WHAT IS THE STANDARD FOR RANGELAND HEALTH ASSESSMENTS?

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Simply stated, rangeland health is the status of the soil, water and biological resources in rangeland ecosystems. An *ad hoc* U.S.A. federal committee defined rangeland health as the degree to which the integrity of the soil, vegetation, water and air as well as the ecological processes of rangeland ecosystems are balanced and sustained. Integrity was defined as the maintenance of functional attributes characteristic of a locale, including normal variability (USDA, NRCS 1997). Many investigators have proposed potential indicators for evaluating rangeland status (de Soyza, Whitford & Herrick 1997, Herrick *et al*. 2002, Herrick *et al.* 2003, Pellant *et al*. 2000, Pyke *et al.* 2002, Weltz, Frasier & Weltz 2000, Whitford *et al.* 1998, Woodley *et al.* 2000). All indicators can provide a moment-in-time estimate of their parameter, but without a range of values as a standard for management, managers will not know the status of the site. Where the only objective is to determine directional change, baseline measurements can be used as an internal reference for monitoring. In most cases, however, managers require an external benchmark to define the desired direction of change and when sufficient change has occurred.

Rangeland condition classification (Dyksterhuis 1949) used plant composition groups (decreasers, increasers and invaders) to generate condition estimates (excellent, good, fair, or poor). Declines in rangeland condition over time often stimulated management changes (Stoddart, Smith & Box 1975, Valentine 1990). Thus, condition classes became the standard for rangeland status in the latter half of the 20th century.

In the late 1900's, groups who reviewed techniques for evaluating rangeland status recommended development of both benchmarks and early warning indicators (NRC 1994, SRM Task Group 1995, West *et al.* 1994). The National Research Council (1994) and the SRM Task Group (1995) recommended that assessments be conducted to compare locales with similar soils and climate that have the capacity to support similar plant communities and production. These locales are defined as ecological sites (SRM Glossary Group 1998). Each ecological site should describe the potential for land to provide a range of soil and plant parameters representing the ecological site's ability to be sufficiently resistant and resilient to disturbances (vegetation phases in a successional state, Stringham, Krueger & Shaver 2001, Westoby, Walker & Noy-Meir 1989) that influence soil, water, and biological resources.

Although NRC (1994) and SRM Task Group (1994) incorporated concepts of thresholds and early warning indicators as elements of successful assessment and monitoring program, both admit that definitions of each are poorly understood. Until science can provide clearer quantifications of thresholds, managers will continue to use expert local knowledge to provide early warnings for changes in rangeland status. West *et al.* (1994) recommended using well-managed rangelands as the benchmark for comparisons of status.

One tool developed in response to these recommendations is Interpreting Indicators of Rangeland Health. In this technique, 17 observable indicators are used to rapidly assess three ecosystem attributes: soil and site stability, hydrologic function, and biotic integrity (Pellant *et al.* 2000, Pellant *et al.* 2003). During its initial development, the standard or reference status relied on information from ecological site descriptions (USDA NRCS 1997) and their associated soil survey descriptions (USDA NRCS 2001) as the primary source for the expected presence and amounts of each indicator. In conjunction with this documented information of indicator values, evaluators were asked to locate adequate reference (benchmark) sites that visually represented the range of indicators in an ecological site. However, some locations did not have soil surveys or ecological site descriptions available. On some ecological sites, adequate reference locations were not available, thus evaluators located potential reference locations and identified indicators that were not in agreement with ecological site descriptions, soil surveys or expert knowledge.

Pyke *et al.* (2002) modified the technique to use a reference worksheet for each ecological site as the standard (Table 1, Pellant *et al.* 2003). This new standard allows all sources of data and other information about the range of variability for each indicator to be integrated and recorded in a single location. The new approach reduces variability associated with individual interpretations of reference sites and ecological site descriptions associated with the Pellant *et al.* (2000) approach.

Table 1. Eleven of the seventeen indicators of Interpreting Indicators of Rangeland Health and an example of their expected presence and range of amounts used as a standard for assessment in the Limy Ecological Site Description, Southern Desertic Basins, Plains and Mountains Major Land Resource Area in New Mexico, U.S.A..

Indicators	Expected Presence & Amount
Number and extent of rills	None
Presence of water flow patterns:	None, except following extremely high intensity storms, when short (less than 1 m) flow patterns may appear
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 20-30 cm diameter; occasional 30 cm patches associated with shrubs. Larger bare patches also associated with ant mounds and rodent disturbances.
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 windstorms.
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 being 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.
Soil surface structure and SOM content (include type and strength of structure, and A-horizon color and thickness)	5-10 cm dark brown A horizon with medium granular structure (Otero County Armesa series description refers to platy structure; probably not from a true reference site).
Functional/Structural Groups (list in order of descending dominance by above-ground biomass)	Blue grama > Black grama > warm season bunchgrasses > Yucca = shrubs >> sub-shrubs = succulents; Forbs 0 – 8% depending on the year.
Average percent litter (cover and depth)	20 – 25% litter cover and 6 mm depth
Expected total above-ground production	727 -1340 kg.ha $^{-1}$ based on ecological site description.
Potential invasive (including noxious) species (native and non-native)	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.
Perennial plant reproductive capability	All species should be capable of reproducing

The worksheet should be developed by an interdisciplinary team of knowledgeable soil scientists along with plant and animal ecologists familiar with the soils and plants in the region. If data are available to support the expected values for an indicator, references should be given to the location or citation of the data. On sites without soil surveys or ecological site descriptions, these reference worksheets may act as a first approximation of the standard for the ecological site. They may be used until additional data are collected that refines the expectations for each indicator.
In the U.S.A., the USDA NRCS state rangeland conservationist was designated as the repository of these proposed reference worksheets. When ecological sites are developed or revised for an ecological region (Major Land Resource Area) of the U.S.A., these reference sheets could become part of the ecological site description and become draft standards throughout that region.

Interpreting Indicators of Rangeland Health, with this modification, could be applied to countries outside the U.S.A. All that is necessary are experts with knowledge of the soil, hydrology and biological interrelationships among the three

attributes of rangeland health. Workshops can be developed to draft an initial set of reference worksheets for soil and plant associations characteristic of ecological sites.

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