About the NRI

The National Resources Inventory (NRI) is a statistical survey designed to help gauge natural resource status, conditions, and trends on the Nation's non-Federal land. Non-Federal land includes privately owned lands, tribal and trust lands, and lands controlled by State and local governments.

The NRI is conducted by the Natural Resources Conservation Service (NRCS) in cooperation with Iowa State University's Center for Survey Statistics and Methodology.

The NRI is carried out under the authority of a number of legislative acts including the Rural Development Act of 1972, the Soil and Water Resources Conservation Act of 1977, the Federal Agriculture Improvement and Reform Act of 1996, and the Farm Security and Rural Investment Act of 2002.

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, grasslike 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 2004 to 2011. 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.

Quality assurance and statistical procedures are designed and implemented 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 Protocols

The findings presented here are derived using data collected for four field protocols:

Rangeland health

Data are used to assess three broad attributes: Soil and site stability, hydrologic function, and biotic integrity. 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 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 was used in place of the 'preponderance of evidence' approach prescribed by the original method in order to standardize 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.

Line point intercept

Line point intercept data are utilized in summaries of non-native plant species, non-native invasive herbaceous species, native invasive woody species, and bare ground. Line point intercept data are collected along two intersecting 150-foot transects centered on each sample location. Data collectors record plant species, litter, lichen, moss, rock fragment, bedrock, and/or bare soil present at each 3-foot interval.

Line intercept for inter-canopy gaps

Data are used to identify areas with large foliar inter-canopy gaps which have more exposure to erosion and may provide opportunity for invasive plants to become established. Inter-canopy gaps are measured using the line intercept transect protocol, an on-site method to record all foliar gaps of at least 1-foot in length along two intersecting 150-foot transects (Herrick et al. 2005).

Soil aggregate stability

Soil aggregate stability is a recognized indicator of soil quality and rangeland health. A rangeland soil stability test is conducted in the field. Soil (~ 1/4" or 6mm diameter) samples are exposed to rapid wetting (USDA-NRCS 2010; Herrick et al. 2001). Soil samples are rated on a scale from one to six based on a combination of ocular observations of slaking during the first 5 min following immersion in distilled water, and the percent remaining on a 1.5-mm sieve after five dipping cycles at the end of the 5-minute period. Soil stability is rated based on the outcomes of these water exposure techniques. Ratings range from 1 (very unstable) to 6 (very stable).

About the Maps

The maps are constructed with NRI rangeland data collected in the field on rangeland during the period 2004 to 2011. The regions are based on level IV ecoregion boundaries defined by the U.S. Environmental Protection Agency Western Ecology Division (http://www.epa.gov/wed/pages/ecoregions/level_iii_iv.htm). In some cases level IV ecoregions were combined to include more sample sites. An additional category, referred to as "Insufficient point count (35 or less)", represents areas where there were too few data points. Regions without non-Federal rangeland are described as "No on-site rangeland samples". Areas of Federal land are depicted with cross-hatching. Legend categories differ by map theme (e.g., rangeland health, invasive plant species, etc.)

Rangeland Health Maps

The maps are constructed with NRI rangeland data collected in the field on rangeland during the period 2004 to 2011. The rangeland health maps present the percent by classes (none, 10% or less, 10-20%, 20-30%, and over 30%) of non-Federal rangeland where rangeland health attributes have at least moderate departures from the reference conditions. The regions are based on level IV ecoregion boundaries defined by the U.S. Environmental Protection Agency Western Ecology Division (http://www.epa.gov/wed/pages/ecoregions/level_iii_iv.htm). In some cases level IV ecoregions were combined to include more sample sites. An additional category, referred to as "Insufficient reporting or point count (35 or less)", represents areas where there were too few data points or areas for which the ecological site descriptions are under development and there is no reported rangeland health data reported for over 10 percent of the region. Estimates were mapped for regions where less than 10 percent of the region did not report rangeland health data. Regions without non-Federal rangeland are described as "No on-site rangeland samples". Areas of Federal land are depicted with cross-hatching.

The figures in this module represent rangeland health at a regional scale where the three attributes (soil and site stability, hydrologic function, and biotic integrity) represent various levels (e.g., moderate, moderate-to-extreme, or extreme-to-total) of departure from the reference state as described in the ecological site description for that land area. Soil and site stability maps exhibit departure ratings based upon nine indicators (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). Hydrologic function is determined by rills, water flow patterns, pedestals and terracettes, bare ground, gullies, litter movement, soil resistance to erosion, soil surface loss or degradation, plant composition relative to infiltration, soil compaction, and litter amount. Biotic integrity is associated with soil resistance to erosion, soil surface loss or degradation, soil compaction, plant functional/structural groups, plant mortality, litter amount, annual production, invasive plants, and reproductive capability. 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.

Although these maps portray percentages of non-Federal rangeland with specific attribute ratings, not all of the indicators associated with that attribute may have that rating. For example, one map displays non-Federal rangeland where soil and site stability shows at least moderate departure from reference conditions. Although some of the indicators associated with soil and site stability may have been rated on a scale representing none-to-slight and slight-to-moderate departure, the median rating was at least moderate. The same departure scenario is indicative of hydrologic function and biotic integrity, but with different sets of indicators.

Non-Native Plant Species Maps

The maps are constructed with NRI rangeland data collected in the field on rangeland during the period 2004 to 2011. The regions are based on level IV ecoregion boundaries defined by the U.S. Environmental Protection Agency Western Ecology Division (http://www.epa.gov/wed/pages/ecoregions/level_iii_iv.htm). In some cases level IV ecoregions were combined to include more sample sites. An additional category, referred to as "Insufficient point count (35 or less)", represents areas where there were too few data points. Regions without non-Federal rangeland are described as "No on-site rangeland samples". Areas of Federal land are depicted with cross-hatching.

Non-native plant species maps are displayed by classes (none, 25% or less, 25-50%, 50-75%, over 75%) of non-Federal rangeland where non-native plant species are present or where they cover at least 25 or 50 percent of the soil surface.

Additional maps for non-native invasive herbaceous species groups are displayed by classes (none, 1% or less, 1-5%, 5-20%, over 20%) of non-Federal rangeland where these non-native invasive species groups are present.

Native Invasive Woody Species Maps

The maps are constructed with NRI rangeland data collected in the field on rangeland during the period 2004 to 2011. The regions are based on level IV ecoregion boundaries defined by the U.S. Environmental Protection Agency Western Ecology Division (http://www.epa.gov/wed/pages/ecoregions/level_iii_iv.htm). In some cases level IV ecoregions were combined to include more sample sites. An additional category, referred to as "Insufficient point count (35 or less)", represents areas where there were too few data points. Regions without non-Federal rangeland are described as "No on-site rangeland samples". Areas of Federal land are depicted with cross-hatching.

The maps present the percent by classes (none, 1% or less, 1-5%, 5-20%, over 20%) of non-Federal rangeland where native invasive woody species groups are present or cover or make up at least 5%, 15%, 30%, or 50% of the soil surface or relative plant canopy cover.

Bare Ground and Foliar Canopy Gap Maps

The bare ground and canopy gap maps present by classes (none, 10% or less, 10-25%, 25-50%, over 50%): (1) overall average bare ground on non-Federal rangeland; (2) non-Federal rangelands where at least 20, 30, 40, or 50 percent is bare ground; (3) non-Federal rangelands where 1- or 2-meter inter-canopy gaps account for at least 20 percent of the area; and (4) non-Federal rangelands where 1- or 2-meter inter-canopy gaps account for at least 20 percent of the area and inter-canopy gaps are at least 50 percent bare ground.

Soil Aggregate Stability Maps

The soil aggregate stability maps present by classes (none, 25% or less, 25-50%, 50-75%, over 75%) the amount of non-Federal rangeland where soil aggregate stability ratings are 4 or less, indicating less stable soil.

Bibliography

USDA Plants Database

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.

Archer, S.R., K.W. Davies, T. E. Fulbright, K.C. McDaniel, B.P. Wilcox, and K.I. Predick. 2010. Brush Management as a Rangeland Conservation Tool: A Critical Evaluation. In: Briske, D.D., editor. 2011. *Conservation Benefits of Rangeland Practices: Assessment, Recommendations, and Knowledge Gaps.* United States Department of Agriculture, Natural Resources Conservation Service. (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/technical/nra/ceap/?cid=stelprdb1045811 (last accessed 05/22/2014).

Daly, C., D. Bachelet, J. Lenihan, R. Neilson, W. Parton, and D. Ojima. 2000. Dynamic simulation of tree-grass interactions for global change studies. *Ecological Applications*. 10(2): 449-469.

Gillette, D.A. and A.M. Pitchford. 2004. Sand flux in the northern Chihuahuan desert, New Mexico, USA, and the influence of mesquite-dominated landscapes. *Journal of Geophysical Research, [Earth Surface]*. 109, F04003, doi:10.1029/2003JF000031.

Herrick, J.E., J.W. Van Zee, K.M. Havstad, and W.G. Whitford. 2005. Monitoring Manual for Grassland, Shrubland and Savanna Ecosystems. USDA-ARS Jornada Experimental Range, Las Cruces, New Mexico

Herrick, J.E., W.G. Whitford, A.G. de Soyza, J.W. Van Zee, K.M. Havstad, C.A. Seybold, and M. Walton. 2001. Field soil aggregate stability kit for soil quality and rangeland health evaluations. Catena 44:27-35.

Houghton, R.A., J.L. Hackler, K.T. Lawrence. 1999. The U.S. carbon budget: Contributions from land-use change. *Science*. 285(5427):574-578.

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.

Sheley, R.L., J.J. James, M.J. Rinella, D. Blumenthal, and J.M. DiTomaso. 2011. Invasive Plant Management on Anticipated Conservation Benefits: A Scientific Assessment, pp. 291-336. In: Briske, D.D., editor. 2011. *Conservation Benefits of Rangeland Practices: Assessment, Recommendations, and Knowledge Gaps.* United States Department of Agriculture, Natural Resources Conservation Service. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/technical/nra/ceap/?cid=stelprdb1045811120 (last accessed 05/22/2014).

Schimel, D., J. Melillo, H. Tian, A.D. McGuire, D. Kicklighter, T. Kittel, N. Rosenbloom, S. Running, P. Thornton, D. Ojima, W. Parton, R. Kelly, M. Sykes, R. Neilson, and B. Rizzo. 2004. Contribution of Increasing CO2 and Climate to Carbon Storage by Ecosystems in the United States. *Science* 287 (5460) [DOI: 10.1126/science.287.5460.2004]