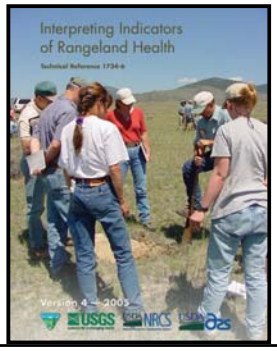
Indicators of Rangeland Health



Lecture Outline

1. User guidelines
2. Background concepts
3. Steps for using the protocol

Three Useful Tools

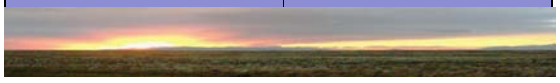
- Ecological sites
  - Land that has a similar potential to support certain plant communities based on soils and climates
  - Stratify landscape into similar units
- State and transition models
  - Evaluate current status of an area relative to its potential
  - Assess potential effectiveness of management options
- Qualitative indicators
  - Used with state and transition models to evaluate current status and identify critical processes
  - Provides preliminary evaluation of three attributes

Herrick et al. Vol. II 2009

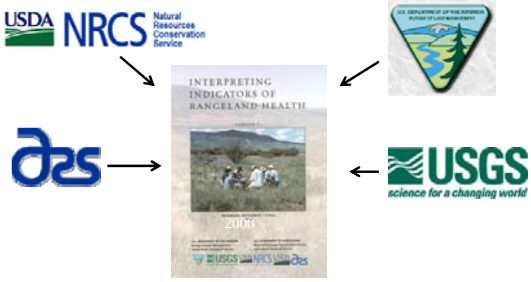
Uses and Constraints

IIRH is primarily a **qualitative assessment** protocol!

Appropriate Applications	Limitations in Use
Initial health evaluation	Requires local experience
Identify "at risk" areas	Doesn't establish cause
Select monitoring sites	Not a stand-alone decision tool
Communication tool	Not a monitoring technique



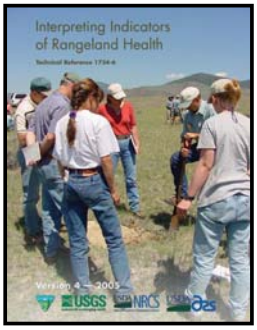
Interpreting Indicators of Rangeland Health-Version 3



1999 Peer Review

Interpreting Indicators of Rangeland Health-Version 4

2001 Peer Review



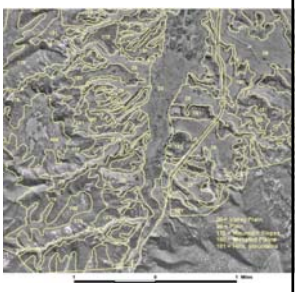
2005 Interagency TR

Background Concepts

1. Landscape Context
2. Natural Range of Variability
3. Indicators
4. Disturbance, Resistance and Resilience
5. States and Transitions

1. Landscape Context

- Divide landscape into similar ecological units
- Based on ecological sites and watersheds



1. Landscape Context

1. Spatial Variability
   - Both within and among ecological sites
2. Landscape relationships
   - Direct and indirect effects of nearby landscape units
     - Exs. Runoff, erosion, herbivory, pathogens
3. Spatial extrapolation
   - Generate maps to extrapolate to watershed

Examples of Landscape Context

- Water run-off upslope becomes run-on downslope
  - Positive downslope if water is captured
  - Negative if it erodes soil
- South vs. north slopes
  - Higher evaporation
  - Shallower soils
  - More bare soil

2. Natural Range of Variability

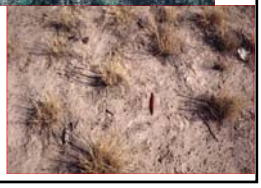
- Biological and physical components of an ecosystem vary in space and time.
  - Spatial Variation
    - Soils vary within an ecological site
    - Weather events can differ (e.g. convective storms)
    - Topographic positions
  - Temporal Variation
    - Precipitation cycles (e.g., drought or wet cycles)
    - Succession – e.g., time since fire

Does not include anthropogenic disturbances

Used to determine reference states

Range of Variation

- Bare Ground
  - Influenced by drought
- Woody plant cover
  - Influenced by fire
- Rills & flow patterns
  - vary with slope and time since heavy rainfall



3. Indicators

- Attributes
  - Larger concepts – e.g. Soil stability, hydrologic function, biotic integrity
  - Too difficult, complex or expensive to measure
- Indicators
  - Components of an attribute that can be measured or observed easily.
  - Suite if indicators is used as an index of an attribute.

IIRH Uses 17 Indicators to Assess Three Attributes

- No one indicator describes Rangeland Health or an individual attribute
- Uses 9-10 indicators per attribute
- Five narrative descriptors aid evaluators in determining ratings for indicators.

	Departure from Ecological Site Description/Ecological Reference Area(s)				
Indicator	**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 slight at infrequent intervals;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)					

Quantitative & Qualitative Studies

- Quantitative
  - Objective
  - Measure attributes

*"Cheatgrass cover is **85%**"*

- Qualitative
  - Observations
  - Describe or rate attributes

*"Cheatgrass is rated as **abundant**"*

Qualitative *vs.* Quantitative Indicators

- IIRH uses:
  - a combination of qualitative and quantitative indicators.
    - Soil stability is a quantitative measure
    - Rills are clearly qualitative
  - continuous indicators evaluated by appropriate ranking for the indicator
    - Five evaluation categories

Table 2 p. 13

Attribute	Qualitative assessment indicators	Key quantitative assessment indicators	Selected measurements and references
Soil and site stability	•Rills •Water flow patterns •Pedestals/terracettes •Bare ground •Gullies •Litter movement •Wind-scoured, blowouts and/or deposition areas •Soil surface resistance to erosion •Soil surface loss or degradation •Compaction layer •Litter amount	Bare ground	Line point intercept (2, 3) Point frame (2)
		Proportion of soil surface covered by canopy gaps longer than a defined minimum	Canopy gap intercept (3) Continuous line intercept (2)
		Proportion of soil surface covered by basal gaps longer than a defined minimum	Basal gap intercept (3) Continuous line intercept (2)
		Soil macroaggregate stability in water	Soil stability kit (3)

4. Disturbance, Resistance & Resilience

- Disturbance is a natural and necessary part of all ecosystems

Resistance and Resilience

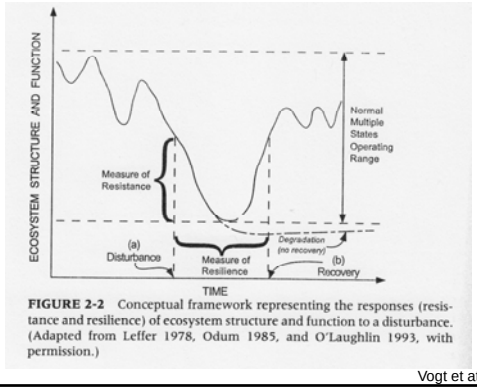


FIGURE 2-2 Conceptual framework representing the responses (resistance and resilience) of ecosystem structure and function to a disturbance. (Adapted from Leffer 1978, Odum 1985, and O'Laughlin 1993, with permission.)

Vogt et al. 1997

High Resistance, Low Resilience Ecosystem

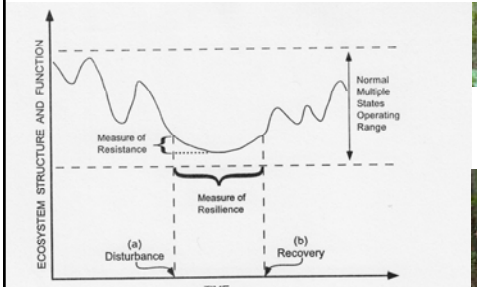


FIGURE 2-3 Ecosystems with a high resistance and lower resilience. (Adapted from Leffer 1978, Odum 1985, and O'Laughlin 1993, with permission.)

Vogt et al. 1997

Low Resistance, High Resilience Ecosystem

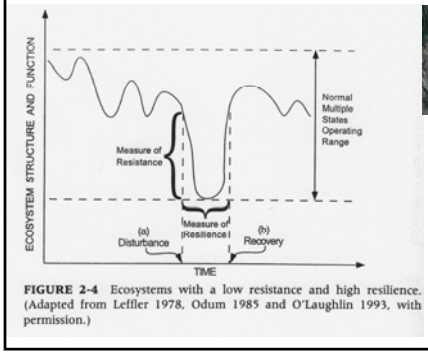


FIGURE 2-4 Ecosystems with a low resistance and high resilience. (Adapted from Leffler 1978, Odum 1985 and O'Laughlin 1993, with permission.)

Vogt et al. 1997

5. State and Transitions

- State – one or more biological and soil communities on a particular ecological site that are similar in:
  - Plant communities
  - Dynamic soil properties
  - Ecosystem properties
  - Response to disturbance
  - Function with respect to soil/site stability, hydrologic function, and biotic integrity

5. State and Transitions

- Transition – shift between states
  - Over time
  - Caused by natural or anthropogenic disturbance
  - May be reversible or irreversible
- Threshold – transition that is irreversible without severe intervention

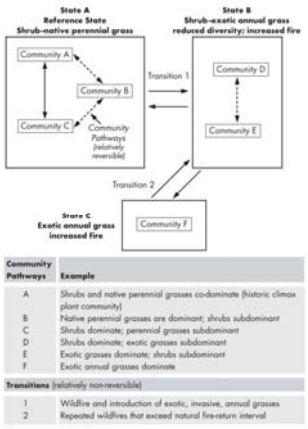
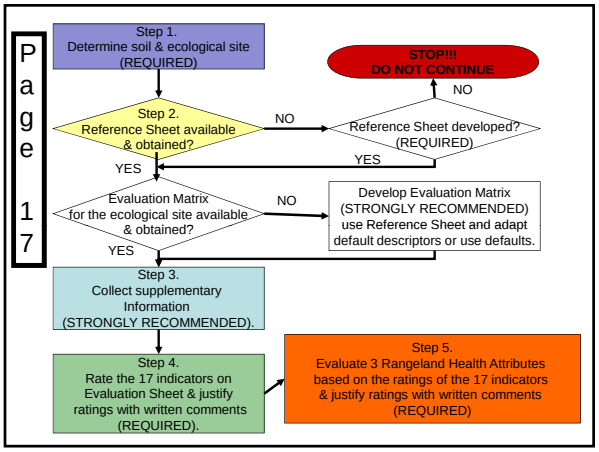


Fig. 2 p. 16
Pellant et al. 2005

Putting Concepts Together

- Ecological Sites
  - – Landscapes divided into similar ecosystems
  - – Natural range of variation
- Reference State
  - – Described by 17 indicators with variation
  - – Consider the resistance and resilience of communities to disturbance
  - – Related to state and transition models

Five Steps to Using Rangeland Health Assessment Protocol



1. Determine Soil and Ecological Site

- Slope, aspect, elevation, topographic position
- Verify soil
  - – Soil pit
    - Surface texture
    - Depth to restrictions
    - Diagnostic horizons
- Verify ecological site
  - – Soil & climate
- Document findings on Evaluation Sheet (front) (page 66)

2a. Develop Reference Sheet

Use:
•Ecological site descriptions, soil descriptions, maps, etc.
•Group of experts
•Define functional/structural groups

Basic – p. 72-73
Standard – p. 74-75


Reference Sheet (Basic Example*)

2B. Evaluation Matrix

- Write or modify descriptors for each site

p. 25

Table 4. Example of a revised descriptor for the bare ground indicator.

Indicator	Departure from Reference Sheet				
	Extreme to Total	Moderate to Extreme	Moderate	Slight to Moderate	None to Slight
4. Bare ground	Greater than 75% bare ground with entire area connected. Only occasional areas where ground cover is contiguous, mostly patchy and sparse.	60-75% bare ground. Bare patches are large (>24" diameter) and connected. Surface disturbance areas becoming connected to one another. Connectivity of bare ground broken occasionally by contiguous ground cover.	45-60% bare ground with much connectivity especially associated with surface disturbance.Individual bare spaces are large and dominate the area.	30-45% bare ground. Bare spaces greater than 12" diameter and rarely connected. Bare areas associated with surface disturbance are larger (> 15') and may be connected to other bare patches.	**Reference Sheet:** 20-30% bare ground; bare patches should be less than 8-10" diameter and not connected; occasional 12" patches associated w/shrubs. Larger bare patches also associated with ant mounds and small mammal disturbances.
Generic Descriptor	Much higher than expected for the site. Bare areas are large and generally connected.	Moderate to much higher than expected for the site. Bare areas are large and occasionally connected.	Moderately higher than expected for the site. Bare areas are of moderate size and sporadically connected.	Slightly to moderately higher than expected for the site. Bare areas are small and rarely connected.	Amount and size of bare areas match that expected for the site.

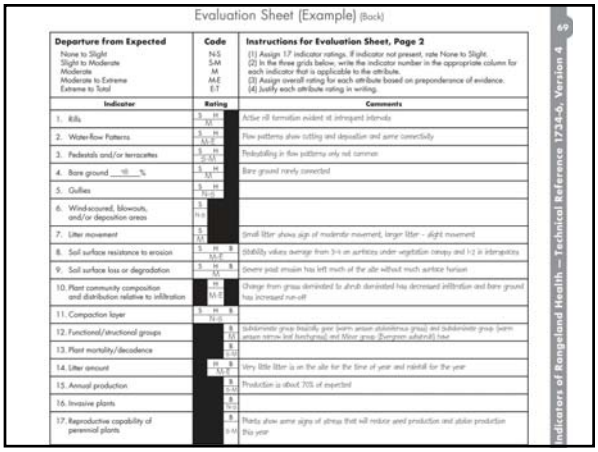
3. Collect Supplementary Data

- Spatial and Temporal Variability
- Ecological Reference Areas
- Functional/Structural Group Work Sheet (p. 78-79)
- Quantitative Data (p. 27)

p. 29-42

4. Rate 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


Evaluation Sheet (Example) (Back)

Departure from Expected	Code	Instructions for Evaluation Sheet, Page 2
None to Slight Slight to Moderate Moderate Moderate to Extreme Extreme to Total	N-S S-M M M-E E-T	(1) Assign 17 indicator ratings. If indicator not present, rate None to Slight. (2) In the three grids below, write the indicator number in the appropriate column for each indicator that is applicable to the attribute. (3) Assign overall rating for each attribute based on preponderance of evidence. (4) Justify each attribute rating in writing.

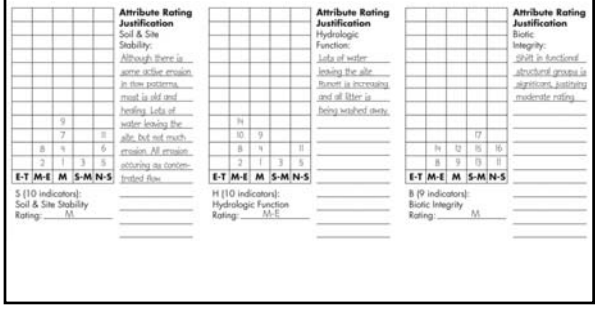
Indicator	Rating	Comments
1. Rills	3 H M	Active rill formation evident at infrequent intervals
2. Water-flow Patterns	3 H M-E	Flow patterns show rutting and deposition and some connectivity
3. Pedestals and/or terracettes	3 H M-E	Pedestalling in flow patterns only not common
4. Bare ground ___%	3 H M	Bare ground rarely connected
5. Gullies	3 H N-S	
6. Wind-scoured, blowouts, and/or deposition areas	3 N-S	
7. Litter movement	3 M	Small litter shows sign of moderate movement, larger litter - slight movement
8. Soil surface resistance to erosion	3 H M-E B	Stability values average from 3-4 on particles under vegetation canopy and 1-2 in interspaces
9. Soil surface loss or degradation	3 H M B	Severe past erosion has left much of the site without much surface horizon
10. Plant community composition and distribution relative to infiltration	H M-E	Change from grass dominated to shrub dominated has decreased infiltration and bare ground has increased run-off
11. Compaction layer	3 H N-S B	
12. Functional/structural groups	3 N-S	Subdominate group (warm season stoloniferous grass) and subdominate group (warm season narrow leaf bunchgrass) and Minor group (Evergreen subshrub) lose
13. Plant mortality/decadence	3 N-S	
14. Litter amount	H M-E B	Very little litter is on the site for the time of year and rainfall for the year
15. Annual production	B M-E	Production is about 70% of expected
16. Invasive plants	B N-S	
17. Reproductive capability of perennial plants	B S-M	Plants show some signs of stress that will reduce seed production and stolon production this year

Indicators of Rangeland Health — Technical Reference 1734-6, Version 4 69

5. Determine Status of Three Attributes

- ✧ Soil and site stability
- ✧ Hydrologic function
- ✧ Biotic integrity

5. Determine Status of Three Attributes


Attribute Rating Justification
Soil & Site Stability:
Although there is some active erosion in flow patterns, most is old and healing. Lots of water leaving the site, but not much erosion. All erosion occuring as concentrated flow.

E-T M-E M S-M N-S
9
7 11
8 4 6
2 1 3 5

S (10 indicators):
Soil & Site Stability
Rating: M

Attribute Rating Justification
Hydrologic Function:
Lots of water leaving the site. Runoff is increasing and all litter is being washed away.

E-T M-E M S-M N-S
H
10 9
8 4 11
2 1 3 5

H (10 indicators):
Hydrologic Function
Rating: M-E

Attribute Rating Justification
Biotic Integrity:
Shift in functional structural groups is significant, justifying moderate rating.

E-T M-E M S-M N-S
17
14 12 15 16
8 9 13 11

B (9 indicators):
Biotic Integrity
Rating: M

Attribute: Soil/Site Stability

The capacity of an area to limit redistribution and loss of soil resources (including nutrients and organic matter) by wind and water.


Desert grassland- good stability


Desert grassland- loss of stability

Indicators of Soil/Site Stability

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

Attribute: Hydrologic Function

The capacity of an area to capture, store, and safely release water from rainfall, run-on, and snowmelt (where relevant), to resist a reduction in this capacity and to recover this capacity when a reduction does occur.

Sagebrush "captures" snow

Grasses have reduced ability (structure) to "capture" snow

Indicators of Hydrologic Function

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

Attribute: Biotic Integrity

The capacity of a site to support characteristic functional communities (above and below ground) in the context of normal variability, to resist loss of this function and structure, due to disturbance, and to recover following such disturbances.

Joshua tree/blackbrush site

Integrity diminished by exotic grasses and increased fire

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. **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**

HOMEWORK!!

- Read about 17 indicators before field trip
  - Verbal descriptions pgs. 27-41
  - Photos pgs. 90-110