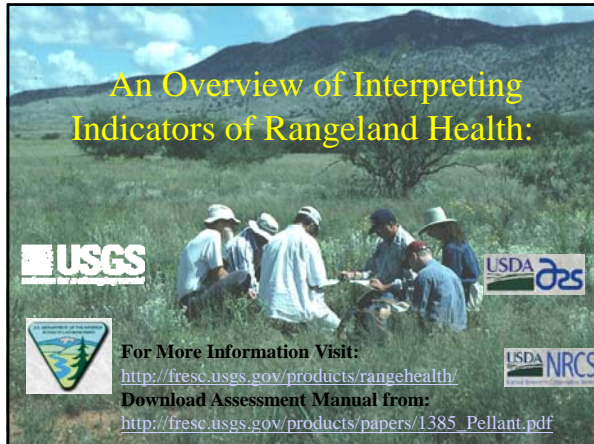


An Overview of Interpreting Indicators of Rangeland Health:



USGS
United States Geological Survey

USDA
Department of Agriculture

USDA NRCS
Natural Resources Conservation Service

For More Information Visit:
<http://fresc.usgs.gov/products/rangehealth/>
Download Assessment Manual from:
http://fresc.usgs.gov/products/papers/1385_Pellant.pdf

Overview: History & Tradition

- Early Surveys
- Vegetation Succession
 - Roots of Rangeland Status
- Traditional Approaches
 - Rangeland Condition
- Current Needs
 - Ecosystem Processes

Early Surveys

- USDA 1869 – 1905
 - Division of Botany (1869)
 - Botanical Surveys of the nation
 - Division of Ornithology & Mammalogy (1885-6)
 - Bird and Mammal Surveys
 - Division of Agrostology (1895)
 - Investigate grass, forage and range management

Carrying Capacity Surveys

- US Forest Service early 1900's
- Grazing on Forest Reserves
 - Allowed if it did not impact water conservation
 - Carrying Capacity Appraisals 1905
 - Indicated that carrying capacity was being reduced by overgrazing



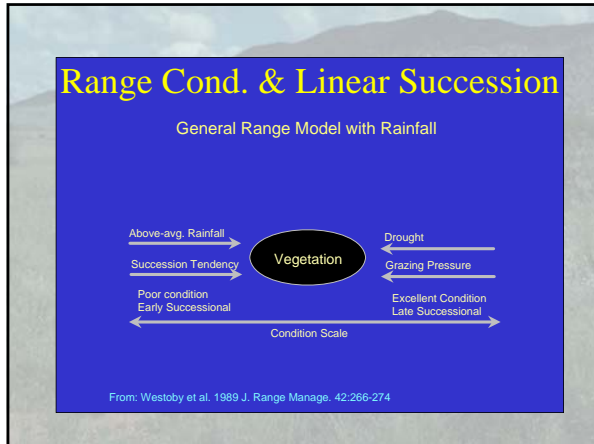
PLANT INDICATORS
THE RELATION OF PLANT COMMUNITIES TO PROCESS AND PRACTICE
BY FREDERIC S. CLEMENTS
PUBLISHED BY THE UNITED STATES DEPARTMENT OF AGRICULTURE

Mixed Grass Prairie

Overgrazed Shortgrass sod

Succession & Rangeland Condition

- Arthur Sampson 1919
 - Grazing shifts plant cover and species composition
- E. J. Dyksterhuis (1949)
 - Range Condition Classification
 - Classified plants into Increasesers, Decreasers and Invaders relative to grazing
 - Excellent, Good, Fair & Poor



- ## Other Techniques
- Parker Three-step (BLM & USFS 1950's)
 - Cover for Range Condition
 - Soil Surface Factors
 - Soil-based Condition
 - Nested Frequency
 - Utilization measurements

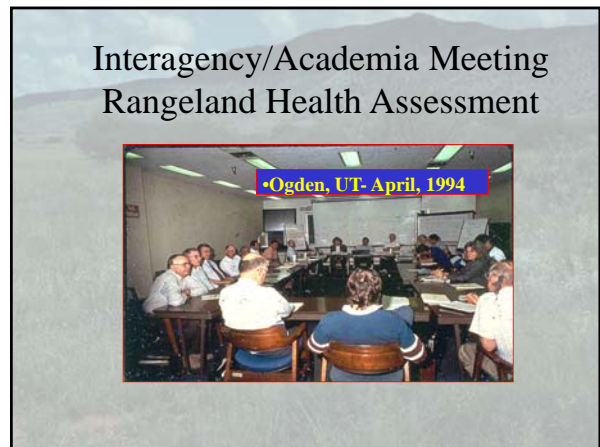
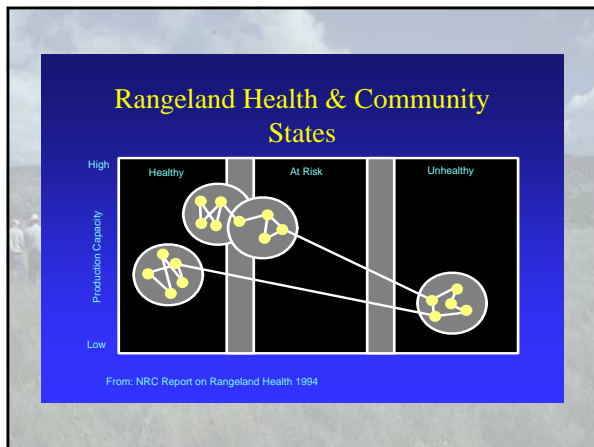
- ## Focused on Livestock Use
- Key Area – “A relatively small portion of rangeland selected because of its location, use or **grazing value** as a monitoring point for **grazing use.**”
 - Key Species – “**Forage** species whose use serves as an indicator to the degree of **use** of associated species.”

Focused on Biological & Physical Processes

1994

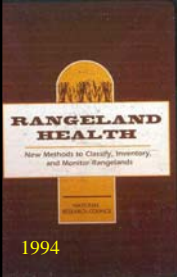
Smith et al. 1995 JRM

NEW CONCEPTS FOR ASSESSMENT OF RANGELAND CONDITION



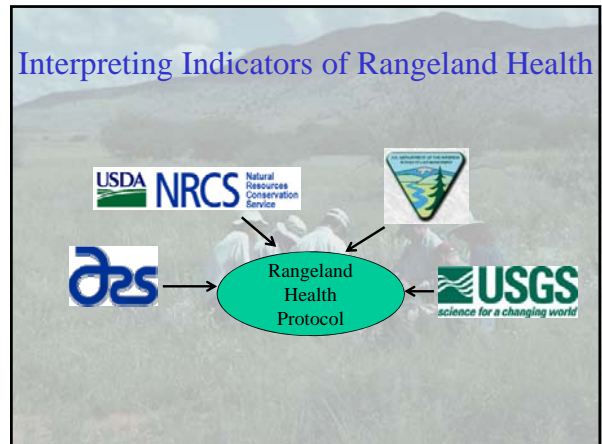
Rangeland Health

Focus Biological & Physical Processes



“The degree to which the integrity⁷ 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”




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

- **Inventory**
- **Monitoring**
- **Assessment**



Inventory

The systematic acquisition and analysis of resource information needed for planning and management. This information is generally not collected as frequently as monitoring data.



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Monitoring

The orderly and quantitative collection, analysis and interpretation of resource data to evaluate progress toward meeting management objectives.

Percent of Cover			
Attribute	1980	1990	2000
Bare Ground	12	20	26
Live Plants (canopy)	47	34	27

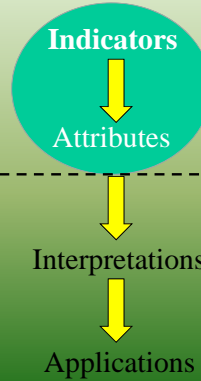
18

Assessment

The process of estimating or judging the value or functional status of ecological processes (e.g., rangeland health). It is generally a “moment-in-time” evaluation that is not repeated in the future (not a monitoring tool).



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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

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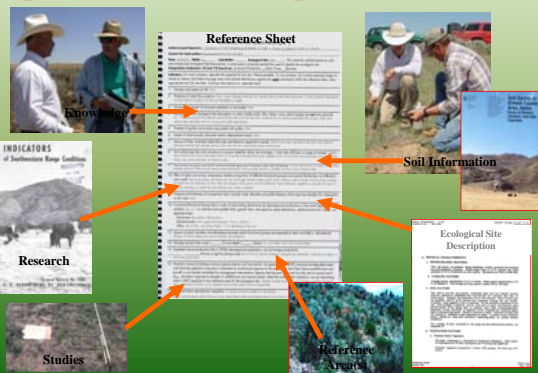
Step 1 – Verify Soils to Identify Ecological Site at Evaluation Area

- 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)



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Step 2 - Obtain or Develop Reference Sheet



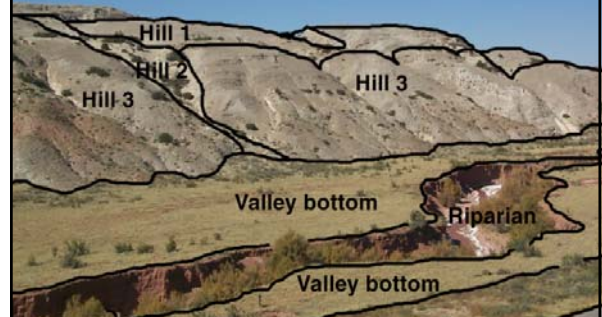
A unique reference is needed for each Ecological Site

- 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

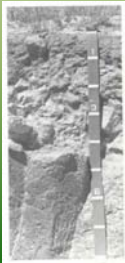


Using soils to identify ecological sites

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.

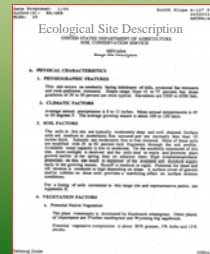
From a clear idea of the “**Reference State**” comes the development of a “**Reference Worksheet**”

Generating the Reference Worksheet

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

Generating the Reference Worksheet

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



<http://plants.usda.gov/esis>

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

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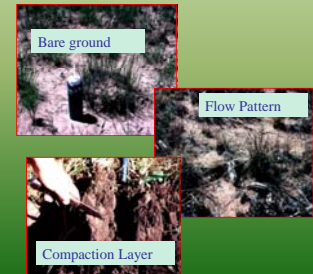
Step 4 - Rate 17 Indicators

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/Terracettes
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

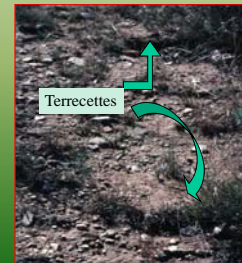
Path that water takes as it moves across the soil surface.



Pedestals/Terrecettes

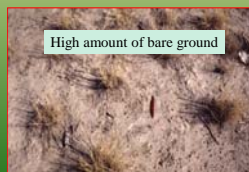


Do not evaluate frost-heaving



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



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



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

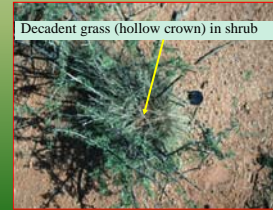
Cool vs. warm season, tall vs. short grass, sprouting vs. nonsprouting Shrub, fibrous vs. tap root, annual vs. perennial.....

Plant Mortality/Decadence

The proportion of dead/decadent plants expected for the site



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
I. 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 mostly in exposed areas.	No recent formation of rills; old rills have blunted or muted features.	Current or past formations of rills as expected for the site.
I. 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.

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.

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.



Indicators of Biotic Integrity

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**
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

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 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)
		<ul style="list-style-type: none"> Proportion of soil surface covered by canopy gaps longer than XX cm 	Canopy gap intercept (3) Continuous line intercept (2)
Hydrologic function	<ul style="list-style-type: none"> Rills Water flow patterns Pedestals and/or terracettes Bare ground Gullies Line assessment Soil surface resistance to erosion Soil surface loss or degradation Compaction layer Plant community composition and distribution relative to infiltration and runoff Litter amount 	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 Plant community composition and distribution relative to infiltration and runoff Litter amount 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 	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)
		Soil macro aggregate 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