United States Department of Agriculture

Soil and Water Resources Conservation Act
National Conservation Program
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IMPROVED CONSERVATION OUTCOMES ON U.S. RANGELAND

Rangelands are the dominant land cover type in the United States. These lands occur mainly in the 17 western States, and slightly more than half of the nearly 800 million acres of U.S. rangelands are non-Federally owned (fig. 1). About 26 million acres of non-Federal rangeland were converted to other uses from 1982 to 2007 (fig. 2), mostly cropland and development. These losses were partially offset by conversion of about 17 million acres of land in other uses, mostly cropland and pasture, to rangeland.

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Rangeland Ecological Sites

Ecological sites comprise a land classification system that describes ecological potential and ecosystem dynamics associated with particular combinations of geomorphology, hydrology, and biotic communities. An ecological site has specific soil and physical characteristics that distinguish it from other sites in its ability to produce distinctive kinds and amounts of vegetation, and in its ability to respond similarly to management actions and natural disturbances. Consequently, each ecological site includes one or more functionally similar patches of rangeland.

Ecological Site Descriptions (ESDs) describe (1) the biophysical properties of the ecological site; (2) plant composition—productivity and cover by plant species; (3) state-and-transition models of the vegetation and dynamic soil properties of each state; (4) the factors that drive shifts among states (across thresholds) and among plant communities

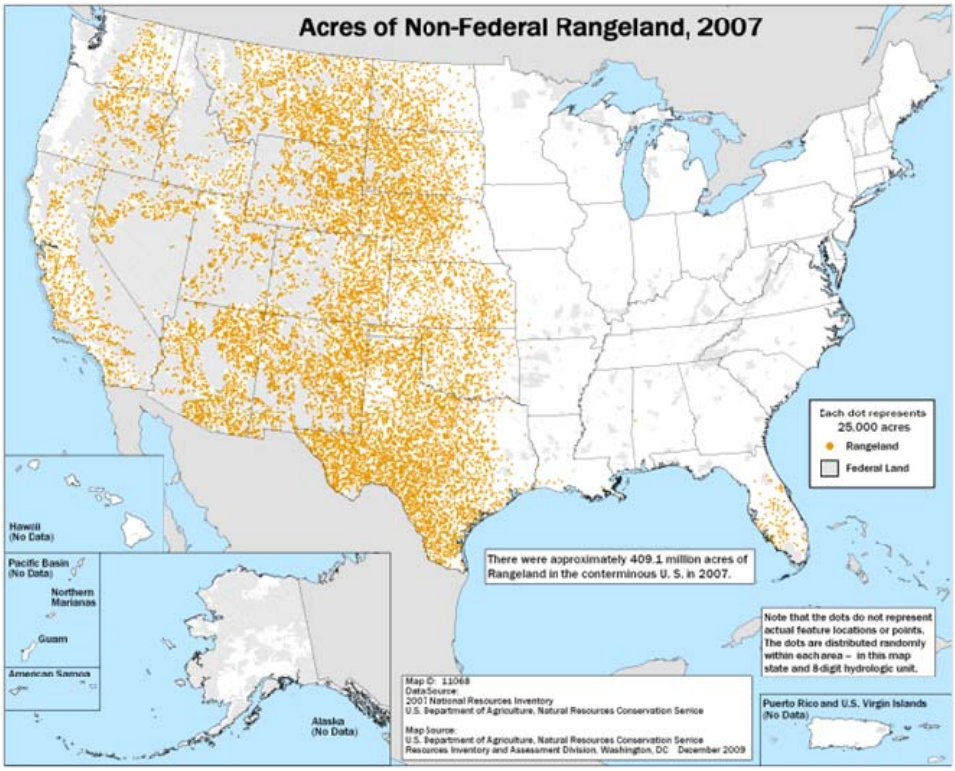


Figure 1. Location of U.S. non-Federal rangeland

SOURCE: USDA-2007 NRI

within states, and (5) some of the ecosystem services that can be provided by the ecological site. State-and-transition models synthesize scientific literature and local knowledge tied to particular ecological sites to distinguish changes in vegetation and soils. Ecological site descriptions also identify thresholds, natural and management disturbances, and selected conservation practices and management treatments. Some thresholds are reversible with the adoption of appropriate conservation practices, but others are too costly or impossible to reverse.

Rangeland Health

In the United States, 17 ecological indicators are used to assess three attributes of rangeland health: soil and site stability, hydrologic function, and biotic integrity. USDA-National Resources Inventory (NRI) data were used to derive a qualitative rangeland health assessment (fig. 3) (Spaeth et al. 2003; Herrick et al. 2010). The analysis of NRI data revealed that approximately 80 percent of the nation's non-Federal rangelands were in a "none to slight" or "slight to moderate" departure class relative to ecological site reference conditions[1] for each of the three rangeland health attributes (Herrick et al. 2010). Conditions on more than 20 percent of the non-Federal rangeland depart at least moderately from reference conditions in terms of resistance to erosion; the ability of the soils to capture, store, and safely release water; or the capacity of the site to support characteristic and functional plant communities. Almost 10

[1] Rangeland health is ranked "none to slight" departure from reference conditions, "slight to moderate," "moderate," "moderate to extreme," or "extreme to total." "Moderate" departure can indicate a significant change or threshold point from reference conditions.

Figure 2. Gains and losses of non-Federal rangeland, 1982–2007

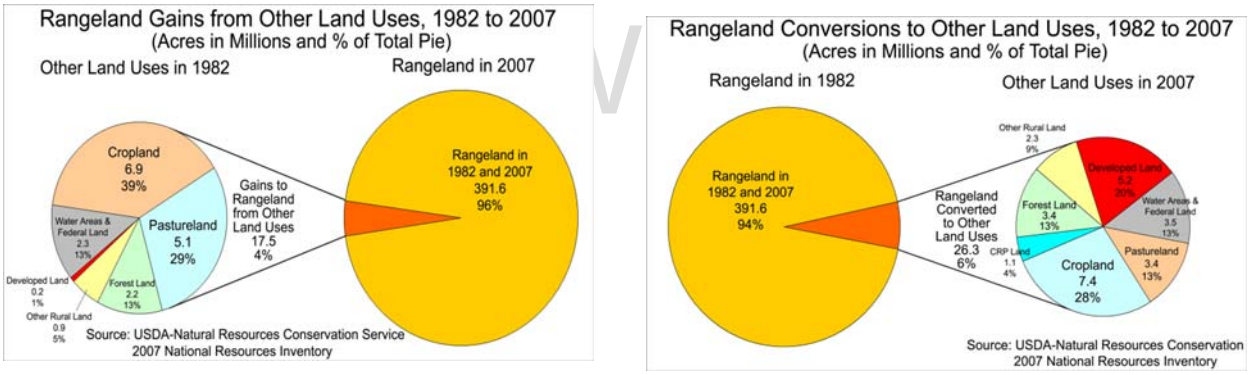
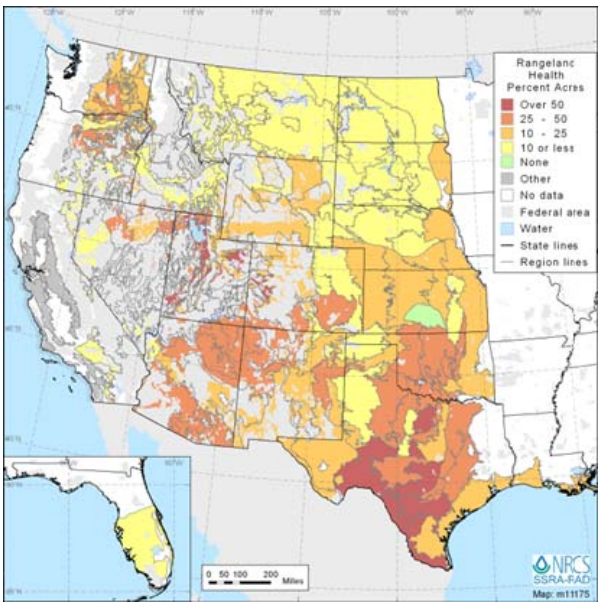
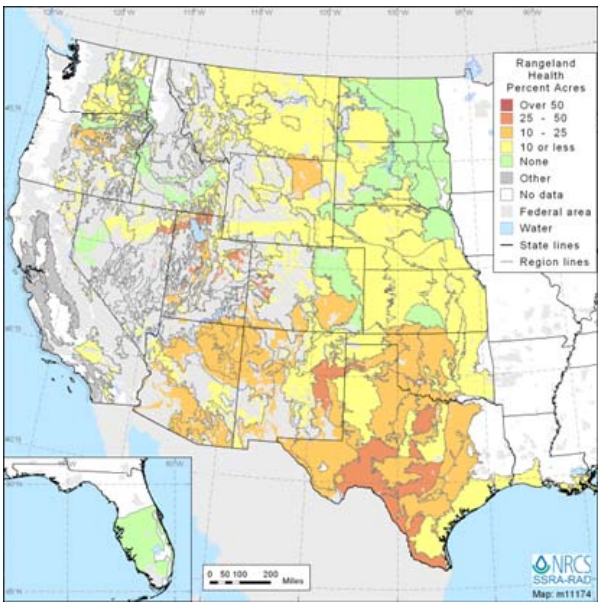


Figure 3 (left). Rangeland showing at least moderate departure from ecological potential for at least one of the three attributes of rangeland health: Soil and site stability, hydrologic function, and biotic integrity.
Figure 4 (right). Rangeland showing at least moderate departure from ecological potential for all three attributes of rangeland health.





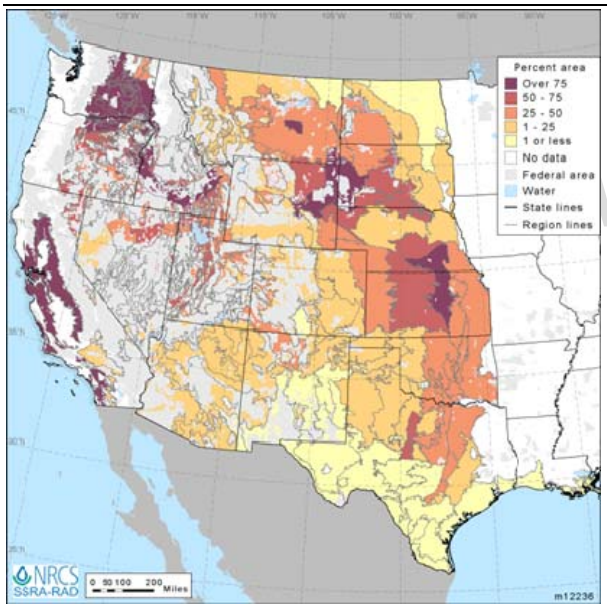
SOURCE FOR BOTH: NRI 2003 –06 RANGELAND DATA

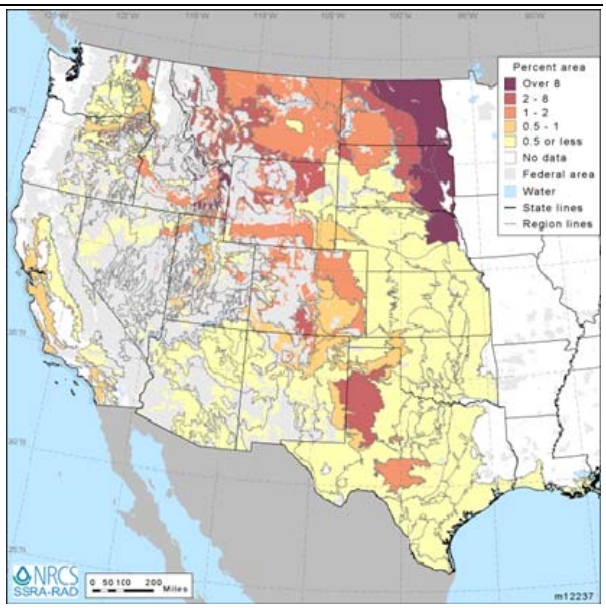
percent of non-Federal rangeland showed at least moderate departure from reference conditions for all three attributes (fig. 4).

Threats to Rangeland Health: Invasive Species

The geographic spread and the number of invasive plant species has increased significantly over the past 200 years as a result of human activities and climate change (di-Castri 1989; Mooney and Hobbs 2000). Controlling and eradicating invasive species is particularly difficult because they occur across such wide geographic ranges and cross public and private jurisdictional boundaries. Invasive species can be exotic (non-native) or native. Non-native species occur on nearly 50 percent of non-Federal rangelands; nationally, non-native species comprise at least 50 percent of the plant cover on 6.6 percent of non-Federal rangeland (Herrick et al. 2010). Invasive plants have contributed to the placement of 35 to 46 percent of the plants and animals on the Federal endangered species list (Wilcove et al. 1998). Weeds on rangeland cause an economic loss of over $2 billion annually (DiTomaso 2000).

Invasive species include grasses (fig. 5), forbs (fig.6), and shrubs and trees (fig. 7). Invasive species can alter the composition and structure of plant communities, reduce forage quality and quantity, destroy wildlife habitat and reduce biodiversity, change natural fire and nutrient cycles,





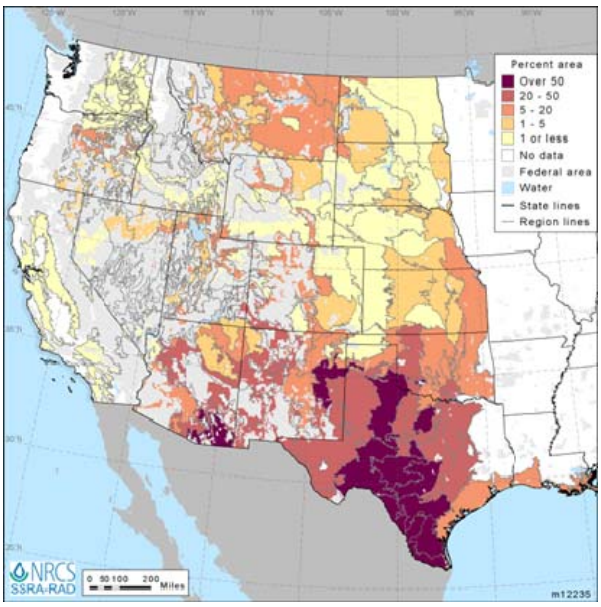


Figure 5 (top left). Non-Federal rangelands where either an exotic brome species or medusahead occurs.

Figure 6 (top right). Non-Federal rangelands where at least one of the following exotic forb species occurs: leafy spurge, knapweed, diffuse knapweed, yellow star thistle, maltase star-thistle, Canada thistle, or bull thistle.

Figure 7 (left). Current extent of mesquite, juniper, and pinyon pine trees on non-Federal rangelands.

SOURCE FOR ALL: NRI 2003 –06 RANGELAND DATA

increase soil erosion and degrade soil health, diminish water quantity and quality, and reduce ecosystem services.

Woody Plants

Native woody species such as juniper and mesquite can become invasive on some ecological sites and change former grasslands and savannahs into shrublands or closed-canopy woodlands (Tausch et al. 2009, Miller et al. 2007). Native woody plants are increasing in distribution and density and can dominate if rangeland conservation practices are not implemented. Woody plant invasions can result in increased wildfire hazard, increased soil erosion, reduced forage production, loss of critical wildlife habitat, and altered biotic integrity of rangeland ecosystems. Mesquite and juniper species occur on 94 million acres of non-Federal rangeland across the West, including areas where they occur naturally and areas where they have invaded or significantly increased in density (NRI rangeland data 2003–06). *Rangeland analysis #1* examines the encroachment of the native shrub or small tree Ashe juniper on rangeland in the Edwards Plateau of central Texas, and *Rangeland analysis #2* examines the effects and potential for controlling native conifer invasions in the Great Basin.

REVIEW DRAFT

Annual Grasses: Cheatgrass and Medusahead Wildrye

Exotic invasive annual grasses are widely distributed across rangelands in the United States, occurring on approximately 112 million acres or 28 percent of non-Federal rangelands (NRI rangeland data 2003–06). The two most dominant exotic annual grasses are cheatgrass (occurring on 67 million acres) and Japanese brome (38 million acres). Though its current extent is less (4 million acres), the exotic annual grass medusahead wildrye is increasing rapidly on western rangelands (see box). Medusahead is a particularly severe problem in the Sierra Nevada foothills of California and the Snake River Plains in Idaho.

Cheatgrass is a prolific seed producer, can germinate in spring or fall, and is able to respond more quickly to water availability than most native species. Cheatgrass invasion alters ecosystem scale nutrient cycling, creating a new system in which it is difficult for native species to re-establish themselves. Cheatgrass provides a fine textured, spatially continuous fuel that increases the chance and frequency of ignition, and frequent fires move the landscape toward cheatgrass monocultures. Cheatgrass can reduce forage availability and biodiversity and degrade soil health and water quality, especially after wildfire. Cheatgrass fires have removed critical habitat for the sage grouse, contributing to this species becoming a candidate for listing for Federal protection, and are also a major cause of the decline in mule deer (Wasley 2004). *Rangeland analysis #2* examines the effects and limited potential for restoring sagebrush sites that are dominated by cheatgrass and the need for comprehensive research to stem the loss of this critical vegetative biome in the Great Basin.

Leafy Spurge

Leafy spurge is a deep-rooted exotic perennial forb that infests more than 1.4 million acres of U.S. non-Federal

Medusahead wildrye and Ventenata

Medusahead wildrye (photo at right, top), an exotic annual grass, is increasing rapidly on western rangelands. It is more prevalent on rangeland with prior invasion and establishment of other annual grasses such as cheatgrass and soft brome. Medusahead can be easily spread due to the nature of its seeds where the awns of the plant can attach to animals, vehicle undercarriages, and clothing. Medusahead and other exotic annual grasses are associated with decreased soil quality and soil health, and they have a negative impact on runoff and soil erosion. Medusahead is extremely competitive with native vegetation (James et al. 2008, Young and Mangold 2008) and can displace cheatgrass (Miller et al. 1999).

Medusahead wildrye litter decomposes more slowly than brome species and litter buildup on the soil surface facilitates medusahead germination, inhibits growth and germination of native plants and other annual grasses, and can increase the frequency of wildfire (Young 1992, Young et al., 1999, Young and Mangold 2008). Medusahead provides even less forage production than cheatgrass because its high ash and silica content make it unpalatable to most livestock.

Other exotic annual grasses such as Ventenata (photo at right, bottom) also pose a serious threat to western rangeland and, once established, may be even more competitive than annual bromes and medusahead (Univ. Idaho 1985, Old and Callihan 1987). Ventenata also has high silica content, which render this species unpalatable to livestock and wildlife. Significant changes in land use (increased wildfire frequency and heavy spring grazing), climate, and increasing densities of medusahead and Ventenata can provide a competitive advantage against cheatgrass (Univ. of Idaho 1985, Young 1992, Miller et al. 1999); once medusahead and Ventenata have become established, reversal to native or cheatgrass dominance has not been observed.

rangelands (NRI rangeland data 2003–06). North Dakota, South Dakota, and Montana have the heaviest infestations, but the plant is also becoming a problem in Colorado, Nebraska, Wyoming, and Idaho. When leafy spurge invades a rangeland system, it replaces native grasses and legumes, weakening ecosystem stability and diminishing ecosystem services (Steenhagen and Zimdahl 1979). Its poor suitability as forage can lead to overgrazing of non-infested areas. Once established, leafy spurge is difficult and costly to control. *Rangeland analysis #3* examines leafy spurge invasion and control in the Northern Plains and the role that research has played in developing cost-effective methods of reducing the impact of this noxious weed.

Soil Erosion on Rangeland

By altering hydrology and fire cycles, invasive species can have significant negative impacts on soil erosion. Increased bare ground, whether due to changes in plant communities or after wildfire, can form concentrated flow paths that generally are not removed on rangeland once formed. During storm events, runoff is channeled into concentrated flow paths and water erosion[2] can cause such significant soil loss that ecological sites cross hydrologic thresholds and become permanently degraded. Approximately 12 percent, or 48.2 million acres, of non-Federal rangelands are vulnerable to accelerated soil loss from a 50-year return period storm event. Accelerated soil loss is defined as soil loss above the expected level for the reference plant community with a similar rainfall event.

Wind erosion is an especially serious problem on rangeland in the drier regions. Wind erosion can generate dust storms that cause significant health and property damage. High dust concentrations also negatively affect human health, particularly for those with respiratory ailments (Nordstrom and Hotta 2004; Smith and Lee 2003). Wind erosion also degrades soil health. Soil carbon and nitrogen contents of wind-eroded sediments are often much higher than those of the remaining soil, as wind tends to remove the lighter, soil organic matter-rich material at the surface. Degraded soils support less plant production, reduce plant cover, and further increase the risk of future wind erosion and water erosion. *Rangeland analysis #4* looks at ways to control wind erosion through establishment of healthy plant communities.

Summary

Estimating the effects of disturbances or conservation practices is more challenging on rangelands than on other land types such as cropland because rangelands consist of a mosaic of plant species with highly diverse landscapes, soils, climate, land use, landownership, disturbance regimes, and management. Also, vegetation responses are highly unpredictable in these environments, where establishment might occur less than once every 10 years (Herrick et al. 2006). Especially challenging is the checkerboard pattern of landownership on rangeland in the West that is a legacy of 19th-century government homestead and railway construction policies.

The interplay of climate, topography, plants, soil parent material, and land management yield a diverse mosaic of plant communities over time, further influenced by episodic disturbances such as fire, drought, and flood (Duriancik et al. 2008). Some of the most reliable and cost-effective indicators of conservation effects on rangelands are modeled soil loss rates of wind and water erosion; plant cover; and plant community composition, including invasive plant species. These indicators can be used to infer impacts on water availability and quality, wildlife habitat quality or suitability for target wildlife species, forage availability for domestic livestock and/or wildlife, and vulnerability to wildfire, all of which will directly influence resilience of the ecosystems.

The NRI provides natural resource managers a means to assess risks and vulnerability of sites to invasion by exotic plants and accelerated wind and water erosion. Newly developed soil erosion tools such as the Rangeland Hydrology and Erosion Model (RHEM) and the Wind Erosion Model WEMO) allow them to improve the probability of achieving rangeland sustainability more cost effectively by implementing appropriate targeted conservation practices before degradation has occurred.

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[2] The Rangeland Hydrology and Erosion Model (RHEM) can provide site-specific estimates of water erosion, but national-scale estimates of water erosion levels on rangeland are not currently available.

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