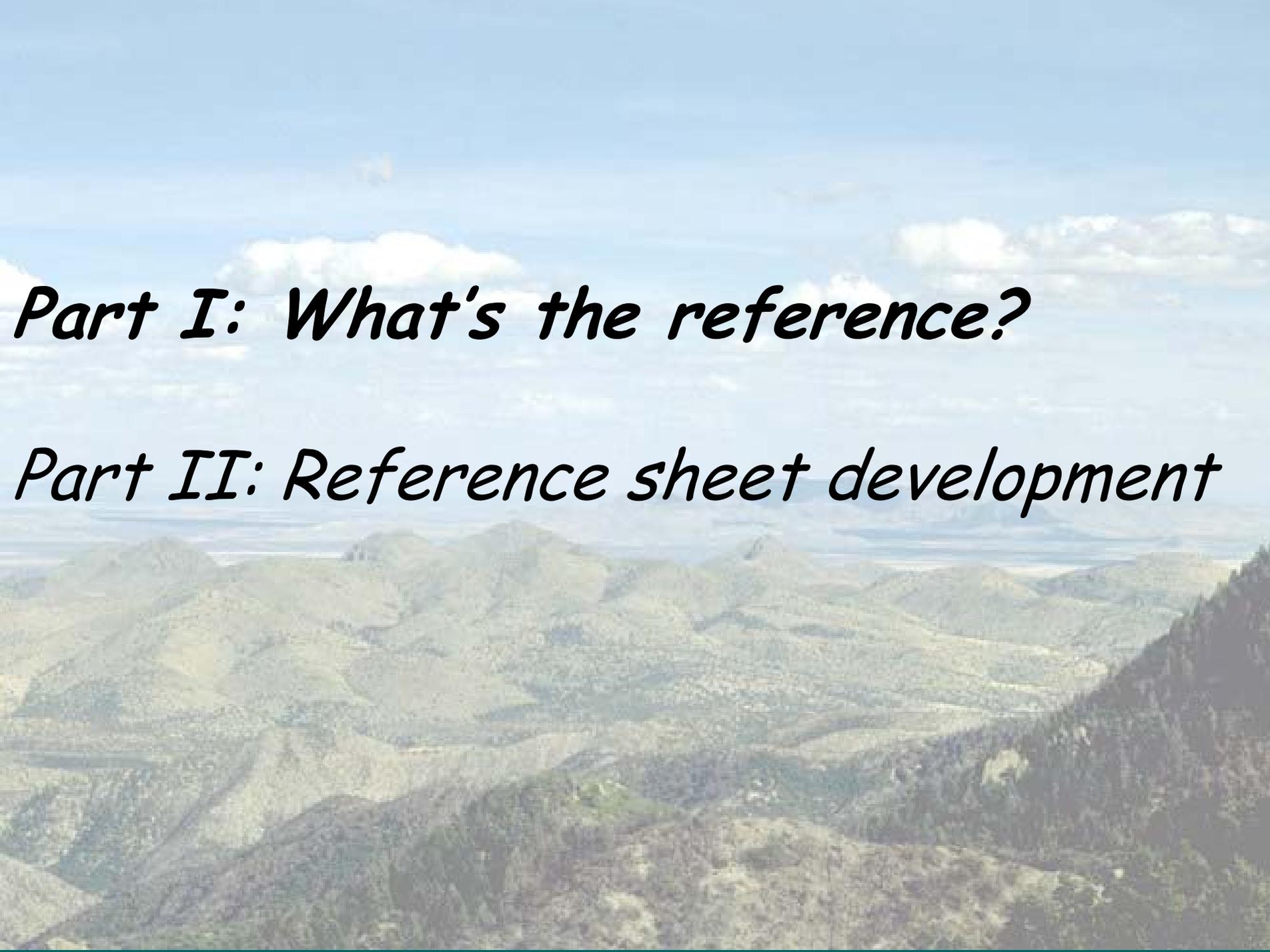


*Developing and Using Ecological  
Reference Sheets Based on  
Rangeland Health Indicators*

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An aerial photograph of a vast mountain range. The foreground and middle ground are filled with rolling hills and valleys covered in dense, green forest. In the far distance, a large, flat valley opens up, featuring a prominent lake or wetland area under a bright blue sky with scattered white clouds. The overall scene is a wide, panoramic view of a natural landscape.

*Part I: What's the reference?*

*Part II: Reference sheet development*

- The rangeland health reference is based on what is ***possible*** (long-term ecological potential) for a particular soil and climate combination (i.e. ***ecological site***)
- S&T models indicate what is ***realistic*** (based on short-term potential and limited resource availability) (i.e. communities in an ***ecological state***)

*A reference sheet is developed for the “Reference State” of each ecological site...*

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.

# *Reminder* -- RH and S&T are used together:

- To determine departure from the reference state
  - » None to Slight - is expected for the ecological site and falls within the range of variation for the indicator (no threshold crossed)
  - » SM, M, ME - indicates that a threshold is being approached or has already been crossed
  - » Extreme to Total - Up to and including maximum possible departure for the indicator
- To identify specific issues of concern (erosion, hydrology, biotic integrity)
- To help identify and communicate management options

# Generating the ecological reference worksheet

Capture  
temporal and  
disturbance  
variability!

## 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](mailto: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 play 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

# *A reference sheet for each Ecological Site is developed for the “reference state”*

**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:** Minimal on slopes less than 5% and increasing slightly as slopes increase up to 15%. Rills spaced 15-50 ft. apart when present on slopes of 10-15% under average when present. After wildfires, high human or herbivore impacts, extended drought or , or combinations of these disturbances, rills may double in numbers on slopes from 10-15% after high intensity summer thunderstorms.

**2. Presence of water flow patterns:** Generally up to 20 feet apart and short (less than 10 feet long) with numerous obstructions that alter the water flow path. On slopes of 10-15%, flow patterns increase in number and length (30% increase in both number and length. Flow pattern length and numbers may double after wildfires, high human or herbivore impacts, extended drought, or combinations of these disturbances if high intensity summer thunderstorms occur.

# Generating the ecological reference worksheet

Reference Worksheet defines the “None to Slight” Category in the Evaluation Worksheet



Table 2. Example of a revised descriptor for the bare ground indicator.

Indicator	Departure from Ecological Site Description/Ecological Reference Worksheet				
	Extreme	Moderate to Extreme	Moderate	Slight to Moderate	None to Slight
<b>4. Bare ground</b>	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.	Ecological Reference Worksheet: 20-30% bare ground; bare patches should be less than 8-10" diameter and not connected; occasional 12" patches assoc. w/shrubs. Larger bare patches also assoc. w/ant mounds & 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.

# *Generating the reference worksheet*

- ◆ What do you need to define potential for an ecological site?
  - Ecological Site Descriptions
  - Soil survey information
  - Ecological Reference Area(s)
  - Expert knowledge (old timers and brilliant ecologists)
  - Other data (e.g. from LTER, NRI, and other long-term studies)

# *Data collection for the reference description*

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- ◆ Become familiar with the 17 indicators
- ◆ Follow the examples.
- ◆ Use a blank reference sheet to record the qualitative observations made at an ESD data collection site.
- ◆ Use data collected from level 3 data soil/plant community data collection

# *Ecological Reference Area(s)*

“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”



**Verify soils**



# *Ecological Reference Area(s)*

Good location for level 3 data collection.

**Communication area**



**Establish baseline studies**



# Reference Sheet Development

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- ◆ Must develop Reference State descriptions for each indicator, if they are not available
- ◆ Done with a group of experts on soils and plants for the ecological site
  - Recommended to include multiple agencies, academics, ranchers and interested NGO's
- ◆ Compile all your resources
  - Ecological site descriptions, soil surveys, maps, photos, your data, etc.

# 12. Functional/Structural Groups

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## ◆ Begin here

- Most people are familiar with dominant plants
- Lays groundwork for understanding other indicators

## ◆ Why use F/S groups not species?

- Several species on an ecological site may fill a similar functional or structural role.
  - » One or a few species can be missing as long as the group's dominance order on the site is maintained

# *What are criteria for F/S Groups?*

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## ◆ Functional Groups

- Life Cycle (History) & Phenology
  - » Annual or Perennial
  - » Early vs. Late-season growth
- Photosynthetic Pathways
  - » C3, C4
- Nitrogen-fixing ability

## ◆ Structure

- Growth Form
  - » Tree, shrub, forb, graminoid, succulent, vine
  - » Tall, Short
  - » Rooting form for forbs (tap vs. fibrous)
  - » Clonal form (rhizomatous vs. bunchgrass)

# *Lumping & Splitting*

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- ◆ Consider plant communities in alternative states vs. the reference state.
  - Be certain you have represented the major F/S groups that can dominate the site in the reference state and any alternative states.
  - Are there F/S groups that will never dominate the site?
    - » If so, lump them with other groups
  - Do not have single species F/S group unless it will likely dominate the site in the reference or alternative states

# *F/S Reference Description*

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- ◆ Dominant > 40% composition
- ◆ Subdominant = 11 - 40 % composition
- ◆ Minor < 11 % composition
  - Describe groups that will be dominant and subdominant in the reference state and under what conditions might they change dominance and remain within the reference state
    - » Example - Sage & grass co-dominate without fire and grass dominates with recent fire.

# Guidance

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- ◆ General guidance for the development of ecological reference sheets for ESD's is available in *Interpreting Indicators of Rangeland Health*, ver 4.0, 2005. See pgs 15-16, 21-27, 72-75.
- ◆ Follow examples when writing each description.
- ◆ [www.blm.gov/nstc/library/techref.htm](http://www.blm.gov/nstc/library/techref.htm)
- ◆ This is a revised version. Changes are minor, except for the addition of the reference worksheet.