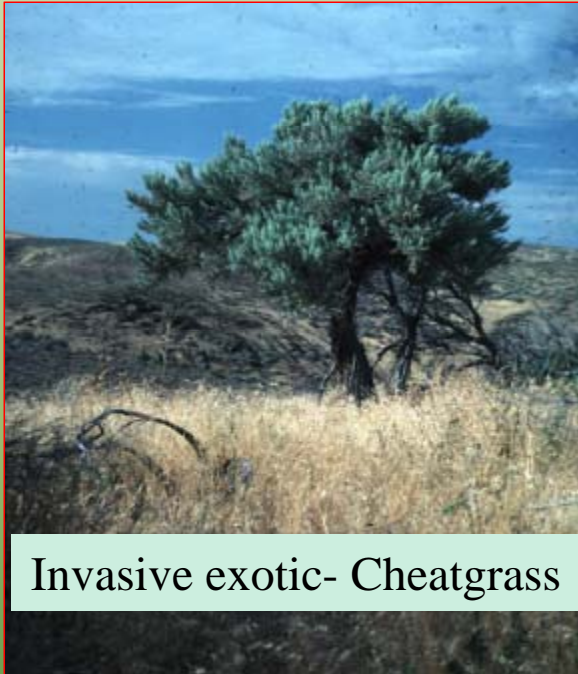


Normal annual production ~ 600 lbs/ac



Annual production less than 300 lbs/ac

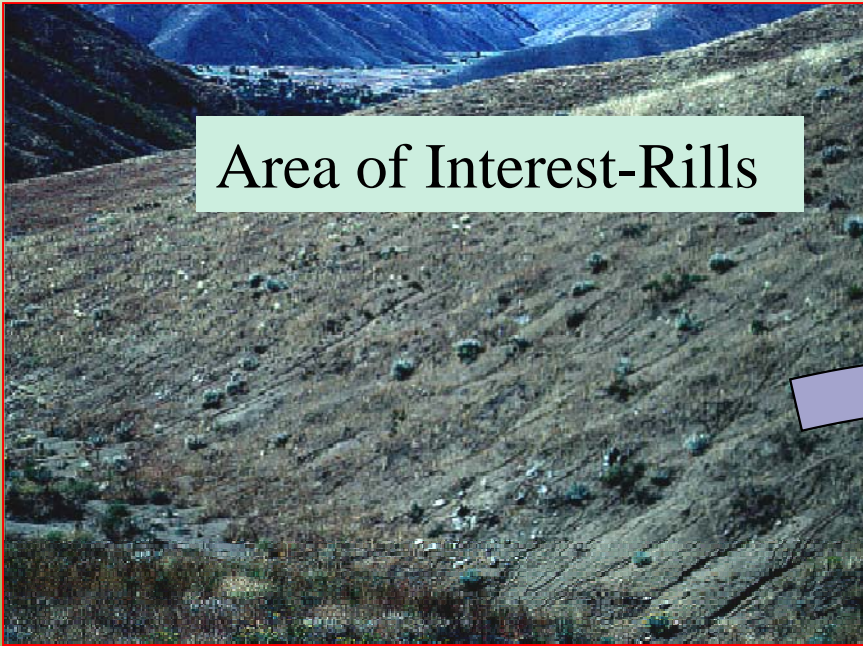
Invasive Plants



Reproductive Capability of Perennial Plants

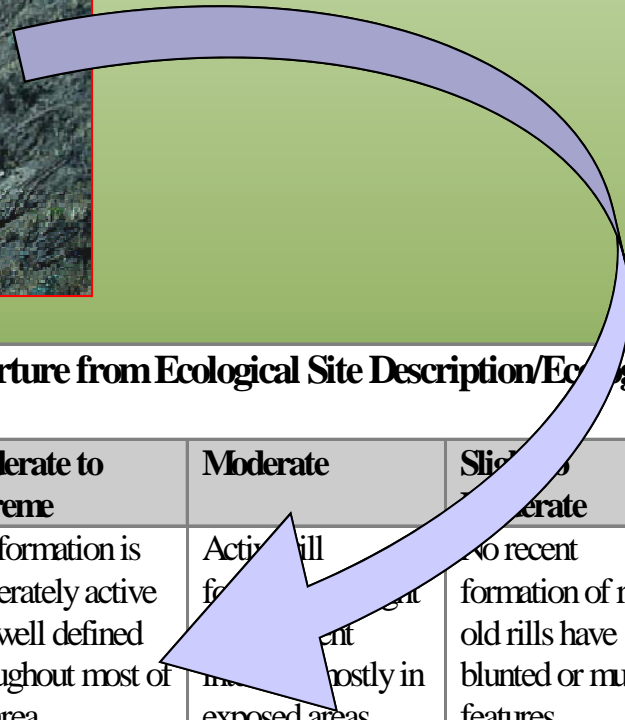
Measure of potential for seed or tiller production, not presence of seedlings/new clonal plants





Area of Interest-Rills

Evaluate 17 Indicators at the Area of Interest



Indicator	Departure from Ecological Site Description/Ecological Reference					
	Area(s)	Extreme	Moderate to Extreme	Moderate	Slight to Moderate	None to Slight
1. Rills (Default description)		Rill formation is severe and well defined throughout most of the area.	Rill formation is moderately active and well defined throughout most of the area.	Active rill formation is present mostly in exposed areas.	No recent formation of rills; old rills have blunted or muted features.	Current or past formation of rills as expected for the site.
1. Rills (Revised description)						

Step 5 - Evaluate the 3 rangeland health attributes

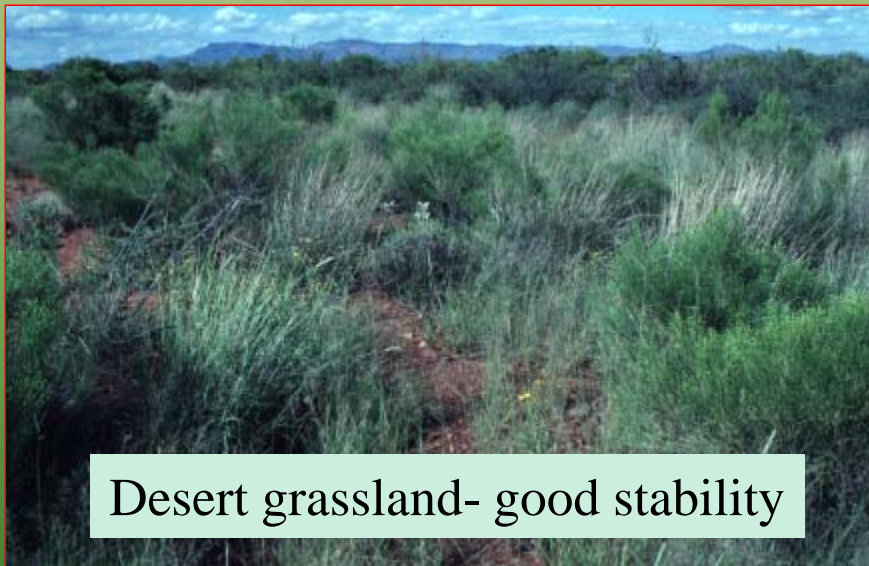
Indicators are grouped into 3 Attributes that collectively describe the “health” of a site:

- **Soil/Site Stability**
- **Hydrologic Function**
- **Biotic Integrity**

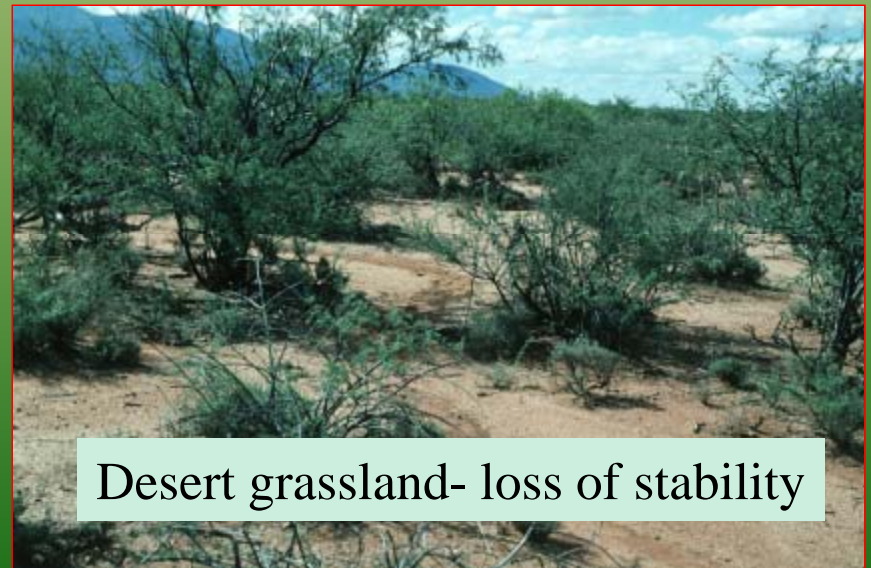
There is not a single rating of “health”

Soil/Site Stability

Capacity of the site to limit loss of resources by wind/water erosion.



Desert grassland- good stability



Desert grassland- loss of stability

Indicators of Soil/Site Stability

1. **Rills**
2. **Water Flow Patterns**
3. **Pedestals/Terrecettes**
4. **Bare Ground**
5. **Gullies**
6. **Wind Scour Areas**
7. Litter Movement
8. **Resistance to Erosion**
9. **Loss of soil surface**
10. **Plant/infiltration effects**
11. **Compaction layer**
12. Functional/structural groups
13. Plant mortality/decadence
14. Litter Amount
15. Annual Production
16. Invasive Plants
17. Reproductive Capability

Hydrologic Function

Capacity of the site to capture, store and safely release water and to resist a reduction and recover this capacity after disturbance.



Sagebrush “captures” snow



Grasses have reduced ability (structure) to “capture” snow

Indicators of Hydrologic Function

1. **Rills**
2. **Water Flow Patterns**
3. **Pedestals/Terrecettes**
4. **Bare Ground**
5. **Gullies**
6. Wind Scour Areas
7. **Litter Movement**
8. **Resistance to Erosion**

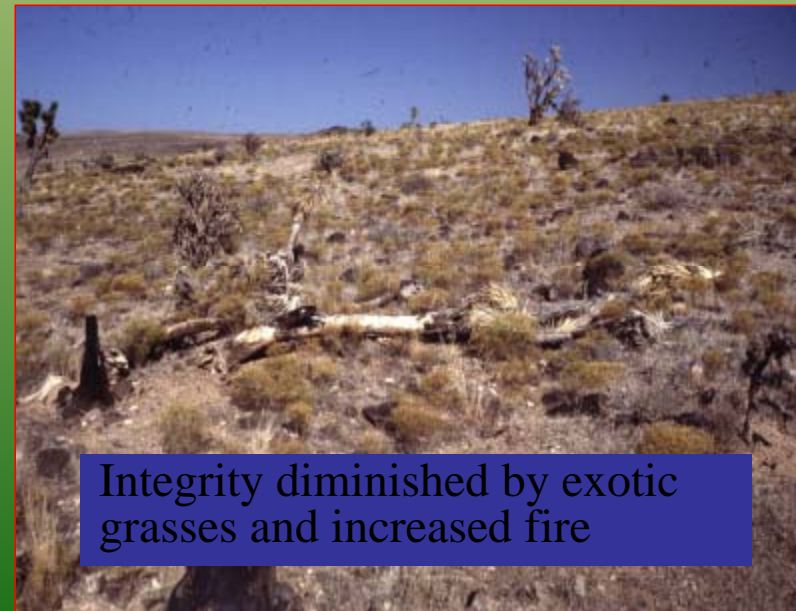
1. **Loss of soil surface**
2. **Plant/infiltration effects**
3. **Compaction layer**
4. Functional/structural groups
5. Plant mortality/decadence
6. **Litter Amount**
7. Annual Production
8. Invasive Plants
9. Reproductive Capability

Integrity of the Biotic Community

Capacity of the site to support characteristic functional and structural communities and to resist disturbance and recover from disturbance.



Joshua tree/blackbrush site



Integrity diminished by exotic grasses and increased fire

Indicators of Biotic Integrity

1. Rills
2. Water Flow Patterns
3. Pedestals/Terrecettes
4. Bare Ground
5. Gullies
6. Wind Scour Areas
7. Litter Movement
8. **Resistance to Erosion**
9. **Plant/infiltration effects**
10. Loss of soil surface
11. **Compaction layer**
12. **Functional/structural groups**
13. **Plant mortality/decadence**
14. **Litter Amount**
15. **Annual Production**
16. **Invasive Plants**
17. **Reproductive Capability**

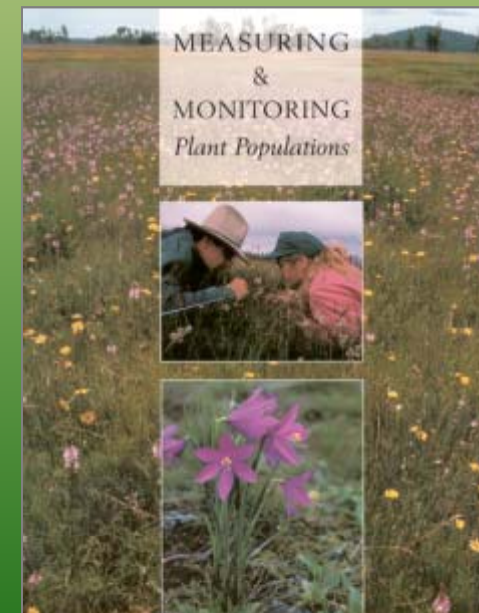
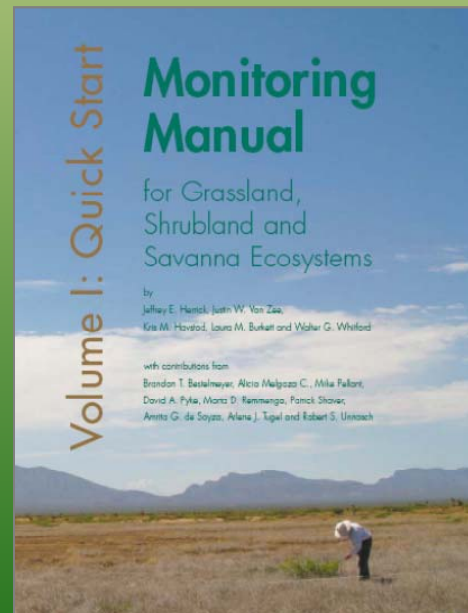
Linking Quantitative and Qualitative Data

REFERENCES: 1 - USDA NRCS, 1977, 2 - Lizalga et al., 2001, 3 - HIGHTER et al., 2003.

Attribute	Qualitative assessment indicators	Key quantitative assessment indicators*	Selected measurements and references
Soil and site stability	<ul style="list-style-type: none"> • Rills • Water flow patterns • Pedestals and/or terracettes • Bare ground • Gullies • Wind-scoured, blowouts and/or deposition areas • Soil surface resistance to erosion • Soil surface loss or degradation • Compaction layer 	Bare ground	Line point intercept (2, 3) Point frame (2)
		Proportion of soil surface covered by canopy gaps longer than XX cm	Canopy gap intercept (3) Continuous line intercept (2)
		Proportion of soil surface covered by basal gaps longer than XX cm	Basal gap intercept (3) Continuous line intercept (2)
		Soil macro aggregate stability in water	Soil stability kit (3)
Hydrologic function	<ul style="list-style-type: none"> • Rills • Water flow patterns • Pedestals and/or terracettes • Bare ground • Gullies • Litter movement • Soil surface resistance to erosion • Soil surface loss or degradation • Compaction layer • Plant community composition and distribution relative infiltration and runoff • Litter amount 	Bare ground	Line point intercept (2, 3) Point frame (2)
		Proportion of soil surface covered by canopy gaps longer than XX cm	Canopy gap intercept (3) Continuous line intercept (2)
		Proportion of soil surface covered by basal gaps longer than XX cm	Basal gap intercept (3) Continuous line intercept (2)
		Soil macro aggregate stability in water	Soil stability kit (3)
Biotic integrity	<ul style="list-style-type: none"> • Soil surface resistance to erosion • Soil surface loss or degradation • Compaction layer • Functional/structural groups • Plant mortality/decadence • Litter amount • Annual production • Invasive plants • Reproductive capability of perennial plants 	Soil macroaggregate stability in water	Soil stability kit (3)
		Plant canopy cover by functional group	Line point intercept (2, 3) Point frame (2)
		Plant basal cover by functional group	Line point intercept Point frame (2)
		Litter cover	Line point intercept (1, 3) Point frame (2)
		Plant production by functional group	Harvest (1) Double sampling (1)
		Invasive plant cover	Line point intercept (1, 3)
		Invasive plant density	Belt transect (2, 3) Quadrats (2)

Added Quantitative and Qualitative Linkages

Indicator	Quantitative Indicator	Measurement (References)	Interpretation
Bare Ground	% Bare Ground	Line Point Intercept (Monitoring Manual and Measuring & Monitoring Plant Populations)	Bare ground is positively correlated with runoff and erosion



Interpreting Indicators of Rangeland Health Intended Uses

- Used by experienced personnel
- Provide a preliminary evaluation of rangeland health
- Identify areas (early warning) that are potentially at risk of crossing a threshold
- Communication tool

Interpreting Indicators of Rangeland Health

Not to be used to:

- Identify the cause(s) of resource problems
- Make grazing or other management decisions
- Stand alone as a trend or monitoring tool
- Independently generate national/regional assessments of rangeland health