RANGELAND
FIELD DATA TECHNIQUES AND DATA APPLICATIONS

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The National Resources Inventory 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.

FOR OVER 65 YEARS, THE U.S. DEPARTMENT OF AGRICULTURE NATURAL RESOURCES CONSERVATION SERVICE (USDA-NRCS) HAS BEEN CONDUCTING NATURAL RESOURCE INVENTORIES (NRI) ON PRIVATELY OWNED RANGELAND (SPAETH ET AL., 2003).

The NRI is important in the development of conservation policy and programs and is a nationally consistent source of data for the public and researchers in many fields.

In 1995, NRCS began to explore new assessment technologies and field data collection techniques for the rangeland NRI. New concepts in evaluating rangeland health were emerging as possible tools to provide a preliminary evaluation of biotic integrity, hydrologic function, and soil surface stability.

Rangeland professionals, managers, and ranchers have "on the ground" expertise that is a valuable asset. Trained people can key into visual aspects of the landscape, which are not always quantitative in nature, but are valuable in determining subtle rangeland trends and changes. For example, indications of water and wind erosion on rangeland can be determined by a variety of field observed indicators, which are generally not parameters in predictive hydrology and erosion computer models (Figure 1). Indicators can be pedestalled plants; the base of plants discolored by soil movement from raindrop splash or overland flow; exposed root crowns; the formation of miniature debris dams and terraces; puddled spots on soil surface with fine clays forming a crust in minor depressions which crack as the soil surface dries and the clay shrinks; initiation of minute rills which can enlarge and form gullies; accumulation of soil in small alluvial where there are minor changes in slope; surface litter, rock or fragments exhibit some movement and accumulation of smaller fragments behind obstacles; and water flow paths contain silt, sand deposits. On every watershed and site within the watershed, a critical point of deterioration due to surface erosion exists. Beyond this critical point, erosion continues at an accelerated rate, which cannot be ove come by the natural vegetation and soil stabilizing forces. Areas th have deteriorated beyond this critical point can continue to eroc even when disturbances are removed.

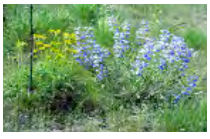
Thus, qualitative based assessments are needed and useful c rangeland. Many versions of these tools have been used over th years by several land management agencies (National Researc Council, 1994). Interagency coordination, refinements, and testir has resulted in the development of a tool to interpret indicators rangeland health. Rangeland Health consists of 17 field observe indicators, which are used to assess biotic integrity, hydrologi function, and soil surface stability (Pellant et al., 2005).

In 2003, the new rangeland NRI was conducted in 15 state The primary sample unit point is navigated via global positior ing system (GPS) and the basic field measurements are conduc ed at three scales: transects (two,150 ft); macroplot (150 fe diameter); and conservation treatment unit. The current range land NRI is designed to sample data at a National leve Rangeland data is collected at two random points for each pr mary sample unit. The current rangeland NRI is conducted c a computer assisted survey instrument (CASI) that has been speci ically programmed with the current rangeland field protocols. Fe example, the USDA PLANTS database (http://plants.usda.gov) included with the ability to create custom, most frequently used, plar files. By using the standard PLANTS database, plant symbols ar names are consistent.

The NRI data can be used for many applications. Tradition data reports (USDA, 1982, 1987, 1992) and an active NRC

Figure 1. Examples of field indicators that are relevant to Rangeland Health determinations.

a) Plant pedestal caused by wind erosion. Note the exposed roots (arrow).



b) Perennial forbs and grasses show good potential for reproduction as evidenced by flowers and seed stalk production.

c) Dead and decadent sagebrush plants. (Artemisia spp.)

d) Excessive water flowpatterns in plant interspaces—indicative of high overland water flow.

e) Juniper, a native tree can be invasive on certain rangeland sites where other shrubs and herbaceous plants are predominant.

f) Surface physical and biological crusts can protect against wind erosion. Biological crusts are an important functional/structural group in many rangeland plant communities

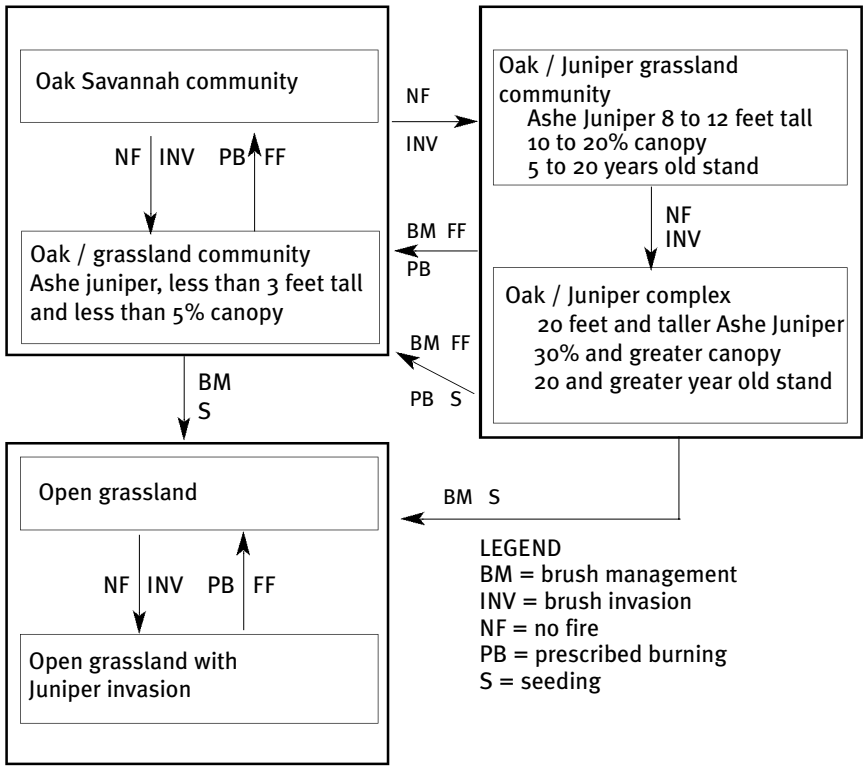


Figure 2. The following diagram illustrates the common plant communities that can occur on the site and the transition pathways (arrows) among communities. Bold lines surrounding each plant community or communities represent ecological thresholds.

NRI website (http://www.nrcs.usda.gov/technical/NRI/) provide reports and current statistics for a variety of land uses. Other uses include ecological site description development, quantitative data to support developing reference materials for Rangeland Health evaluations, training, scientific studies, and conservation program development.

Ecological Site Development

The Ecological Site Information System is the repository for the data associated with the collection of forestland and rangeland plot data and the development of ecological site descriptions (http://esis.sc.egov.usda.gov/). The Ecological Site Information System is organized into two applications and associated databases: ecological site description, and ecological site inventory. The Ecological Site Description application provides the capability to produce automated ecological site descriptions. The Ecological Site Inventory application provides the capability to enter, edit, and retrieve rangeland, forestry and agroforestry plot data.

The collection of plot data is an important activity conducted by the NRCS. The data are used to develop inventories for planning, to monitor ecological change, provide data to make management decisions, develop ecological site descriptions, obtain data for rangeland hydrology and erosion models, study conservation treatment effects, and provide information to develop ecological reference sheets for rangeland health. For example, the number of completed primary sample unit points in the 2003 survey was 980; whereas in 2004, 2,369 points were sampled. These data can be used to refine existing or develop new ecological sites.

NRCS now uses the State and Transition Model concept for describing a site's response to natural and human induced disturbances (Figure 3,4). State and Transition Models provide the framework for documenting potential ecosystem dynamics. Each newly revised ecological site description will contain a state and transition diagram. A state is a recognizable, resistant, and resilient vegetative complex consisting of two ecosystem components, the soil base and vegetation structure (Stringham et al., 2003). Transitions are trajectories of change that are caused by natural and/or management actions (Bestelmeyer et al., 2003). The information in the rangeland NRI will provide much needed quantitative information for ecological site description updates.

Develop a Quantitative Basis

It is a challenge for scientists and land managers to communicate information about rangeland condition and health into ways that the public can easily understand. The NRCS uses three evaluation tools (similarity index, apparent rangeland trend, and Rangeland Health) to assess ecological processes and function on rangeland. These three tools are included in the rangeland NRI process. Similarity index is a mathematical measure of the percentage of a specific vegetation state plant community that is presently on the site (USDA-NRCS, 2003). Apparent trend is defined as the direction of change in an existing plant community relative to the historic climax plant community. Trend ratings include moving toward historic climax plant community (HCPC), moving away from the HCPC, or not apparent.

The Rangeland Health assessment provides information about how ecological processes such as the water cycle, energy flow, and nutrient cycle are functioning relative to the ecological site-specific reference sheet. The reference sheet is developed by experts with knowledge of soil, hydrology, and plant relation-

DEEP REDLAND ECOLOGICAL SITE
STATE AND TRANSITION MODEL EXAMPLE

Figure 3. Pictorial representation of state and transitions for Deep Redland Ecological Site.

ships to facilitate consistent application by integrating all available sources of data and knowledge for each of the 17 Range Health indicators (Pyke et al., 2002). The range of expected conditions is based on the natural variation within the historic climax plant community. The historic climax plant community is the primary or first state given in the ecological site description. The 17 indicators are evaluated on degree of departure (none-slight, slight-to-moderate, moderate, moderate-to-extreme, and extreme) from the expected levels in the ecological site description (Pellant et al., 2005). Rangeland Health does not produce an overall condition or numeric score for a site and should be used in association with other quantitative monitoring and assessment approaches.

The Rangeland Health procedure can be taught to experienced rangeland managers with a good understanding of rangeland ecological processes to provide a preliminary assessment of biotic integrity, hydrologic function, and soil surface stability at the ecological site level. The Rangeland Health tool is intended to communicate ecological concepts to the public and landowners, help identify possible land monitoring areas for more comprehensive programs, and provide "early warnings" of potential problems.

Training Opportunities

The rangeland NRI process has trained many range and grassland specialists and contractors from all participating states (Figure 4). The NRI process also requires that all field crews be competent in identifying native rangeland plants and noxious and invasive species. Experienced, as well as new employees, are honing their plant identification skills.

Rangelands are complex, and determining their condition and health requires a combination of quantitative and qualitative assessment tools. An interagency two-volume set of monitoring manuals has been recently published by ARS Jornada Experimental Range (Herrick et al., 2005). These volumes include the quantitative NRI protocols and are intended to assist a wide range of users such as ranchers and landowners, land managers, rangeland professionals, and researchers.

Apart from published results of the NRI, the data can be used to enhance our scientific knowledge about rangeland environments. For example, types of plant species, amount of biomass and cover, and numerous soil properties are associated with hydrology and erosion dynamics (Spaeth et al.,19 9 6 a ; b; Pierson et al., 2002). The NRI data will allow rangeland scientists to study correlations between these landscape components. In the western United States, rangeland specialists and scientists are interested in relationships between canopy cover and basal gaps in vegetation and soil surface stability. For example, on Wyoming and Mountain big sagebrush sites, the NRI data already shows a strong correlation between canopy cover and soil surface stability: As canopy cover increases, soil surface stability increases. These trends are what rangeland managers would expect and preliminary data shows that the rangeland health tool, although qualitative in nature, shows these relationships quite definitively. The rangeland NRI can be used to help provide a quantitative basis for the qualitative aspect of rangeland health.

As the NRCS continues to gather rangeland data from the NRI, a large national database on trends and conditions of the Nation's non-federal rangelands will be developed. When the data from the ecological evaluations of rangeland trend, rangeland similarity index, and rangeland health are combined with the remaining NRI data, the ability to analyze the conditions of the Nation's rangeland resources will be greatly enhanced. Publications and scientific symposia will be a valuable part of transferring NRI information.

As rangeland status is obtained, analysis can be used to evaluate the effectiveness of NRCS technical assistance and program implementation, and can be used to develop and refine long range plans for organization, staffing, and conservation program development.

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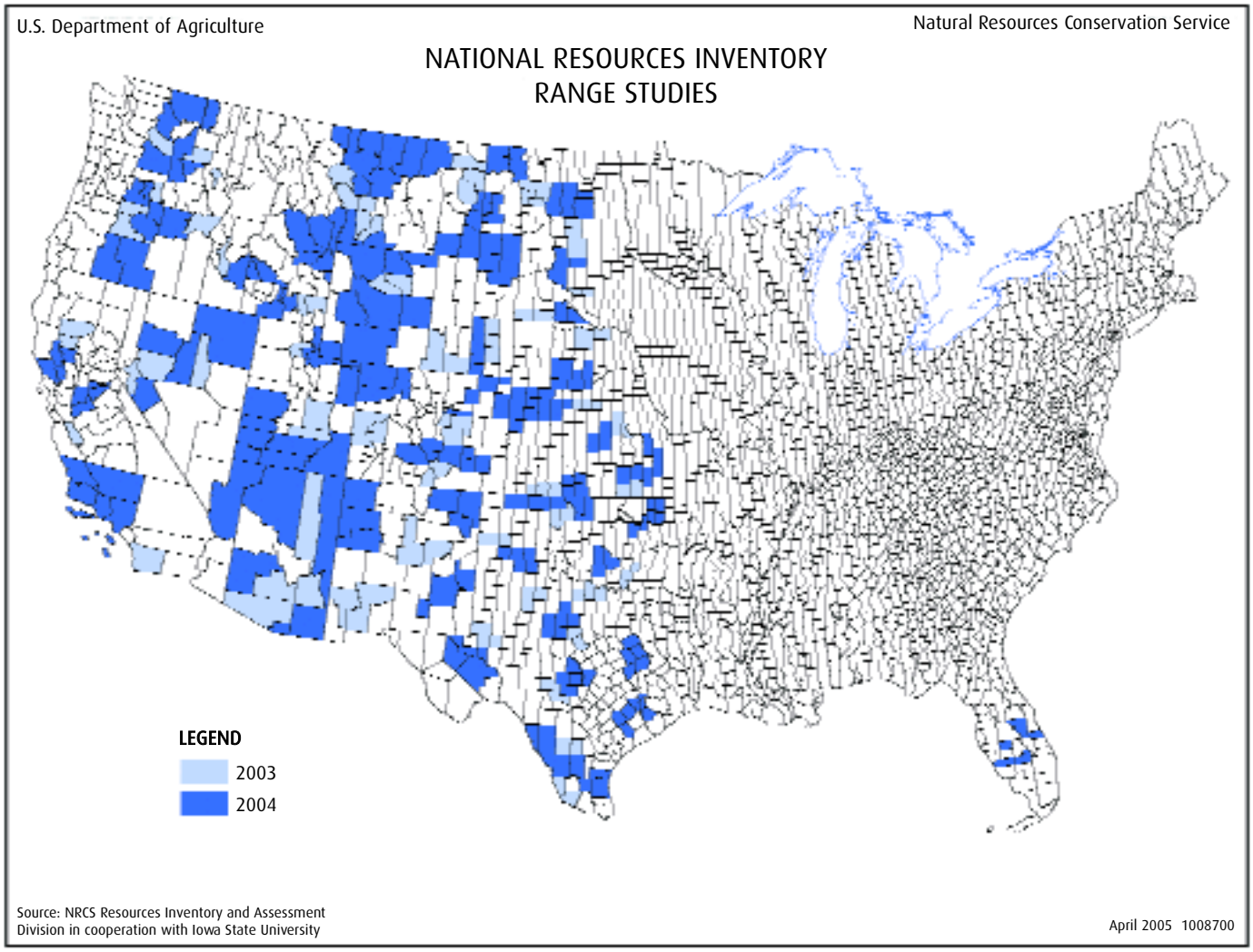

Figure 4. States and counties sampled in the 2003-04 USDA-NRCS Rangeland National Resources Inventory. Note: additional counties will be sampled in subsequent years.

A preliminary analysis of 980 primary sample unit points from the 2003 Natural Resources Inventory (NRI), showed that rangeland health-biotic integrity appears to be moderately correlated with apparent trend (r -0.44) and similarity index (r -0.40). The negative correlations indicate that as biotic integrity moves toward extreme departure from the ecological site description, apparent trend and similarity index decrease. At the ecological site level, the correlation can be higher because of less variability as found in the entire sample data set. As an example, biotic integrity, hydrologic function, and soil surface stability were highly correlated with similarity index (> r 0.80) for the loamy foothills ecological site (Colorado).