National Resources Inventory
Rangeland Resource Assessment

Rangeland Health

October 2010

The National Resources Inventory (NRI) is a statistical survey of natural resource conditions and trends on non-Federal land in the United States. Non-Federal land includes privately owned lands, tribal and trust lands, and lands controlled by state and local governments.

The NRI rangeland results presented here address current conditions. In the future, the NRI rangeland survey sample will include revisited sites. This will allow estimates for change in rangeland resource conditions to be made.

Basic interpretations of patterns recorded for each of the three attributes of rangeland health (soil and site stability, hydrologic function, and biotic integrity) throughout the United States are provided. Interpretations rely primarily on qualitative assessments that were made relative to the land's potential to support ecosystem services.

Plant and animal life depends on ecological processes such as the water cycle (the capture, storage, and safe release of precipitation), energy flow (conversion of sunlight to plant and then animal matter), and nutrient cycle (the cycle of nutrients through physical and biotic components of the environment). The rangeland health assessment provides information about how ecological processes are functioning relative to ecological potential. Because ecological potential varies both locally and regionally, NRI assessments of rangeland health use unique reference information for groups of soils that differ in their ability to support plant production, and in their response to management ("ecological sites").

Direct measures of site integrity and status are difficult or expensive due to the complexity of the processes and their interrelationships. Instead, biological and physical characteristics are used as indicators of the functionality of these processes. Taken together,

About the Data

Estimates presented here are based upon rangeland data collected on-site as part of the National Resources Inventory (NRI). Rangeland is defined by the NRI as a *Land cover/use* category on which the climax or potential plant cover is composed principally of native grasses, grass-like plants, forbs, or shrubs suitable for grazing and browsing, and introduced forage species that are managed like rangeland. This includes areas where introduced hardy and persistent grasses, such as crested wheatgrass, are planted and such practices as deferred grazing, burning, chaining, and rotational grazing are used, with little or no chemicals or fertilizer being applied. Grasslands, savannas, many wetlands, some

deserts, and tundra are considered to be rangeland. Certain communities of low forbs and shrubs, such as mesquite, chaparral, mountain shrub, and pinyon-juniper, are also included as rangeland.

These results are based upon NRI rangeland data collected in the field on rangeland during the period 2003-2006. Current estimates cover non-Federal rangeland in 17 western states (extending from North Dakota south to Texas and west) and to a limited extent in Florida and Louisiana.

The findings presented here summarize departures from reference conditions for three rangeland health attributes:

- Soil and site stability (SSS)
- Hydrologic function (HF)
- Biotic integrity (BI).

Quality assurance and statistical procedures are designed/developed

these indicators are used to assess three rangeland health attributes that collectively reflect the status of key ecological processes:

- **Soil and site stability** is the capacity of a site to limit redistribution of loss of soil resources (including nutrients and organic matter) by wind and water.
- **Hydrologic function** characterizes the capacity of the site 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 following degradation.
- **Biotic integrity** is defined as the capacity of a site to support characteristic functional and structural communities in the context of normal variability, to resist loss of this function and structure caused by disturbance, and to recover following such a disturbance.

Rangeland health evaluations enable identification of potential problems with respect to the associated attributes. These attributes provide qualitative ratings for on-site characteristics that would be difficult to capture with quantitative measures. The rangeland health tool is intended to communicate ecological concepts to the public and landowners, help identify possible land monitoring areas for more comprehensive conservation programs, and provide "early warnings" of potential problems.

Key Findings

- Nearly 80% of the Nation's 405 million acres of non-Federal rangeland is in a relatively healthy condition and has no significant soil, hydrologic or biotic integrity problems. Nationally, 20.7% of the of non-Federal rangeland showed at least moderate departure from reference conditions for at least one of the three attributes (Figure 1, Table

to ensure data are scientifically legitimate. Irrespective of the scale of analysis, margins of error must be considered. Margins of error (at the 95 percent confidence level) are presented for all NRI estimates.

About the Rangeland Health Protocol

A reference sheet is developed for each ecological site by experts with knowledge of soil, hydrology, and plant relationships to facilitate consistent application of the rangeland health assessment by integrating all available sources of data and knowledge for each of 17 rangeland health indicators (Pyke et al., 2002). The range of reference conditions is based on the natural variation of plant communities within the reference state

2) and 9.4% showed at least moderate departure for all three attributes (Figure 2, Table 2).

Figure 1. Non-Federal rangeland where at least one rangeland health attribute shows at least moderate departure form reference conditions

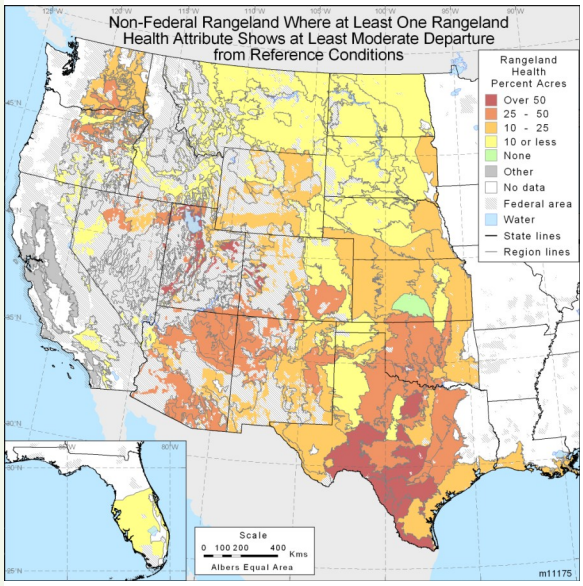
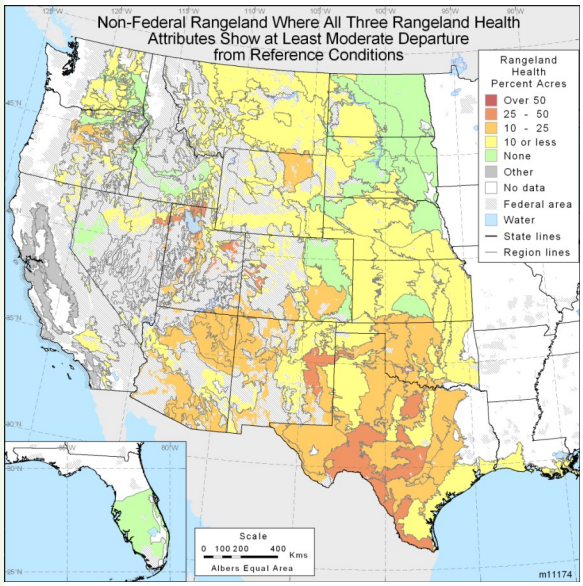


Figure 2. Non-Federal rangeland where all three rangeland health attribute show at least moderate departure form reference conditions



which includes the historic climax plant community. The 17 indicators are evaluated on degree of departure (none-to-slight, slight-to-moderate, moderate, moderate-to-extreme, and extreme-to-total) from the expected levels in the ecological site description (Pellant et al., 2005). The rangeland health attribute ratings for soil and site stability, hydrologic function, and biotic integrity were determined at each NRI sample location as the median rating for the group of indicators associated with each attribute (See Table 1 for the list of indicators and associated attribute). The median rating was used in place of the 'preponderance of evidence' approach prescribed by the original method in order to standardize

- Biotic integrity showed the most widespread departure from reference conditions, with moderate departure recorded on 17.7% of non-Federal rangeland (Figure 3, Table 2). Hydrologic function was second at 14.4% (Figure 4), followed by soil and site stability with 11.6% (Figure 5).

Figure 3. Non-Federal rangeland where biotic integrity shows at least moderate departure from reference conditions

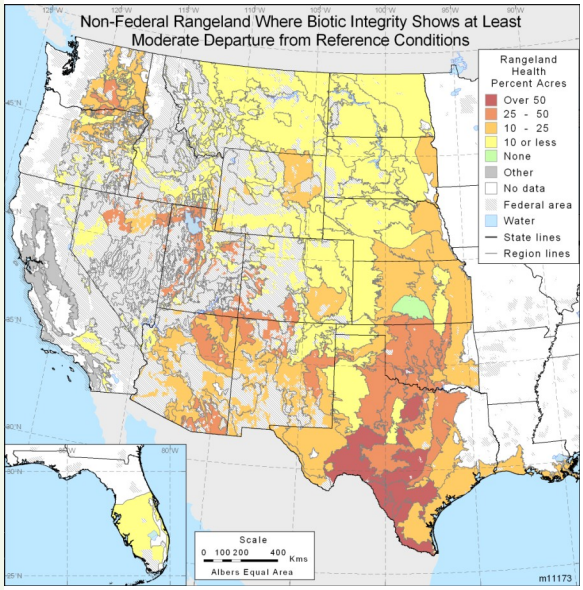
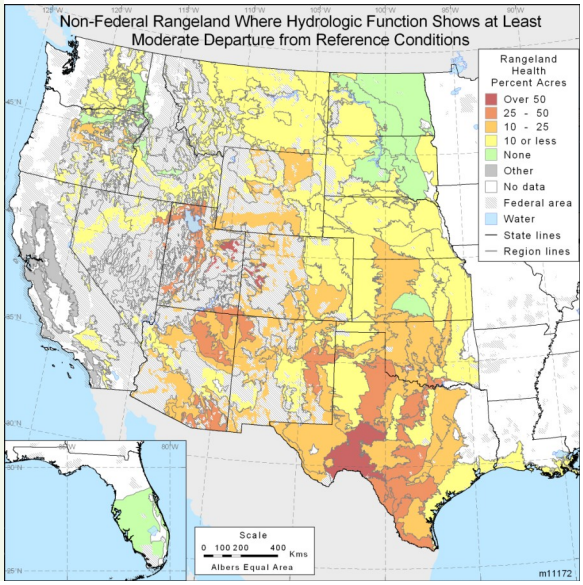


Figure 4. Non-Federal rangeland where hydrologic function shows at least moderate departure from reference conditions

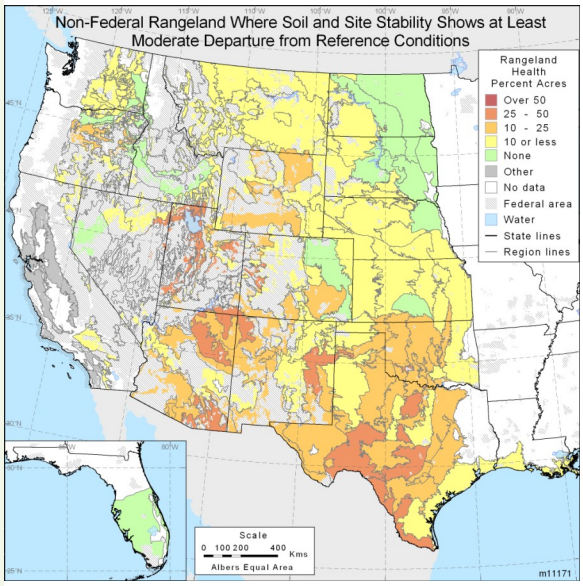


the method at the national level. For local applications of the method, the NRCS continues to advocate the use of the 'preponderance of evidence' approach.

About the Rangeland Health Maps

The maps are constructed with NRI rangeland data collected in the field on rangeland during the period 2003-2006. The rangeland health maps present the percent by classes (none, <10%, 10-25%, 25-50%, and >50%) of non-Federal rangeland where rangeland health attributes have at least moderate departures from the reference conditions. The regions are based on Common Resource Area (CRA) boundaries; in some cases CRAs were combined to include more sample sites. An additional category, referred to as "Other",

Figure 5. Non-Federal rangeland where soil and site stability shows at least moderate departure from reference conditions.



- The spatial patterns provide general information on the extent to which different types of ecosystem services from rangeland have been modified. Those services that depend on minimizing soil degradation, including soil erosion, should be relatively intact across much of the northern U.S., while greater changes are likely to have occurred in those that depend on a diverse, productive, native plant community. In the more arid southwest, degradation of both soils and vegetation has significant implications for the capacity of the land to support a wide variety of ecosystem services, including those related to water (Herrick et al. 2010).

represents areas for which the ecological site descriptions are under development and there is no reported rangeland health data. Regions without non-Federal rangeland are described as "No data". Areas of Federal land are depicted with cross-hatching.

Figures 1-5 represent rangeland health at a regional scale where the three attributes (SSS, HF, and BI) represent moderate, moderate-to-extreme, or extreme-to-total departure from the reference state as described in the ecological site description for that land area. Although the SSS map (Figure 5) exhibits departure ratings based upon rills, water flow patterns, pedestals and terracettes, bare ground, gullies, wind scour and depositional areas, soil resistance to erosion, soil surface loss or degradation, and soil compaction, not all of these indicators associated with SSS

Importance to the Nation

Rangeland health provides information on types, patterns and severity of problems in rangeland ecosystems relative to an agreed upon standard for each site. Land managers and policy-makers need this information to support strategic decisions and to identify the ecosystem processes that must be restored to improve the services that the land provides and to maintain or improve profitability.

Rangeland makes up 21% of the total area of the lower 48 States and thus:

- The condition of these lands directly or indirectly influences the environment enjoyed by the Nation.
- Meeting the Nation's objectives for natural resources and environmental quality will depend on how these lands are used and conserved.

represent greater than moderate departure. Some of the indicators associated with SSS may have been rated on a scale representing none-to-slight and slight-to-moderate departure, however, median rating was at least moderate. The same departure scenario is indicative of HF and BI (Figures 4 and 3, respectively), but with different sets of indicators. Note that some indicators are associated with more than one attribute while others are specific to a single attribute; this is intentional and is part of the evaluation process. See Table 1 for the list of indicators and associated attribute.

Tables and Results

Estimates presented here are based upon rangeland data collected on-site as part of the National Resources Inventory (NRI), a sample survey based upon scientific statistical principles and procedures. These results are based upon NRI rangeland data collected in the field on rangeland during the period 2003-2006 and address current conditions. These estimates cover non-Federal rangeland in 17 western states (extending from North Dakota south to Texas and west) and to a limited extent in Florida and Louisiana.

Margins of error are reported for each NRI estimate and must be considered at all scales of analysis. The margin of error is used to construct the 95 percent confidence interval for the estimate. The lower bound of the interval is obtained by subtracting the margin of error from the estimate; the upper bound is obtained by adding the margin of error to the estimate. A 95 percent confidence interval means that in repeated samples from the same population, 95 percent of the time the true underlying population parameter will be contained within the lower and upper bounds of the interval. In the following tables, if there are instances where the margin of error is greater than or equal to the estimate, the confidence interval includes zero and the estimate should not be used. In those cases, the estimate in the table is replaced by the word “Trace”.

Table 1. Standard indicators included in the Rangeland Health protocol and attribute (soil and site stability, hydrologic function, and/or biotic integrity) to which each indicator applies (Pellant et.al. 2005). The "X" indicates that the indicator is applied to the attribute.

Rangeland Health Indicator	Rangeland Health Attribute		
	Soil and Site Stability	Hydrologic Function	Biotic Integrity
1. Rills	X	X	
2. Water flow patterns	X	X	
3. Pedestals and/or Terracettes	X	X	
4. Bare ground	X	X	
5. Gullies	X	X	
6. Wind scoured, blowouts, and/or deposition areas	X		
7. Litter movement	X		
8. Soil surface resistance to erosion	X	X	X
9. Soil surface loss or degradation	X	X	X
10. Plant community composition and distribution relative to infiltration and runoff		X	
11. Compaction layer	X	X	X
12. Functional/structural groups			X
13. Plant mortality/decadence			X
14. Litter amount		X	X
15. Annual aboveground production			X
16. Invasive plants			X
17. Reproductive capability of perennial plants			X

Table 2. Percent of Non-Federal Rangeland by State Where Rangeland Health Attribute Ratings Are Moderate, Moderate-to-Extreme, or Extreme-to-Total Departures from Expected, by State, with Margins of Error

State	Area Not Reporting Rangeland Health[1]	Soil and Site Stability	Hydrologic Function	Biotic Integrity	All 3 Attributes	At Least One Attribute
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Arizona	0 NA	18.0 ±5.5	22.0 ±6.3	18.5 ±6.6	12.4 ±5.3	26.7 ±6.7
California	39.2 ±5.8	0 NA	0 NA	Trace	0 NA	Trace
Colorado	0 NA	7.8 ±3.4	12.0 ±5.0	13.5 ±4.0	6.6 ±3.0	16.7 ±5.4
Florida	0 NA	0 NA	0 NA	Trace	0 NA	Trace
Idaho	0 NA	Trace	1.7 ±1.6	5.3 ±2.0	Trace	5.6 ±2.1
Kansas	0 NA	5.8 ±2.0	7.6 ±1.9	6.0 ±2.2	2.9 ±1.6	10.0 ±2.5
Louisiana	0 NA	0 NA	0 NA	0 NA	0 NA	0 NA
Montana	0 NA	2.3 ±1.2	4.1 ±1.8	3.6 ±1.5	0.9 ±0.7	6.0 ±2.0
Nebraska	0 NA	3.7 ±2.2	4.5 ±2.3	7.9 ±2.4	1.8 ±1.5	10.2 ±2.9
Nevada	0 NA	Trace	3.9 ±3.0	12.9 ±6.4	Trace	13.6 ±6.2
New Mexico	0 NA	13.4 ±3.9	15.9 ±4.0	17.1 ±3.8	10.5 ±3.7	21.2 ±3.7
North Dakota	0 NA	Trace	0.8 ±0.7	4.5 ±2.1	0 NA	4.9 ±2.1
Oklahoma	0 NA	6.0 ±3.1	9.4 ±3.0	26.6 ±5.2	3.4 ±1.8	30.6 ±4.7
Oregon	0 NA	4.4 ±2.1	6.5 ±3.2	11.4 ±4.8	3.9 ±2.2	11.9 ±4.8
South Dakota	0 NA	1.0 ±0.8	Trace	5.6 ±3.1	Trace	5.9 ±3.1
Texas	0 NA	24.6 ±4.4	30.5 ±4.6	37.7 ±4.1	23.6 ±4.3	39.1 ±4.1
Utah	0 NA	28.2 ±11.7	34.5 ±13.3	33.0 ±9.3	19.4 ±7.9	43.8 ±13.5
Washington	0 NA	Trace	Trace	16.4 ±5.0	Trace	17.5 ±5.3
Wyoming	0 NA	10.2 ±4.5	9.4 ±4.1	8.0 ±3.6	4.1 ±3.1	13.6 ±4.2
Nation	1.7 ±0.3	11.6 ±1.3	14.4 ±1.4	17.7 ±1.1	9.4 ±1.1	20.7 ±1.2

[1] Areas where ecological site descriptions are still under development. Without an ecological site description and reference worksheet, no rangeland health assessment can be made. Notes: Estimates where margins of error are at least as large as the estimates are denoted as "Trace".

More Information

For more information about the NRI, visit http://www.nrcs.usda.gov/technical/NRI/

More information about ecological site descriptions may be found on, http://esis.sc.egov.usda.gov/

For more information about rangeland health, see:

Herrick, J.E., V.C. Lessard, K.E. Spaeth, P.L. Shaver, R.S. Dayton, D.A. Pyke, L. Jolley, J.J. Goebel. 2010. National ecosystem assessments supported by scientific and local knowledge. *Frontiers in Ecology and the Environment*. 8, pp.

Miller, M. E. 2008. Broad-scale assessment of rangeland health, Grand Staircase-Escalante National Monument, USA. *Range. Ecol. Manage*. 61, 249-262.

Pellant, M., P. Shaver, D.A. Pyke, and J.E. Herrick. 2005. Interpreting indicators of rangeland health, version 4. Technical Reference 1734-6. U.S. Department of the Interior, Bureau of Land Mangement, National Science and Technology Center, Denver, CO. BLM/WO/ST-00/001+1734/REV05. 122pp.

Pyke, D.A., J. E. Herrick, P. Shaver, M. Pellant, 2002. Rangeland health attributes and indicators for qualitative assessment. *Journal of Range Management*. 55, 584-597.

Send comments and questions to the NRI Help Desk (nri@wdc.usda.gov).