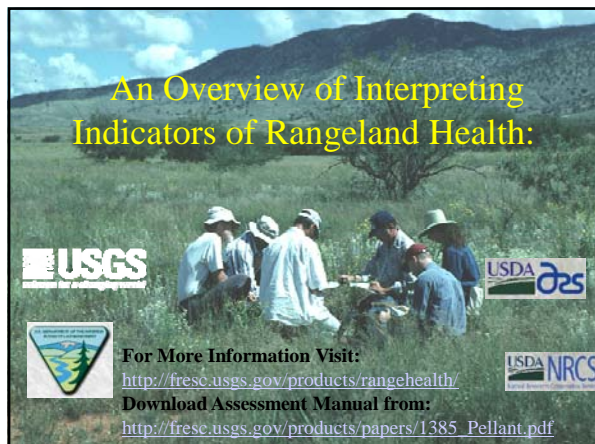


An Overview of Interpreting Indicators of Rangeland Health:



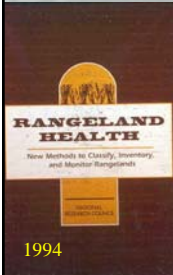
USGS **USDA** **NRCS**

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

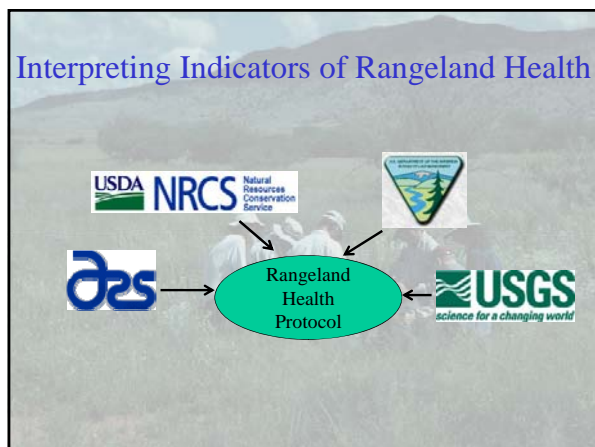
Focus Biological & Physical Processes

“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.”



1994

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



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.

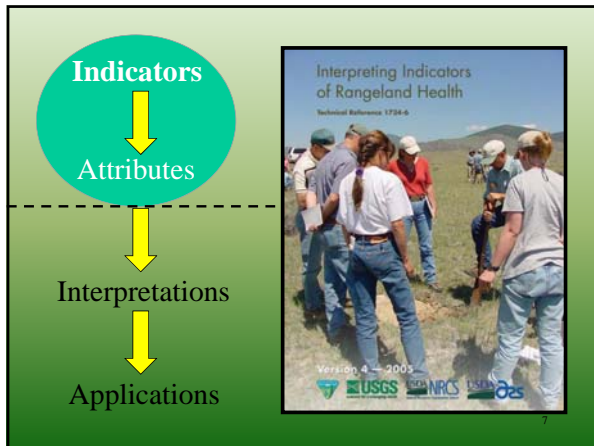
Assessment - The process of estimating or judging the value or functional status of ecological processes. It is generally a “moment-in-time” evaluation that is not repeated in the future. In other words, it not a monitoring tool).

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.”

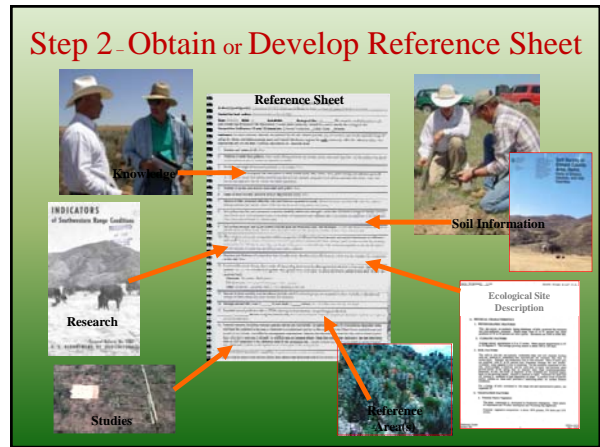


6



- ### 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

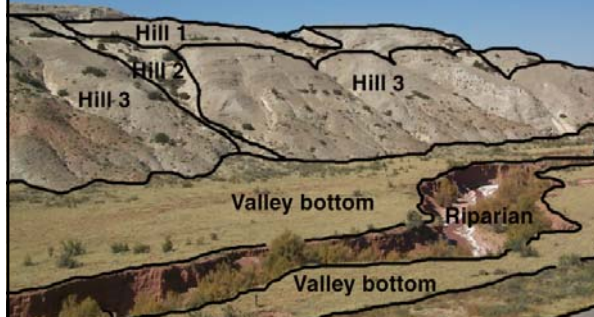
- ### Step 1 – Verify Soils to Identify Ecological Site at Evaluation Area
- Consider slope, aspect, elevation, & topographic position
 - Verify soil with a shallow soil pit:
 - Surface Texture
 - Depth to restrictions
 - Diagnostic horizons
 - Identify ecological site
 - Document soil-ecological site 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

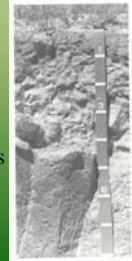


Using soils to identify ecological sites

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**”



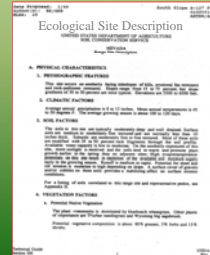
Reference State...

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

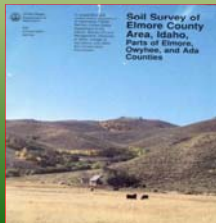
- What do you need to define potential for an ecological site?
 - Ecological Site Descriptions



<http://esis.sc.egov.usda.gov>

Generating the Reference Worksheet

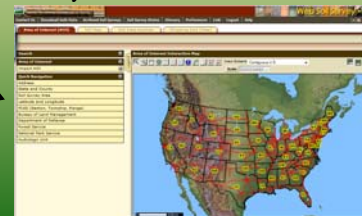
- What do you need to define potential for an ecological site?
 - Ecological Site Descriptions
 - Soil Survey Information



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



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!

19-11-2008-1

Ecological Reference Worksheet (Example)

Author(s): [blank] (page 2) | Location: [blank] | Date: [blank] | Project: [blank] | Contact: [blank] | Reference site used? Yes/No: [blank]

Date: [blank] | Mile(s): [blank] | Ecological Site: [blank] | This may be verified based on soils and climate data.

Individuals: For each indicator, describe the potential for the site. When possible, list the number of individuals observed in each of the sites and the average count for each indicator within the reference area, which is appropriate to the site type. Capture the following information:

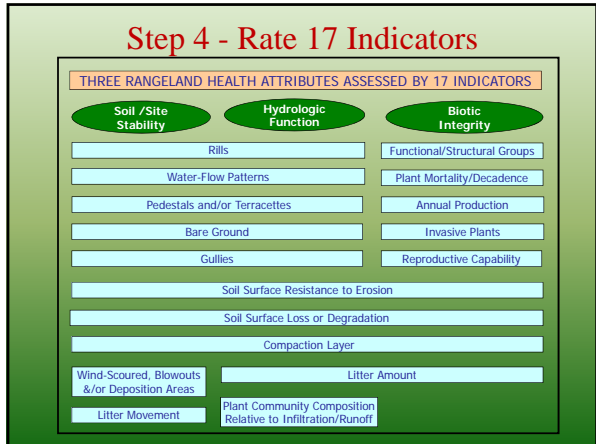
1. Number and extent of the site.
2. Presence of water (flow pattern, flow, depth, flow events) and other abiotic characteristics that affect the pattern and degree of soil moisture.
3. Number and height of structural products in the reference area.
4. Have grasses from Ecological Site Descriptions or other studies (rock, litter, forbs, ferns, plant canopy) are not have previously been reported for this site? If so, list the species and their approximate percent cover of the site. Large herbaceous plants are not included in the soil survey data.
5. Number of gullies and erosion associated with gullies? [blank]
6. Extent of sites covered. Do you have any other potential areas? [blank]
7. Amount of litter accumulation (cover the site and distance expected to travel). Amount of litter accumulation is not included in the soil survey data.
8. Soil surface (top to soil) resistance to erosion (stability when wet) - report this will allow a range of values. [blank]
9. Soil surface roughness and RSM (extent, frequency and strength of ripples, and 4-Riskless color and thickness) [blank]
10. Soil surface roughness and RSM (extent, frequency and strength of ripples, and 4-Riskless color and thickness) [blank]
11. Effect of litter on naturally occurring vegetation (e.g., different functional groups or species distribution) - indicate if possible. If possible, report the cover and height of the litter and the cover of the vegetation. If possible, report the cover of the litter and the cover of the vegetation. If possible, report the cover of the litter and the cover of the vegetation.
12. Presence and thickness of competition layer (usually thin) describe soil profile features which may be relevant for competition in this site? [blank]
13. Functional/Structural Groups that in order of decreasing dominance by above-ground weight being 100%, % of the biomass that is greater than, greater than, and equal to) the same in the same area. If possible, report the cover of the litter and the cover of the vegetation. If possible, report the cover of the litter and the cover of the vegetation.
14. Amount of plant mortality and densities (include which functional groups are expected to show mortality or dieback) [blank]
15. Average percent litter cover? [blank] % and depth [blank] inches. [blank]
16. Expected natural productivity (NPP) of the site (above ground production, and total biomass production). [blank]
17. Potential for natural productivity (NPP) of the site (above ground production, and total biomass production). [blank]
18. Potential for natural productivity (NPP) of the site (above ground production, and total biomass production). [blank]
19. Potential for natural productivity (NPP) of the site (above ground production, and total biomass production). [blank]
20. Potential for natural productivity (NPP) of the site (above ground production, and total biomass production). [blank]
21. Potential for natural productivity (NPP) of the site (above ground production, and total biomass production). [blank]

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




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
- | | |
|---|--|
| <ol style="list-style-type: none"> 1. Rills 2. Water Flow Patterns 3. Pedestals/Terracettes 4. Bare Ground 5. Gullies 6. Wind Scour Areas 7. Litter Movement 8. Resistance to Erosion | <ol style="list-style-type: none"> 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



Rills are a natural component of this site



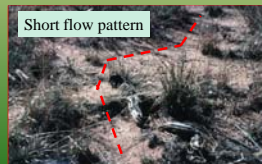
Short erosional rill

Water Flow Patterns

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



Large water flow path



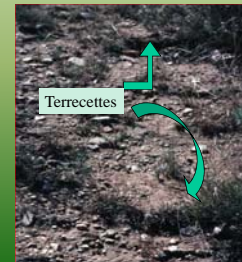
Short flow pattern

Pedestals/Terrecettes



Plant on erosional pedestal

Do not evaluate frost-heaving



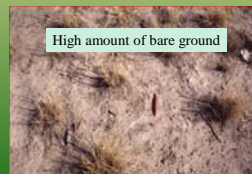
Terrecettes

Bare Ground

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



Minimal bare ground at site potential



High amount of bare ground

Gullies

Channel that has been cut into the soil by moving water



Active erosion on parts of this gully



Stable gully except for active headcut

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



Litter movement by water



Litter redistributed by wind

Soil Surface Loss or Degradation

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



Loss of soil surface

Intact soil surface



Upslope side

Downslope side

3 m upslope

Under ironwood tree

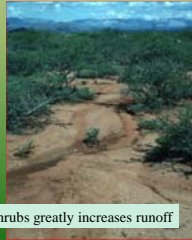
3 m downslope

Plant Community Composition & Distribution Relative to Infiltration & Runoff

Vegetation growth form and composition affects infiltration and interrill erosion



Desert grassland has good infiltration



Conversion to shrubs greatly increases runoff

Compaction Layer

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



Soil surface

Compaction layer

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

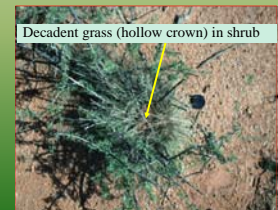
Cool vs. warm season, tall vs. short grass, sprouting vs. nonsprouting Shrub, fibrous vs. tap root, annual vs. perennial.....

Plant Mortality/Decadence

The proportion of dead/decadent plants expected for the site



Dead sagebrush in larger stand



Decadent grass (hollow crown) in shrub

Litter Amount

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



Adequate litter for site processes



Inadequate litter for site protection and nutrient cycling

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



Invasive exotic- Cheatgrass



State-listed noxious weed- Knapweed



Invasive native- Juniper

Reproductive Capability of Perennial Plants

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



Good reproductive potential



Poor reproductive potential



Area of Interest-Rills

Evaluate 17 Indicators at the Area of Interest

Indicator	Departure from Ecological Site Description/Ecological Reference				
	Extreme	Moderate to Extreme	Moderate	Slight to Moderate	None to Slight
L 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 in exposed areas.	Recent formation of rills; old rills have blunted or muted features.	Current or past formation of rills as expected for the site.
L 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

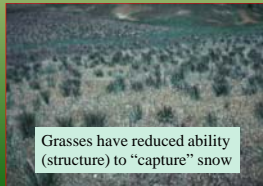
- | | |
|---------------------------------|---------------------------------------|
| 1. Rills | 9. Loss of soil surface |
| 2. Water Flow Patterns | 10. Plant/infiltration effects |
| 3. Pedestals/Terrecettes | 11. Compaction layer |
| 4. Bare Ground | 12. Functional/structural groups |
| 5. Gullies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

Linking Quantitative and Qualitative Data

Attribute	Qualitative assessment indicators	Key quantitative assessment indicators*	Selected measurements and reference
Soil and site stability	<ul style="list-style-type: none"> Rills Water flow patterns Pedestals and/or terraces 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 leaf gaps longer than XX cm	Basal gap intercept (3) Continuous line intercept (2)
Hydrologic function	<ul style="list-style-type: none"> Rills Water flow patterns Pedestals and/or terraces Bare ground Gullies Linear 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)
Biologic integrity	<ul style="list-style-type: none"> Soil surface resistance to erosion Soil surface loss or degradation Compaction layer Functional/structural groups Plant mortality/hydrochordae 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



56

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