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Chapter 1:

Purpose and Need for a Grassland Assessment

Purpose

This report is volume 1 of an ecological assessment of grassland ecosystems in the Southwestern United States, and it is one of a series of planned publications addressing major ecosystems of the Southwest. The first assessment, General Technical Report RM-GTR-295, *An Assessment of Forest Ecosystem Health in the Southwest* (by Dahms and Geils, technical editors, published July 1997), covered forested ecosystems. Given the complexities of grassland ecology and the increasing number of challenges facing grassland managers, the USDA Forest Service Southwestern Region, in partnership with the agency's Rocky Mountain Research Station, focused on grasslands in its second assessment. The assessment is regional in scale and pertains primarily to lands administered by the Southwestern Region (Arizona, New Mexico, Texas, and Oklahoma).

Broad-scale assessments are syntheses of current scientific knowledge, including a description of uncertainties and assumptions, to provide a characterization and comprehensive description of ecological, social, and economic components within an assessment area (USDA Forest Service 1999b). A primary purpose of this assessment is to provide context to National Forest System land management planning efforts involving grasslands, both at the Forest Plan level for Plan amendments and revisions, and at the project level to place site-specific activities within the larger framework. The assessment is not a decision document because it surfaces issues and risks to grassland ecosystems that provide the foundation for future changes to Forest Plans or project activities but does not make any site-specific decisions or recommendations. The report also provides a scientific basis for conducting ecosystem restoration projects, provides a starting point for public discussion on desired conditions for the future, and contributes to the overall understanding of the physical, biological, and human dimensions of grassland ecosystems in the Southwest.

The report is divided into two volumes. The first volume (herein) focuses on the ecology, types, conditions, and management practices of Southwestern grasslands. The second volume emphasizes wildlife and fish species and their habitat requirements in Southwestern grasslands.

To prepare this document, we assembled a team of authors from the Southwestern Region and the Rocky Mountain Research Station whose expertise focused on or included grassland ecosystems. An outline of chapter titles and chapter contents was prepared using a group consensus process. Authors volunteered to write specific chapters that were then reviewed by the team. Following team review, each individual chapter was sent to a minimum of two peer reviewers for critique, and in addition, the entire revised volume was sent to two reviewers. Also, the team interviewed Forest Service employees (see appendix).

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Southwestern Grassland Ecosystems

In the Southwestern Region, the Forest Service has adopted the Soil Conservation Society (SCS) of America's definition of grasslands, that is, "lands on which the existing plant cover is dominated by grasses" (SCS 1982). Risser (1995) defined grasslands as "biological communities that contain few trees or shrubs, are characterized by mixed herbaceous vegetation, and are usually dominated by grasses." Supported by the National Science Foundation, the U.S. International Biological Program (IBP) characterized *natural grasslands* as climatically determined by soil water availability and precipitation volume and seasonality, *successional grasslands* where forest vegetation has been removed, and *agricultural grasslands* where a few native or introduced species are maintained. This report addresses natural grasslands.

This assessment includes the following Southwestern grassland types:

- Montane grassland
- Colorado Plateau
- Desert grassland
- Great Basin grassland
- Plains grassland

Subalpine grasslands are discussed within the montane grassland category. Alpine grasslands are not discussed as a separate category because they have a limited extent in the Southwest. Where they are mentioned, they are discussed in conjunction with montane grasslands, although they occur on a different mountain gradient. Riparian and/or wetland inclusions occur in all grassland types and are discussed separately where appropriate.

Ecologists and geographers identify broad-scale Southwestern grasslands (that is, biome level) as **temperate grassland**. These biome classifications are according to macroclimate conditions defined by Köppen, Threwartha and others (Coupland 1992, French 1979). Further subdivisions according to physiographic province include Great Basin grassland and Plains grassland. In general, the term **plains** refers to grasslands in areas of flat topography (Coupland 1992). Plains grassland is then subdivided into short, tall, and mixed grasslands. At a finer scale, grasslands are designated by vegetation community/plant association as classified by Küchler (1964), Clements (1920), and others.

Temperate grasslands are areas at mid-latitude that are dominated by perennial grasses and forbs. Climate is moderately dry (semiarid) with discrete wet/dry seasons and temperature and precipitation extremes (Sims 1988). Soils are predominantly characterized as Aridisol or Mollisol with large amounts of humus (Aber and Melillo 1991, Sims 1988, Whittaker 1975). Temperate grasslands include tall, mid and short grasses (Odum 1971, Whittaker 1975). Tall grasses are about 150 to 245 cm (5 to 8 feet) high, mid grasses approximately 60 to 120 cm (2 to 4 feet) high, and short grasses 15 to 45 cm (0.5 to 1.5 feet) in height. Short grasses include buffalograss (*Buchloe dactyloides*), blue grama (*Bouteloua gracilis*), and other gramas. Mid grasses include little bluestem (*Schizachyrium scoparium*), needlegrass (*Stipa* spp.), western wheatgrass (*Pascopyrum smithii*), and Indian rice grass (*Achnatherum hymenoides*) (Odum 1971).

Temperate grassland biomes include **prairie** and **steppe** (French 1979, McKnight 1993, Odum 1971, Whittaker 1975). Prairie, including the true tall-grass prairie, mixed-grass prairie, and short-grass prairie, is dominated by grasses and forbs, has a scarcity of shrubs, and has no trees. Mixed-grass prairie is an ecotone between tall and short-grass prairie. The term steppe refers to a temperate biome that is dominated by short grasses and bunchgrasses (McKnight 1993) and is dryer than prairie. Steppes receive approximately 25 to 50 cm (10 to 20 inches) of rain per year and experience hot summers and cold winters; these climatic conditions support plants such as blue grama, buffalograss, big bluestem (*Andropogon gerardi*), cacti, and sagebrush.

Grasslands can be subdivided using the U.S. National Vegetation Classification system (Federal Geographic Data Committee 1997) and other methods according to class, subclass, group, formation, regional biome type, alliance, plant associations, or habitat types. Grassland categories for the Southwestern United States include the Plains grassland, Great Basin grassland, and the Colorado Plateau as discussed above, as well as montane grassland and desert grassland. **Montane grassland** can be found in small patches within the mixed conifer and ponderosa pine forests. Montane or high-mountain grasslands consist of meadows below timberline (French 1979), while **alpine grassland** is located above timberline (Whittaker 1975). **Desert**

View of Animas Valley, looking east toward Animas Mountains, New Mexico. Mesquite in perennial grassland. (Photo by Ronald Bemis)

grassland occurs in arid and semi-arid climates. It varies in composition from mixed herbaceous species with few shrubs to primarily a combination of shrub species (French 1979) such as mesquite (*Prosopis* spp.) and creosote bush (*Larrea tridentata*). Subregions include the Chihuahuan Desert grasslands of southern New Mexico, characterized by black grama (*Bouteloua eriopoda*), and the Sonoran Desert grasslands of southeastern Arizona.

Biome classification systems use the term *savanna* to describe tropical grasslands that are primarily located in Africa and Australia, South America and southern Asia/India (Whittaker 1975, McKnight 1993). Similarly, Bailey's ecosystem classification uses the term savanna to describe a Division within the Humid Tropical Domain. However, some people use the term temperate savanna to describe areas in the Southwestern United States. McPherson (1997) defines North American savannas as "ecosystems with a continuous grass layer and scattered trees or shrubs." The woody plant overstory has approximately 30 percent cover or less with a grass understory. He further defines and maps areas of the Southwest as Piñon-Juniper Savanna, Southwestern Oak Savanna, Ponderosa Pine Savanna, and Mesquite Savanna. Although this terminology is sometimes used, a savanna biome does not occur in the Southwestern United States according to broad-scale vegetation classification systems based on climate. The Forest Service also uses a classification system based on a geographic approach, also referred to as regionalization, which is a process of classification and mapping to identify homogeneous map units at various scales. The National Hierarchical Framework of Ecological Units adopts Bailey's classification by ecoregions (Bailey 1995); the hierarchy consists of domain, division, province, section, subsection, landtype, landtype association, and landtype phase. At the regional scale, provinces and sections are the most useful units for assessments.

Relationship of Assessment to Ecosystem Management

Ecosystem management is an evolving philosophy that has been adopted by many government agencies including the Forest Service. The Forest Service has defined ecosystem management as "a concept of natural resource management wherein national forest activities are considered within the context of economic, ecological, and social interactions within a defined area or region over both short and long term"

(Thomas and Huke 1996). National Forest activities in this context are all activities occurring on National Forest System lands, including grassland ecosystems. Ecosystem management is sometimes referred to as ecology-based multiple-use management in that there is a shift from focusing exclusively on sustaining production of goods and services to sustaining the viability of ecological, social, and economic systems. While other agencies and organizations have developed their own definitions of ecosystem management reflecting their differing missions, they typically have a goal of ecosystem sustainability or maintaining ecological integrity (Grumbine 1994, Kaufmann and others 1994) while recognizing that people are part of the ecosystem and that human needs should be reflected in ecosystem sustainability (Keystone Center 1996, USDA Forest Service 1994).

A significant difference among various ecosystem management philosophies may be the degree in which people are included within the sustainability concept. Former Forest Service Chief Dombeck stated, "We will still track traditional outputs of goods and services but they will be accomplished within the ecological sideboards imposed by land health" (Dombeck 1999). The Keystone Center's National Policy Dialogue Group on Ecosystem Management placed the goals of sustaining vibrant, livable, and economically diverse human communities and the involvement of stakeholders on a par with the goals of maintaining ecosystem integrity and sustaining biodiversity and ecosystem processes at a regional scale (Keystone Center 1996). The Southwestern Region's philosophy embraces all these goals as well. In developing the human dimension principles and strategies for the Southwestern Region, the Human Dimensions Team recognized that human needs and wants must be balanced with ecosystem capabilities. However, on a practical level, they also recognized that the goal of meeting human needs frequently conflicts with the goal of sustaining natural ecosystems (USDA Forest Service 1994). When this is the case, ecosystem management may be considered an optimal integration of ecological sustainability and human dimensions (including both economic considerations and societal needs and desires) (Jensen and others 1996).

Assessments are a tool in ecosystem management to develop a holistic understanding of ecological sustainability as well as the human dimension of ecosystems. As an introductory chapter, chapter 1 not only describes the purpose and need for assessments, it also gives a brief overview of Southwestern grassland types and defines two terms in frequent use in later chapters: ecosystem sustainability and adaptive management. Chapter 1 also explores and emphasizes the role of, and need for, monitoring of grassland conditions and trends, a topic not covered in detail in later chapters. In this report, chapter 2 describes the extent and types of grasslands in the Southwest. The general ecology of Southwestern grasslands is evaluated in chapter 3. A discussion of the biological diversity, functional processes, and consequences of grassland fragmentation is provided in chapter 4. Cultural dimensions of grassland management, both from a historic and contemporary perspective, are covered in chapter 5. Historic and current conditions of southwestern grasslands in relation to land management are covered in chapter 6. Chapter 7 discusses the concept of grassland sustainability and why understanding sustainability is critical for managers and stakeholders to collaboratively develop desired conditions for grassland areas. Management decisions will need to be site-specific based on the unique characteristics of the area. Because there is no one-size fits-all management strategy for an area, chapter 8 discusses a wide range of tools available for use by grassland managers.This chapter has an eye toward highlighting some of the more innovative work being done in grasslands rather than attempting to document all possible tools. Chapter 8 also covers research needs, since adaptive management and the utilization of the best scientific knowledge are important components of ecosystem management.

Ecosystem Sustainability

Ecosystem sustainability is the ability of an ecosystem to maintain ecological processes and functions, biological diversity, and productivity over time (Kaufmann and others 1994). It was the subject of the 1992 Earth Summit/United Nations Conference on Environment and Development in Rio de Janeiro and a 1987 World Commission on Environment and Development report called *Our Common Future* (also known as the Bruntland Report; Bruntland 1987). **Sustainable ecosystems** are able to maintain their ecological integrity.

Ecological integrity is achieved when ecosystem structure, function, processes, and services are preserved over space and time (Grumbine 1994). *Ecosystem structure* is the spatial arrangement of the living and nonliving elements of an ecosystem, for example, abiotic elements (temperature, light, wind, relative humidity, rainfall) and community structure (species richness and the distribution of *heterotroph*s, *autotrophs*, and consumers). *Ecosystem function* refers to the processes whereby the living and nonliving elements of ecosystems change and interact, such as biogeochemical processes and succession. *Ecological processes* are the actions or events that link organisms and their environment. Ecosystem processes include disturbance, succession, evolution, adaptation, natural extinction rates, colonization, dispersion, fluxes of materials, and decomposition (Kaufman and others 1994).

Sustainable ecosystems continue to provide essential services. The Ecological Society of America (1997) has identified the following services provided by ecosystems:

- moderating weather extremes and their impacts
- seed dispersal
- drought and flood control
- protection from ultraviolet rays of the sun
- nutrient cycling
- protection from channel and coastal erosion
- waste decomposition and breakdown
- agricultural pest control
- maintaining biodiversity
- generating and preserving soils; renewing soil fertility
- helping to stabilize climate
- cleaning the air and water
- regulating organisms that carry disease
- pollination

Sustainable grasslands can be described as productive grasslands with erosion rates that do not exceed soil tolerance for sediment and nutrient loss; having natural fire frequencies; biologically diverse; not overgrazed; and containing important social and aesthetic values (Mac and others 1998).

Adaptive Management

This assessment utilizes existing information, and the assessment team did not initiate any new data collection activities. However, the assessment team synthesized information on grasslands that had been available only in a piece-meal fashion up to this point, and the presentation of that information at the regional scale provides new insights that can be used in adaptive management.

Adaptive management is a proactive approach to implement ecosystem management. The theory and practice of adaptive management has evolved over the past two decades through the works of Holling (1978) and Lee (1993). One of the fundamental tenets of adaptive management is that ecosystems and people are unpredictable as they evolve together. Ecological conditions change as do societal values and economic developments. In addition, our understanding of ecosystem behavior is imperfect, and managers will never be able to completely predict responses to management activities. The purpose of adaptive management is to rapidly increase our level of knowledge of ecosystem dynamics and the effects of management. In the adaptive management approach, management plans and activities are continually altered in response to changing societal values and goals, emerging issues, and new scientific understanding (Haynes and others 1996).

The dynamic nature of grasslands requires an adaptive management approach. Change has been and continues to be rapid in grassland ecosystems. The intensity of grazing has fluctuated through time, new uses such as off-road vehicle recreation and energy development have emerged, and development pressures continue to escalate. Some wildlife species have declined or disappeared altogether, while other species have increased in population. These changes, along with others such as climatic variation, introduced plants, and changing fire regimes, have all shaped grassland ecosystems, sometimes to the point where the land cannot be returned to a previous state. Adaptive management experiments would be useful in understanding where these thresholds occur and management's ability to reverse changes as the system approaches these thresholds.

Adaptive management encompasses both deliberate experimentation to gain new knowledge (active adaptive management) as well as the ongoing process of monitoring and inventorying to assess the effects of management actions (passive adaptive management). Passive adaptive management may seem a misnomer because it requires an active program for the monitoring and evaluation of project activities. Active adaptive management is a departure from traditional management in that it views management actions as experiments from which to learn. Conducting adaptive management experiments involves being explicit about expected outcomes, designing methods to measure responses, collecting and analyzing information to compare expectations to actual outcomes, learning from the comparisons, and changing actions and plans accordingly. In both forms of adaptive management, monitoring plays a crucial role in surfacing any needed changes to management plans and activities, and monitoring can lead to the need for new assessments.

Ecological Monitoring of Grasslands

The basis of ecosystem management is management driven by explicit goals and made adaptable by monitoring and research based on ecological interactions and processes necessary to sustain ecosystems (Gordon et al. 1992). Monitoring, as an overall process, is a measurement process that establishes a baseline with periodic measurements for the purposes of change detection and adaptive management. Monitoring is defined as the systematic observation of parameters related to a specific problem, designed to provide information on the characteristics of the problems and their changes with time (Spellerberg 1991). In a natural resources context, ecological monitoring assesses the status and trends of ecological, social, or economic outcomes (Powell, unpublished paper 2000). The information being collected depends on the purpose of the monitoring—that is, which questions are to be addressed—and the scale at which a question needs to be answered. The results of monitoring are expected to generate an action of some kind, even if the action is to maintain current management (Johnson and others 1999).

Monitoring is a step-wise process that involves:

1. Framing a question(s) and developing a study plan to address the question(s) using a standard protocol.
2. Collecting data according to the monitoring plan.
3. Storing the data for retrieval.
4. Evaluating the results.

Monitoring should include goals, thresholds for change, and remedial actions that occur when thresholds are met or exceeded. An ecological systems approach to monitoring ensures a strong foundation in ecological theory, adequate consideration and understanding of cause-and-effect relationships, and a systematic approach to selecting and evaluating parameters that are monitored (USDA Forest Service, unpublished paper 1999a). Furthermore, the questions should focus on key ecological processes and interactions, rather than on individual parts of the system. Powell (unpublished papers 2000, 2001) listed the following characteristics for successful monitoring:

- Purposeful and conducted to answer specific questions. Conducted at the appropriate spatial and temporal scale to answer the question.
- Conducted in collaboration with others (for example, agencies, interested publics, researchers, and nongovernmental organizations) to share the workload (including obtaining data from other sources), gain expertise, and build credibility and trust.
- Conducted using the best available science and established protocols to collect and evaluate the data.
- Conducted using modern information management techniques and tools.
- Stringent selection criteria applied so that a monitoring activity is only conducted if it is feasible, realistic, and affordable.
- Evaluation emphasized as much as the collection of the data.

Protocols for monitoring should include standard sampling and analytical methods that determine the precision and accuracy of measurements. Proper training and supervision of field and laboratory staff is necessary to ensure adherence to the protocol and the success of the monitoring program.

Based on these criteria, one of the activities in the interagency Southwestern Strategy effort is to develop a unified set of tools and techniques, approved by Federal and State agencies, for rangeland monitoring training in New Mexico (de la Torre, personal communication).

Monitoring addresses both management activities on the land and conditions of the ecosystem being monitored. The monitoring of management activities can further be subdivided into three arenas: implementation, effectiveness, and validation monitoring. Implementation monitoring addresses, evaluates, and determines whether plans, projects, and activities were implemented as designed and in compliance with Forest Plan objectives, standards, and guidelines. Effectiveness monitoring addresses, evaluates, and determines whether plans, projects, and activities met Forest Plan management direction, objectives, standards, and guidelines. Validation monitoring determines whether the assumptions and relationships between the activity and the expected results were valid. In 2000, the Southwestern Region undertook an analysis of the Forest Plan Monitoring Reports for fiscal years 1998 and 1999. Most of the forest level monitoring in the Region was implementation monitoring (65 percent). About 32 percent of the reported monitoring was evaluation monitoring, and the remaining 3 percent was validation monitoring. The information was not detailed enough to know whether grassland monitoring followed this general trend (USDA Forest Service, unpublished data, 2000). To monitor ecological conditions, quantitative or qualitative parameters are monitored; these parameters are typically referred to as indicators, attributes, variables, or monitoring elements. In connection with condition and trend monitoring, it is useful to establish baseline reference conditions to serve as a context for determining desired conditions and interpreting existing conditions.

In the Forest Service, monitoring and evaluation of management actions is one step in the overall process for proposed action identification, design, and monitoring. In outlining the process for Forest Plan implementation, the Southwestern Region has developed a desk guide, *Integrated Resource Management: The Road to Ecosystem Management*. Monitoring forms the base of the Southwestern Region's Integrated Resource Management Process triangle (USDA Forest Service 1993). In an effort to capture monitoring activities on National Forest System Lands, since 1997 an annual "Forest Monitoring and Evaluation Report and State of the Region Evaluation" has been included in the Forest Service's performance reporting system (MAR—Management Attainment Report). Despite being integrated into Forest Service processes, monitoring within the agency tends to be uncoordinated and inconsistent (Powell 2000). There is a perception in the Southwestern Region that monitoring activities chronically suffer from a lack of funding and personnel (see appendix, question 1). These problems may be even greater in grassland areas than in forested ecosystems, since progress has been slower at developing an agreed-upon set of ecological indicators to monitor.

Ecological Indicators of Sustainability

Numerous *ecological indicators* have been proposed or are being used to address grassland sustainability. Indicators can be used to define any expression of the environment that estimates the condition of ecological resources, magnitude of stress, exposure of a biological component to stress, or the amount of change in a condition (Breckenridge and others 1994). Indicators, by their very nature, will vary depending on the scale to which they are applied. At the project-level and landscape-level scales, a commonly agreed-upon set of indicators for grasslands is lacking. Selecting indicators at these scales is an enormous challenge because of the complexity of ecosystems. There are potentially hundreds if not thousands of ecosystem characteristics that could be measured in response to environmental or management-induced changes, and it is difficult to separate responses occurring at the fine scale from potential influences occurring at the broader scale. One approach used at the Sevilleta Long Term Ecological Research (LTER) site is to identify a matrix of indicators at many levels and scales to sample the diversity of responses across spatial and temporal scales. Identifying the key indicators and the scales they reflect is an ongoing process (Gosz and others 1992).

On a national scale, there have been several major efforts to identify ecological indicators, though none specifically address grasslands. The National Academy of Science's National Research Council recommended the following indicators to portray ecological condition: land cover and land use; total species diversity; native species diversity; nutrient runoff estimates, especially for nitrogen and phosphorus; soil organic matter; productivity (including carbon storage, net primary production, and production capacity); lake trophic status; stream oxygen concentration; and nutrient-use efficiency and nutrient balance (Committee to Evaluate Indicators for Monitoring Aquatic and Terrestrial Environments and others 2000). Land cover—including cropland, forest, nature reserves, rivers, wetlands, and riparian zones—is usually detected and monitored using remote sensing, while land use is typically classified by measurements from the ground. Soil organic matter is important as a nutrient and energy source for soil biota. It improves soil structure by strengthening soil aggregates, increases water retention and available water capacity, reduces the sealing of soil surfaces thereby promoting infiltration and reducing erosion, increases cation exchange capacity, chelates metals, and influences the fate of pesticides. Nutrient-use efficiency is a good indicator for crops, industries, counties, or watersheds.

A multiscale effort to develop indicators has sprung from the Montreal Process, which initially identified international criteria and indicators for sustainability of forest ecosystems. The United States has endorsed the seven criteria and 67 indicators, and the Forest Service is in the process of applying them within the agency. The criteria that have been identified are:

- Conservation of biological diversity.
- Maintenance of productive capability of forest ecosystems.
- Maintenance of forest ecosystem health and vitality.
- Conservation and maintenance of soil and water resources.
- Maintenance of forest contribution to global carbon cycles.
- Maintenance and enhancement of long-term multiple socio-economic benefits to meet the needs of societies.
- Legal, institutional, and economic framework for forest conservation and sustainable management.

The Forest Service has been conducting a series of pilot projects in an effort to identify indicators that would be appropriate at a Forest Management Unit scale, including those appropriate for rangelands (USDA Forest Service Inventory and Monitoring Institute 2001). Concurrently, a national team reviewed the Montreal indicators for their applicability to rangelands at a national scale. While the results should be considered preliminary, for the first five criteria, the review concluded that almost all the indicators were as relevant for rangeland ecosystems as for forested ecosystems, although the lack of a generally accepted classification system, consistent definitions, data, and/or mechanisms to measure most of the indicators makes quantification at a national scale problematic. Also, it was noted that some of the indicators may be more effective if they were refined to capture aspects of the criteria goals that are more relevant to rangeland dynamics (Flather and Sieg 2000, Joyce 2000, Joyce and others 2000, McArthur and others 2000, Neary and others 2000).

Why Assess Grassland Ecosystems?

The selection of grassland ecosystems as the second major Southwestern ecosystem type to be assessed was based on several factors. A huge amount of grasslands acreage has been lost to development, agriculture, and other uses across the country, yet it is likely that the average person is unaware that grasslands are endangered. Over half of the critically endangered ecosystems in the United States (those with over 98 percent of area either lost or degraded) are grasslands (Noss and others 1995). In the Southwest as elsewhere, grasslands are often lumped together with other grazed ecosystems and analyzed as rangelands or grazing lands. Between 1982 and 1992, Arizona had a net loss of 382,000 acres of non-Federal grazing land; New Mexico, 351,000 acres. During this period in New Mexico, 23 percent of non-Federal rangeland that was converted to other uses, was converted to developed land, and 16 percent was developed for agricultural uses (Goddard and others 1999). The amount of National Forest lands, including rangelands, has not increased significantly in the past 20 years (Mitchell 2000) and the amount of Federal grasslands may even be lower in the Southwest due to the loss of montane meadows and the expansion of woodlands. The loss of grazing land in the non-Federal sector increases the importance of the remaining Federal lands.

The effects of grazing on grasslands have always been a contentious issue, particularly in the Southwest, since domestic livestock was introduced to the Southwest much earlier than other Western States. Sheep were brought to the Rio Grande pueblos in 1598, and other livestock soon followed. By 1890, it is estimated that over 1.5 million cattle were grazing in the Southwest, and range deterioration was being reported (Baker and others 1988). In a document submitted to the Senate in 1936, the Secretary of Agriculture indicated that the Southwest contained the most severe range depletion in the Western United States. Much of the Southwest was in the "extreme" range depletion class, where 76 to 100 percent of the area was considered depleted (Secretary of Agriculture 1936). Determining the condition of rangeland today is complicated by not having a standard process in place across all ownerships. As assessment of non-Federal lands was made in 1989 from data collected in 1982 during the National Resource Inventory (USDA Soil Conservation Service 1990) and supplemented in 1992. Conditions were determined based on how closely the species composition of a range site met those projected for the climax plant community for that site. For both 1982 and 1992, only 2 percent of non-Federal rangelands were considered to be in excellent condition in Arizona and New Mexico. During this period, percentages of good condition rangeland increased from 16 to 27 percent in Arizona, and from 30 to 36 percent in New Mexico.

The USDI Bureau of Land Management (BLM) is a major Federal land manager of rangelands in the Southwest. The agency's assessments of range condition are by ecological status categories: potential natural community (PNC), late seral, mid seral, and early seral. In 1996, while only 5,607,000 acres had been classified out of the 11,643,000 acres of BLM managed Arizona rangelands, the results were 9 percent PNC, 40 percent late seral, 40 percent mid seral, and 12 percent early seral. In New Mexico, the percentage of acres classified is much greater. Out of 12,597,000 acres of BLM rangelands in New Mexico, 9,752,000 have been classified. These fall into the following categories: PNC 1 percent, late seral 36 percent, mid seral 48 percent, and early seral 15 percent (USDI Bureau of Land Management 1997). Forest Service assessments have also been in upland rangelands rather than specifically grasslands. These are not assessed by range condition categories, but by whether the vegetation meets or is moving toward Forest Plan Management Objectives (FPMO). Of all the Regions assessed during the 1995 to 1997 period, the Southwestern Region had the largest percentage of rangelands not meeting FPMO objectives and not moving toward FPMO, roughly 25 percent (Mitchell 2000).

Another primary factor for selecting grasslands for an assessment effort is the complexity of grassland ecology combined with the variety of anthropogenic influences on grassland ecosystems. As was mentioned previously in the adaptive management section, changes have occurred rapidly in grassland ecosystems, and some areas may have passed a threshold where they cannot be returned to an earlier condition.

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