Farm Old-Growth Forests to Old-Growth Grasslands: Managing Rangelands for Structure and Function

by

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FROM OLD-GROWTH FORESTS TO OLD-GROWTH GRASSLANDS: MANAGING RANGELANDS FOR STRUCTURE AND FUNCTION

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I. INTRODUCTION

Public forest managers in the United States recognize that forests serve important ecological and social functions other than timber production and that mature forests provide certain benefits that cannot be obtained from younger forests. Cutting mature forests therefore can result in a severe loss of values, regardless of whether the cut forests regenerate into young forests of the same tree species. In order to avoid this loss, recent forest management decisions provide for reduced rates of timber harvest and designate substantial areas of public forests to be retained in a natural state.

For the most part, public rangeland management has not undergone a similar development. Although agency policies nominally recognize some of the ecological and social functions of rangelands other than forage production, actual rangeland management practices still reflect an implicit assumption that loss of forage productivity is the only potential negative impact of livestock grazing. Under this implicit assumption, any level of grazing that preserves or improves the quantity and composition of forage production is considered to be harmless or even beneficial. Other rangeland values that may be compromised by grazing,

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such as wildlife habitat, water quality, and scenic beauty, are generally ignored. Moreover, the agencies' narrow focus on productivity of forage plants is ultimately self-defeating. By considering only the effects of grazing on the growth and propagation of individual plants, and neglecting the complexity of structure and function of rangeland ecosystems, agency managers authorize levels of grazing that bring about systemic changes that eventually lead to the depletion of the very forage species their management is ostensibly designed to protect.

We propose an agenda for a reformed public rangeland management that respects the structure and function of grasslands. Borrowing concepts from modern developments in forest management, this agenda includes a moratorium on construction of new livestock water developments in areas where grazing has so far been limited by lack of water, creation of reserves that are protected from livestock grazing, and extended rotations and reduced stocking levels in areas where grazing continues.

For many years, the agencies that manage America's public forests have understood that a major loss of environmental values occurs when an old-growth forest is logged. "It'll grow back" is no longer considered a sufficient response to the dismay experienced at the sight of a once-forested hillside denuded of trees and covered with logging slash and bulldozer tracks. Further, a forest of young matchstick trees does not provide the same benefits of wildlife habitat and water quality, and the same experience of awe and wonder, as a grove of thousand-year old monarchs. Even if it does "grow back," it may be centuries before the regenerated forest exhibits the characteristics of an old-growth ecosystem, including large, old trees, a multi-storied canopy, standing snags, and downed logs. In the meantime, old-growth dependent wildlife species are depleted, watercourses are degraded, and the public is denied the inspirational experience the old-growth forest and its wildlife provided. The managing agencies—primarily the U.S. Forest Service but also the Bureau of Land Management ("BLM")—have come to understand this and have, to varying degrees, incorporated preservation of at least some remaining old-growth forests into their plans and decisions.

An analogous evolution of thinking and practice, however, has not occurred in the management of the country's public rangelands. While the plans and programs of the Forest Service and the BLM recognize that excessive or poorly-managed livestock grazing can have negative environmental consequences, for the most part these consequences have been viewed solely in terms of changes in the abundance of desirable forage species. Levels of grazing that allow forage plants to "grow back" are explicitly or implicitly assumed to be harmless. Range condition is usually assessed simply by counting the numbers of plants of various species in a series of sample plots or line transects. The concept of an "old-growth grassland," with complex structures and functions that cannot be characterized simply by counting plant species, is foreign to current management.

Yet there are significant parallels between the ecological functioning of mature grasslands and mature forests. In grasslands, as in forests, undisturbed sites develop attributes over time that are not found in recently disturbed systems. In grasslands, as in forests, live and dead standing plant material together with fallen dead plant material create the structural diversity and the microclimates necessary to support essential soil microorganisms as well as many species of wildlife. In grasslands, as in forests, large-scale harvesting of plant material can degrade or destroy wildlife habitat, disrupt water and nutrient cycles, prevent essential natural fires, expose soils to erosion by wind and rain, and destroy aesthetic values, regardless of whether the harvested plants eventually grow back. To evaluate the ecological condition of a rangeland by simply counting plants is no more sensible than to evaluate the condition of a forest by counting trees.

Moreover, production-oriented management of grasslands that ignores their complexity of structure and function, like similar management of forests, can be self-defeating. While individual plants may be capable of regrowing and reproducing after suffering severe defoliation by grazing, the grassland ecosystem may not be. In the long run, loss of protective ground cover, compaction of soil by trampling, depletion of soil nutrients, elimination of natural fire regimes, and competition from grazing-resistant opportunistic plants can reduce or eliminate the forage species that production-oriented management is designed to sustain.

If public rangeland management is to reflect and fulfill the public's demands for a variety of ecological and aesthetic benefits, it must undergo a transformation similar to what public forest management has gone through. Part II of this Article briefly discusses the transformation of public forest management from a focus on timber production to a recognition of ecological and social functions. Part III discusses some of the ecological and social functions of rangelands and the ways in which those functions can be disrupted by domestic livestock grazing. Part IV examines the prevalent methods used by the U.S. Forest Service and the BLM to evaluate rangeland conditions and the impacts of grazing on those conditions, and will show how these methods fail to consider the structure and functions of rangelands. Finally, Part V shows how modern developments in public forest management can be used as a model for a transformed approach to rangeland management based on ecological and social functions rather than merely on livestock production.

II. FROM PRODUCTION TO FUNCTION: FOREST MANAGEMENT IN THE LATE TWENTIETH CENTURY

In the 1940s, 1950s, and 1960s, timber production was the primary focus of public forest management in the United States, and the rate of production was the principal measure by which the condition of a forest was evaluated.[1] By

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[1] *See* A UNIVERSITY VIEW OF THE FOREST SERVICE, S. DOC. NO. 91-115, at 14–16 (1970), *reprinted in* GEORGE CAMERON COGGINS ET AL., FEDERAL PUBLIC LAND AND RESOURCES LAW 634–35 (3d ed. 1993); GEORGE C. COGGINS & ROBERT R. GLICKSMAN, PUBLIC NATURAL RESOURCES LAW § 20.02[2] (1990); Charles F. Wilkinson & H. Michael Anderson, *Land and Resource Planning in the National Forests*, 64 OR. L. REV. 1, 136–38 (1985).

production we mean the biological process by which the quantity of timber is increased; in other words, growth.[2] In the world of production forestry, a growing forest was a good forest. Trees that had passed the age of maximum growth were considered wasting assets whose harvest was overdue, and any physical or biological process that detracted from the increase in wood fiber production—tree mortality, insect infestation, fire, etc.—was considered undesirable.[3] The ultimate manifestation of the fixation on production was the wide-scale use of clearcutting to replace old-growth forests with new stands of young, even-aged, rapidly-growing trees, either of the same species or of a more commercially valuable species.[4] In this production-oriented view, not only did clearcuts provide immediate economic benefits, they were also good forestry because they "improved" the forest, i.e., increased the rate of growth.[5]

Disenchantment with this production-oriented view developed as Congress, the public, and the agencies came to recognize that forests served functions other than wood and fiber production. Public forests came to be valued more for wildlife habitat, clean water, recreational opportunities, and scenic beauty than for commercial commodities.[6] Eventually foresters came to recognize that forest health cannot be measured simply by identifying the species of trees, counting their numbers, and measuring their growth rates. Modern forest science views a forest as a complex system with diverse and interdependent attributes and processes that develop over time and that therefore may differ drastically between young and old forests of the same tree species.[7]

One critical attribute is the physical structure. Old-growth forests commonly feature a multi-storied canopy of old, young, and middle-aged trees.

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[2] *See* Jerry F. Franklin & Thomas A. Spies, *Composition, Function, and Structure of Old-Growth Douglas-Fir Forests*, *in* FOREST SERVICE, U.S. DEP'T OF AGRICULTURE, WILDLIFE AND VEGETATION OF UNMANAGED DOUGLAS-FIR FORESTS 71, 73 (1991) [hereinafter UNMANAGED DOUGLAS-FIR FORESTS] ("Foresters define productivity as wood biomass increment.").

[3] *See, e.g.*, W.D. Hagenstein, *The Old Forest Maketh Way for the New*, 8 ENVTL. LAW 479, 493–95 (1978).

[4] *See* Robert O. Curtis, *The Role of Extended Rotations*, *in* CREATING A FORESTRY FOR THE 21ST CENTURY: THE SCIENCE OF ECOSYSTEM MANAGEMENT 165, 165–66 (Kathryn A. Kohm & Jerry F. Franklin eds., 1997) [hereinafter CREATING A FORESTRY FOR THE 21ST CENTURY]; Jerry F. Franklin et al., *Alternative Silvicultural Approaches to Timber Harvesting: Variable Retention Harvest Systems*, *in* CREATING A FORESTRY FOR THE 21ST CENTURY, *supra*, at 111, 111–12; Wilkinson & Anderson, *supra* note 1, at 128–29.

[5] *See* COGGINS ET AL., *supra* note 1, at 632; Hagenstein, *supra* note 3, at 492–93.

[6] *See* Wilkinson & Anderson, *supra* note 1, at 70.

[7] *See, e.g.*, Thomas Spies, *Forest Stand Structure, Composition, and Function*, *in* CREATING A FORESTRY FOR THE 21ST CENTURY, *supra* note 4, at 11, 13–27; Dennis E. Teeguarden, *The Forest as a System*, *in* FOREST RESOURCE MANAGEMENT: DECISION-MAKING PRINCIPLES AND CASES 159, 161–62 (William A. Duerr et al. eds., 1979) [hereinafter FOREST RESOURCE MANAGEMENT].

Depending on the species, the older trees may display not only large height and girth, and thick, deeply-furrowed bark, but also different shapes from young trees, including thick branches, forked trunks, and flattened or broken tops. The physical structure of old forests also typically includes standing dead trees (snags), large downed logs, and a variety of downed branches, leaves and needles, and other organic matter accumulated on the forest floor.[8] Each of these physical attributes of an old-growth forest contributes to the support of communities of large and small organisms that also differ substantially from those found in younger, even-aged forests.[9]

Old-growth forests also serve important functions related to the quality and quantity of water emanating from forested watersheds. The vegetation, the soil, and the biomass on the forest floor act as a filter and a sponge, reducing surface runoff and trapping sediments in times of rainfall and slowly releasing water to streams during dry periods.[10] Finally, old-growth forests provide an important social function as places for recreation, appreciation of nature, contemplation, and inspiration.[11]

Management to maintain these multiple forest functions requires a system of accounting that can distinguish between a young plantation of seedlings or saplings and a complex, multi-storied old-growth forest. Any method of evaluation of the condition of a forest that relied merely on inventorying the species, numbers, and growth rates of trees would be grossly insufficient.

For this reason, forest scientists and the U.S. Forest Service have developed methods of classifying, inventorying, and evaluating forests that measure a multitude of forest attributes, including the sizes and/or ages of trees, the nature and extent of the forest canopy, the amount and type of understory vegetation, and the numbers of standing snags and downed logs.[12] Furthermore, modern forest management plans contain elements designed to maintain and enhance forest functions other than production of wood and fiber. The most prominent of these elements are provisions that set aside and reserve from logging

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[8] *See generally*, Franklin & Spies, *supra* note 2.

[9] *See, e.g.*, Bruce G. Marcot, *Biodiversity of Old Forests of the West: A Lesson from Our Elders*, *in* CREATING A FORESTRY FOR THE 21ST CENTURY, *supra* note 4, at 87, 89–96.

[10] *See, e.g.*, Donald R. Satterlund, *Water and Watershed Services*, *in* FOREST RESOURCE MANAGEMENT, *supra* note 7, at 226, 227–30.

[11] *See generally, e.g.*, Marion Clawson, *Recreation Services*, *in* FOREST RESOURCE MANAGEMENT, *supra* note 7, at 199; R. Burton Litton, Jr., *Aesthetic Values*, *in* FOREST RESOURCE MANAGEMENT, *supra* note 7, at 215.

[12] *See, e.g.*, FOREST ECOSYSTEM MANAGEMENT ASSESSMENT TEAM, FOREST ECOSYSTEM MANAGEMENT: AN ECOLOGICAL, ECONOMIC, AND SOCIAL ASSESSMENT IV-10 to IV-12, IV-24 to IV-27 (1993) [hereinafter FEMAT REPORT]; U.S. FOREST SERVICE, MANAGEMENT RECOMMENDATIONS FOR THE NORTHERN GOSHAWK IN THE SOUTHWESTERN UNITED STATES 2–3, 30–32 (1992) [hereinafter RECOMMENDATIONS FOR THE NORTHERN GOSHAWK].

substantial areas of the remaining old-growth forests.[13] Also present are provisions for maintaining forests of higher densities than the optimum for timber production, and for extended rotations that allow trees to grow beyond the harvest ages that would be specified by a plan designed solely for timber production.[14]

Another key concept that has emerged as managers have moved away from strictly production-oriented management is the importance of natural disturbance regimes, particularly fire. Once seen as a purely destructive force that wasted valuable timber,[15] fire is now understood to be an essential factor in the long-term maintenance of many forest ecosystems.[16] The natural role of fire differs depending on climate and forest type. For example, in forests of the Pacific Northwest, high-intensity fires that occurred every few centuries served to maintain populations of Douglas-fir that might otherwise have been replaced by fire-intolerant tree species such as western hemlock or western redcedar;[17] in ponderosa pine forests, low-intensity fires that burned every few years prevented the buildup of excessive numbers of young trees and maintained a relatively open, grass understory;[18] in the Rocky Mountains, fire is needed to open the serotinous cones and release the seeds of lodgepole pine.[19]

Ruthless suppression of fires was a hallmark of production-oriented forest management, and the exclusion of fire has greatly altered the structure and function of some North American forests.[20] As forest managers have come to recognize the value of fire, however, prescriptions for allowing natural fires to

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[13] *See* FEMAT REPORT, *supra* note 12, at II-6 to II-9 (describing "Late-Successional Reserves" in the forests of the Pacific Northwest).

[14] *See id.* at II-10 to II-11.

[15] *See generally* STEPHEN J. PYNE, FIRE IN AMERICA: A CULTURAL HISTORY OF WILDLAND AND RURAL FIRE (1982).

[16] *See, e.g.*, James K. Agee, *Fire Management for the 21st Century*, *in* CREATING A FORESTRY FOR THE 21ST CENTURY, *supra* note 4, at 191, 192–94.

[17] *See, e.g.*, James K. Agee, *Fire History of Douglas-Fir Forests in the Pacific Northwest*, *in* UNMANAGED DOUGLAS-FIR FORESTS, *supra* note 2, at 25, 25–26.

[18] *See, e.g.*, Michael G. Harrington & Stephen S. Sackett, *Past and Present Fire Influences on Southwestern Ponderosa Pine Old Growth*, *in* U.S. FOREST SERVICE, OLD-GROWTH FORESTS IN THE SOUTHWEST AND ROCKY MOUNTAIN REGIONS: PROCEEDINGS OF A WORKSHOP 44, 45 (1992) [hereinafter OLD-GROWTH WORKSHOP].

[19] While timber harvest may mimic the function of fire in some respects, such as removing trees, the ecological impact of timber cutting is much different than that of fire in other respects. Fire can benefit fire-resistant tree species such as Douglas Fir and Giant Sequoia by removing less fire-tolerant competitors, but the fire-resistant species are some of the most valuable for lumber and are therefore often targeted by timber harvest. Low-intensity fires tend to selectively remove younger trees that are too small to be commercially useful; timber harvest does the opposite. Fire creates snags; logging does not. The ash produced by fire enriches forest soils; logging operations disrupt and compact soils. *See* Agee, *supra* note 17, at 33.

[20] *See generally, e.g.*, W.W. Covington & M.M. Moore, *Postsettlement Changes in Natural Fire Regimes: Implications for Restoration of Old-Growth Ponderosa Pine Forests*, *in* OLD-GROWTH WORKSHOP, *supra* note 18, at 81.

burn and for deliberately igniting some fires are finding their way into modern forest management plans.[21]

III. OLD-GROWTH RANGELANDS: STRUCTURES AND FUNCTIONS OF MATURE COMMUNITIES OF GRASSES, FORBS, AND SHRUBS

Like a forest, a community of grasses, forbs, and shrubs exhibits structures and functions that cannot be characterized simply by counting the numbers and species of plants. And, as in a forest, these structures and functions develop over time; a mature herbaceous community has species and characteristics that are not shared by a community that has recently been heavily grazed, burned, or otherwise denuded.

From the outset, it is necessary to recognize there is one fundamental respect in which grasses and forbs (but not shrubs) differ from trees. Grasses and forbs do not have woody stems that persist and increase in size from year to year. Rather, the above-ground parts of most herbaceous plants die back each winter and new leaves and stems grow from the ground up.[22] Therefore, of course, a grass plant can never develop the size or structural complexity of a tree. Nonetheless, grasslands do have a vertical structure of living and residual plants that develops over time, both within a growing year and from one year to the next. And this structure is essential to the functions performed by grasslands. Moreover, a minority of grasses resemble woody plants in that they do have stems that survive and store carbohydrates from year to year, even when the plant is brown and dormant. These grasses, known as suffrutescent grasses, include some of the most common and important forage plants in the desert rangelands of the southwestern United States.[23]

For the purposes of this Article, we divide the functions of grassland vegetation into two categories, internal and external. *Internal functions* are those functions, such as soil conservation, moisture retention, and fire propagation, that are necessary to the sustenance of the grassland itself. *External functions* are those functions, such as provision of wildlife habitat, water quality, and scenic and aesthetic values, that serve ecological and societal needs beyond grassland maintenance.[24] Management that fails to maintain internal functions results in the

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[21] *See* Agee, *supra* note 16, at 192–94.

[22] *See* Tony L. Burgess, *Desert Grassland, Mixed Shrub Savanna, Shrub Steppe, or Semidesert Scrub?, The Dilemma of Coexisting Growth Forms*, *in* THE DESERT GRASSLAND 31, 38 (Mitchel P. McClaran & Thomas R. Van Devender eds., 1995) [hereinafter DESERT GRASSLAND].

[23] *See id.*; Joseph R. McAuliffe, *Rangeland Water Developments: Conservation Solution or Illusion?*, *in* CENTER FOR THE STUDY OF LAW, SCIENCE AND TECHNOLOGY, ARIZONA STATE UNIVERSITY, ENVIRONMENTAL, ECONOMIC, AND LEGAL ISSUES RELATED TO RANGELAND WATER DEVELOPMENTS: PROCEEDINGS OF A SYMPOSIUM 310, 327–29 (1998) [hereinafter RANGELAND WATER DEVELOPMENTS].

[24] External functions of an ecosystem are sometimes termed "services." *See, e.g.*, FOREST RESOURCE MANAGEMENT, *supra* note 7, at 157–290.

degradation or loss of the grassland and eventually results in the loss of external functions as well. Management that maintains internal functions but fails to maintain external functions may result in significant loss of social and ecological values even though the grassland itself is maintained.

Internal and external functions are not always distinct. For example, the internal function of soil conservation is closely linked to the external function of water quality maintenance; if soils erode away they usually end up in streams. Sometimes, however, external functions may be seriously impaired even while internal functions are maintained. For example, a grazing regime that is not deleterious to soils or vegetation may nonetheless leave insufficient cover and shade for some wildlife species and may result in trampling of archaeological sites, deposition of manure and urine in streams, and degradation of natural scenery.[25]

The internal functions of grasslands begin with soils.[26] Soils provide the medium in which rangeland vegetation roots, and supply that vegetation with water and nutrients. For rangeland soils to function properly, they must be sufficiently permeable to be penetrated by the roots of plants. The soil surface must absorb water from rainfall and the subsurface must store that water and make it available to the roots.[27] The soil must store essential nutrients, particularly nitrogen, in a form that is available to, and usable by, plants.[28]

In many arid and semi-arid rangelands, a critical structural component of undisturbed soil is a biological crust on the surface, known variously as a microbiotic, cryptogamic, cryptobiotic, or microphytic crust, consisting of interwoven communities of cyanobacteria, algae, lichens, mosses, and their byproducts.[29] These crusts, which can be destroyed by trampling livestock or by other disturbances, stabilize soils against erosion, absorb and hold water, fix nitrogen, and add organic matter to the soil.[30]

Other critical functions related to soils are performed by the rangeland vegetation itself. These functions include development of soils, thermal regulation, moisture absorption and retention, protection from erosion, and nutrient

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[25] *See* Joseph M. Feller, *What is Wrong With the BLM's Management of Livestock Grazing on the Public Lands?*, 30 IDAHO L. REV. 555, 561–63 (1994).

[26] For a good discussion of the relationship between soils and vegetation in arid environments, see generally Joseph R. McAuliffe, *Landscape Evolution, Soil Formation, and Arizona's Desert Grasslands*, *in* DESERT GRASSLAND, *supra* note 22, at 100.

[27] *See* Thomas L. Thurow, *Hydrology and Erosion*, *in* GRAZING MANAGEMENT: AN ECOLOGICAL PERSPECTIVE 141, 142–48 (Rodney K. Heitschmidt & Jerry W. Stuth eds., 1991) [hereinafter GRAZING MANAGEMENT].

[28] *See* Steve Archer & Fred E. Smeins, *Ecosystem-level Processes*, *in* GRAZING MANAGEMENT, *supra* note 27, at 109, 118.

[29] *See* NATURAL RESOURCES CONSERVATION SERVICE, U.S. DEP'T OF AGRICULTURE, INTRODUCTION TO MICROBIOTIC CRUSTS 1–4 (1997).

[30] *See id.* at 8.

replenishment. Within a growing year, as grass leaves increase in height, they increasingly shade the soil from direct sunlight. The shading moderates soil temperature, thereby decreasing the evaporation rate and helping to maintain soil moisture.[31] The shading effect is increased by standing and fallen dead leaves that may persist from one year to the next. Live and residual grass leaves also enhance soil moisture by retarding air movement at the soil surface, thus creating a layer of relatively still air that protects the soil from the drying effect of wind.[32] This layer of relatively still air also moderates soil temperature, reducing the severity of frosts in winter and extremes of heat in summer.[33]

In addition to the shading function, a covering of plant litter forms a natural mulch that absorbs and holds rainwater, allowing it to infiltrate into the soil. A layer of vegetation at the soil surface also reduces erosion and enhances soil formation in several ways.[34] First, it intercepts raindrops, breaking their fall, reducing their velocity, and thereby protecting the soil from splash erosion. Second, the vegetative layer acts as a physical barrier to air and water movement at the soil surface, protecting the soil from both wind and sheetflow erosion. Third, the vegetative layer traps wind-borne and water-borne sediments, thereby contributing to soil formation. Fourth, as residual vegetation decomposes, it adds to the soil mass and organic and nutrient content.[35]

Another essential internal function of grasses and other rangeland vegetation is the propagation of fire. In many areas of the West, before the arrival of Euro-American settlers, periodic fires ignited by lightning maintained grasslands by suppressing such woody species as acacia, mesquite, sagebrush, and juniper.[36] Fire may also promote the cycling of nutrients into the soil.[37] When livestock grazing or other land use leaves insufficient standing grass to propagate a fire, grasslands give way to woody plants. The suppression of fire by grazing has been identified as a major cause of the loss of grasslands in the western United States over the last century and a half.[38]

External functions of rangelands include regulation of water flows, maintenance of water quality, provision of wildlife habitat, and provision of scenic beauty and recreational opportunities. Absorption of water by rangelands reduces

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[31] *See, e.g.*, LARRY HOWERY, RANGELAND MANAGEMENT BEFORE, DURING, AND AFTER DROUGHT 3 (1999).

[32] *See* Archer & Smeins, *supra* note 28, at 116–17.

[33] *See id.*

[34] *See* HOWERY, *supra* note 31, at 3; Thurow, *supra* note 27, at 153–58.

[35] *See* HOWERY, *supra* note 31, at 3.

[36] *See, e.g.*, ROBERT R. HUMPHREY, THE DESERT GRASSLAND: A HISTORY OF VEGETATIONAL CHANGE AND AN ANALYSIS OF CAUSES 51–64 (1958); Guy R. McPherson, *The Role of Fire in the Desert Grasslands*, *in* DESERT GRASSLAND, *supra* note 22, at 130.

[37] *See* McPherson, *supra* note 36, at 133–34.

[38] *See, e.g.*, CONRAD JOSEPH BAHRE, A LEGACY OF CHANGE: HISTORIC HUMAN IMPACT ON VEGETATION OF THE ARIZONA BORDERLANDS 124–42 (1991); HUMPHREY, *supra* note 36, at 51–64.

surface runoff and the incidence and intensity of floods.[39] If the absorbed water moves into aquifers it contributes to groundwater recharge; if it moves through groundwater to stream channels, it helps maintain streamflows during periods of drought. The trapping and retention of airborne and waterborne sediment by rangeland vegetation keeps the retained sediment out of lakes and streams.

As with a forest, the physical structure of a grassland includes elements that are important to the survival and propagation of numerous species of wildlife.[40] And, as in the case of a forest, these elements develop over time, so that an undisturbed grassland has characteristics that differ from those of a grassland that has been recently grazed. Standing grass, especially when composed of residual plants from the previous year's growth, provides cover under which many species of small mammals and birds build their nests and hide from predators.[41] Larger mammals, such as pronghorn, use the shelter of tall grass to conceal their young. Residual grass also provides shade from the sun and a thermal cover that moderates both high and low extremes of temperature. Shrubs provide nesting, roosting, and perch sites for some species of birds.[42]

IV. IGNORING STRUCTURE AND FUNCTION: RANGELAND MANAGEMENT PRACTICES OF THE FOREST SERVICE AND THE BLM

In public policies and pronouncements, the Forest Service[43] and the BLM have for many years committed themselves to managing their rangelands in a manner that recognizes and maintains a full range of ecological and social

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[39] *See* Thurow, *supra* note 27, at 146–47.

[40] *See generally* RANGELAND WILDLIFE (Paul R. Krausman ed., 1996) (examining the habitat needs of rangeland wildlife).

[41] *See, e.g.*, DAVID E. BROWN, ARIZONA GAME BIRDS 110–12, 129–32 (1989); David E. Brown, *Factors Influencing Reproductive Success and Population Densities in Montezuma Quail*, 43 J. WILDLIFE MGMT. 522, 522, 525 (1979). Birds that require tall grass cover include, for example, Cassin's sparrow (*Aimophila cassinii*), Botteri's sparrow (*Aimophila botterii*), and grasshopper sparrow (*Ammodramus savannarum*). *See* Carl E. Bock & Jane H. Bock, *Factors Controlling the Structure and Function of Desert Grasslands: a Case Study from Southeastern Arizona*, *in* ROCKY MOUNTAIN RESEARCH STATION, U.S. FOREST SERVICE, THE FUTURE OF ARID GRASSLANDS: IDENTIFYING ISSUES, SEEKING SOLUTIONS 33, 35 fig.1 (1998).

[42] *See, e.g.*, Fritz L. Knopf, *Perspectives on Grazing Nongame Bird Habitats*, *in* RANGELAND WILDLIFE, *supra* note 40, at 51, 53–54.

[43] The U.S. Forest Service manages the National Grasslands as well as the National Forests. *See* 16 U.S.C. § 1611 (1994). Moreover, the national forests themselves include large areas of rangeland. The majority of the land in the national forests, as well as almost all BLM land, is used for livestock grazing. *See* U.S. BUREAU OF LAND MANAGEMENT, RANGELAND REFORM 1994 DRAFT ENVIRONMENTAL IMPACT STATEMENT 3–5 (1994) [hereinafter RANGELAND REFORM EIS].

functions.[44] These policies and pronouncements, however, are generally not reflected in actual rangeland management.

In part, the discrepancy between leadership philosophy and on-the-ground management is a function of bureaucratic inertia, permittee resistance, and lack of adequate funding and personnel, resulting in the absence of up-to-date management plans for many grazing allotments.[45] Even where newly-developed grazing management practices are in place, however, these practices are almost always characterized by a narrow focus on the growth and reproduction of individual range plants, to the exclusion of broader considerations of rangeland structure and function.[46] This narrow focus is reflected in the measurements that these agencies use to gauge the condition of rangelands and to make decisions about future levels and locations of grazing. There are two types of measurements most commonly employed by the Forest Service and the BLM in their range management programs: (1) measurements of forage utilization to regulate the intensity of livestock grazing, and (2) measurements of changes in the numbers and types of plants, also known as trend, to gauge the long-term impacts of grazing.[47] These measurements fail to account for any of the myriad functions of grasslands other than forage production.

A. Use of Forage Utilization Measurements to Regulate Grazing Intensity

Utilization is defined as the percentage, by weight, of a year's growth of a plant that is consumed by grazing animals.[48] Increasingly, utilization is being used not only as a measure of grazing impact but also as a means of prescribing grazing practices.[49] A typical BLM or Forest Service grazing management plan specifies utilization standards or limits that should not be exceeded. The limits frequently

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[44] *See, e.g.*, Rangeland Reform Regulations, 60 Fed. Reg. 9894, 9898 (1995) (codified at scattered sections of 43 C.F.R. pts. 4, 1780, 4100 (1998)) (discussing "fundamentals of Rangeland Health" purported to "address the necessary physical components of functional watersheds, ecological processes required for healthy biotic communities, water quality standards and objectives, and habitat for threatened or endangered species or other species of special interest").

[45] *See generally* U.S. GENERAL ACCOUNTING OFFICE, RANGELAND MANAGEMENT: SOME RIPARIAN AREAS RESTORED BUT WIDESPREAD IMPROVEMENT WILL BE SLOW (1988); U.S. GENERAL ACCOUNTING OFFICE, RANGELAND MANAGEMENT: MORE EMPHASIS NEEDED ON DECLINING AND OVERSTOCKED GRAZING ALLOTMENTS (1988).

[46] *See* Feller, *supra* note 25, at 578–79.

[47] *See id.* at 578.

[48] *See* 43 C.F.R. § 4100.0-5 (1998). *See also* SOCIETY FOR RANGE MANAGEMENT, A GLOSSARY OF TERMS USED IN RANGE MANAGEMENT 30 (4th ed. 1998).

[49] *See* Kenneth D. Sanders, *Utilization Standards: The Quandary Revisited*, *in* AGRICULTURAL EXPERIMENT STATION, OREGON STATE UNIVERSITY, STUBBLE HEIGHT AND UTILIZATION MEASUREMENTS: USES AND MISUSES 3, 5 (1998) [hereinafter USES AND MISUSES]; Lee Sharp et al., *Management Decisions Based on Utilization—Is it Really Management?*, 16 RANGELANDS 38, 38 (1994); E. Lamar Smith, *Seasonal Effects on the Measurement and Interpretation of Utilization*, *in* USES AND MISUSES, *supra* at 9, 10.

depend on the season of the year in which a pasture is grazed and the frequency (e.g., every year, every other year, two years out of three) of grazing.[50] Plans typically require that livestock be removed from a pasture when the limits are reached, and/or that livestock numbers be decreased in future years if the limits are exceeded in one year.[51] Thus, utilization measurements are the primary determinant of the permissible level of grazing.

There are many serious problems with the agencies' heavy reliance on utilization limits.[52] To begin with, because utilization limits are expressed as a percentage of a year's growth, they often fail to leave sufficient vegetation on the ground in dry years. During a drought, a plant's growth may be barely sufficient to produce enough carbohydrates to keep it alive, with nothing to spare. A percentage-based utilization limit that allows the same fraction of the year's growth to be consumed under these conditions as would be allowed in a period of ample rainfall results in the weakening or death of the plant.[53]

Beyond this fundamental problem, there are at least three ways in which the agencies' use of utilization limits fails to maintain rangeland structure and function. First, there are numerous impacts of livestock grazing on structure and function that simply are not reflected in utilization measurements. Second, the utilization limits themselves are generally *determined* through methods that ignore most aspects of structure and function. Third, the utilization limits are often *applied* in a manner that fails to protect structure and function.

1. Impacts that Are Not Reflected in Utilization Measurements

Utilization measurements do not reflect the impacts of livestock grazing on rangeland structure and function that are *not* the result of forage consumption. For example, utilization measurements provide no indication of the degree of soil compaction occurring as the result of trampling by livestock. Soil compaction increases surface runoff and resultant soil erosion and water pollution, reduces rainfall infiltration and soil water storage, and thereby increases flooding in times of rainfall and reduces streamflows in times of drought.[54] Measurements of forage utilization also fail to gauge the extent of destruction of microbiotic soil crusts by livestock hooves[55] or the quantity of livestock manure and urine that finds its way into lakes and streams. Such measurements also fail to reflect impacts such as the

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[50] *See, e.g.*, U.S. FOREST SERVICE, U.S. DEP'T OF AGRICULTURE, KAIBAB NATIONAL FOREST LAND MANAGEMENT PLAN 31–32 (amended 1996) [hereinafter KAIBAB LMP]; BUREAU OF LAND MANAGEMENT, U.S. DEP'T OF THE INTERIOR, SAN JUAN RESOURCE MANAGEMENT PLAN: PROPOSED RESOURCE MANAGEMENT PLAN, FINAL ENVIRONMENTAL IMPACT STATEMENT 1-275 (1987) [hereinafter SAN JUAN RMP/EIS].

[51] *See, e.g.*, SAN JUAN RMP/EIS, *supra* note 50, at 27 (specifying that changes in livestock use may be made in response to utilization monitoring).

[52] *See generally* USES AND MISUSES, *supra* note 49.

[53] *See* McAuliffe, *supra* note 23, at 329.

[54] *See* Thurow, *supra* note 27, at 151–52.

[55] *See supra* note 30 and accompanying text.

spread of seeds of invasive or noxious plants in cattle hair, feed, and manure,[56] or the spread of invasive animal species that accompany livestock.

2. *Shortcomings in the Setting of Utilization Limits*

The utilization limits set by the BLM and the Forest Service are generally designed only to ensure the survival and growth of individual range plants. They are typically derived from experiments that involve periodically clipping plants to simulate grazing of varying intensities and then measuring the growth rates and other characteristics of the clipped plants.[57] The utilization limits permit a level of grazing that has been shown by such experiments to allow a grazed plant to survive, regrow, and reproduce.[58] These limits generally ignore the myriad other aspects of rangeland structure and function that may be impaired by the large-scale removal of vegetative biomass. Even if a closely-cropped plant regrows and reproduces, the removal of vegetative material may degrade or destroy both the internal and external functions that that plant would otherwise perform.[59]

a. Failure to Account for Internal Functions

With respect to internal functions, grazing at levels deemed acceptable according to clipping experiments may cause loss of the thermal-moderating layer at the soil surface, desiccation and compaction of the soil, reduced water infiltration, and loss of soil through wind and water erosion.[60] These changes in turn create a micro-environment that is inhospitable to the original native grass species and invites the invasion of opportunistic plant species that are adapted to more open conditions, drier, thinner, and/or harder soils, and greater extremes of soil temperature; in short, desertification occurs.[61] Furthermore, utilization limits designed to protect the health of individual plants generally do not leave sufficient residual vegetation to carry a fire. A grassland that is "well-managed" by conventional standards may be taken over by shrubs and trees, and eventually depleted of grass, because of the effective exclusion of fire by grazing. Moreover, even moderate levels of grazing may tip the competitive balance between plants

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[56] *See, e.g.*, J.R. Brown & Steve Archer, *Woody Plant Invasion of Grasslands: Establishment of Honey Mesquite* (Prosopis glandulosa var. glandulasa) *on Sites Differing in Herbaceous Biomass and Grazing History*, 80 OECOLOGIA 19, 20–25 (1989).

[57] *See* Smith, *supra* note 49, at 13.

[58] *See id.*

[59] *See id.* ("[Utilization standards] based on the physiological and/or morphological tolerance to grazing...have no direct relevance to other management concerns such as adequate soil cover, residual cover for nesting birds, or stubble height requirements for sediment capture.").

[60] *See* Archer & Smeins, *supra* note 28, at 116–17; Thurow, *supra* note 27, at 153–58.

[61] *See, e.g.*, McAuliffe, *supra* note 23, at 323–25, 330; Thurow, *supra* note 27, at 156–58.

that are highly palatable to livestock and those that are less so, thus altering rangeland composition.

b. Failure to Account for External Functions

Even if stocking rates and utilization levels are set low enough to maintain the internal functions of rangelands, and thereby maintain or improve the density and composition of vegetation, the removal of vegetative material by grazing may impair the external functions of rangelands. That is, the stubble left after grazing, even if sufficient to maintain soil moisture and prevent excessive erosion, may be insufficient to provide thermal, hiding, and nesting cover for wildlife,[62] or to regulate water flows and water quality,[63] or to maintain the scenic and aesthetic qualities of grasslands.[64]

c. Some Exemplary Numbers

The severe impacts on rangeland structure and function of grazing at utilization levels determined acceptable through clipping experiments can best be appreciated by a quick look at some numbers. A typical BLM land use plan authorizes grazing utilization levels of fifty percent on key species.[65] The utilization is measured by weight, not by height. Most grass plants have their weight concentrated near the base of the plant, so that removal of the top fifty percent by weight typically involves removing much more than fifty percent of the height of the plant. For example, for black grama (*Bouteloua eriopoda*) and tobosa (*Hilaria mutica*), two common grasses on southwestern semidesert rangelands,[66] fifty percent utilization reduces a twenty-inch plant to a three-inch stubble.[67] This short stubble provides little in the way of soil shading, erosion protection, wildlife cover, fire propagation, or scenic beauty. In fact, experiments on actual rangelands

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[62] *See, e.g.*, David E. Brown, *Grazing, Grassland Cover and Gamebirds*, 43 TRANSACTIONS N. AM. WILDLIFE & NAT. RES. CONF. 477, 483 (1978) ("Even a conservative utilization of forage in the neighborhood of 20 to 40% could be highly detrimental to grassland birds during drought periods.").

[63] *See supra* note 39 and accompanying text.

[64] *See* Feller, *supra* note 25, at 562–63.

[65] *See* GEORGE RUYLE ET AL., STRATEGIES FOR MANAGING GRAZING ALLOTMENTS ON PUBLIC LANDS 3 (1995) (defining "heavy" utilization as utilization exceeding 50%); Jerry L. Holechek et al., *Grazing Studies: What We've Learned*, RANGELANDS, April 1999, at 12 ("Conventional wisdom has been that moderate stocking involves 50% use of forage."); *id.* at 15 (stating that the Natural Resources Conservation Service of the Department of Agriculture continues to recommend 50% utilization).

[66] *See* David E. Brown, *Semidesert Grassland*, *in* BIOTIC COMMUNITIES: SOUTHWESTERN UNITED STATES AND NORTHWESTERN MEXICO 123, 127 (David E. Brown ed., 1994).

[67] The Authors derived this measurement by using the *Utilization Gauge: An Instrument for Measuring the Utilization of Grasses*, produced by the Rocky Mountain Forest and Range Experiment Station, Forest Service, U.S, Dep't of Agriculture in 1980.

rather than experimental clipping plots show that fifty percent utilization results in deterioration of range condition in arid and semi-arid areas.[68]

3. *Shortcomings in the Application of Utilization Limits*

Another aspect of the failure to take into account the structure and function of rangeland vegetation is the manner in which utilization limits are incorporated into grazing management plans. The BLM and the Forest Service draw a sharp distinction between the effects of grazing during the growing (spring or summer) season and during the dormant (fall or winter) season. BLM and Forest Service range managers typically assume that dormant-season grazing removes only residual grass tissue that is no longer photosynthetically active, and has little or no effect on subsequent plant growth.[69] This assumption is incorrect with respect to the suffrutescent grasses[70] that store carbohydrates in their stems. Dormant-season grazing can be very deleterious to these grasses.[71] But even where the assumption is correct (i.e., even where the physiology of an individual plant can tolerate removal of much of its above-ground biomass during the dormant season), dormant-season grazing still drastically affects the structure and function of rangelands. Standing and fallen plant material provides essential thermal and hiding cover for wildlife, protects the soil from erosion, moderates soil temperature, maintains soil moisture, propagates fire, and provides aesthetic benefits.[72] Removal of plant material by grazing impairs these functions as much in the dormant season as in the growing season. In some cases, grazing during the dormant season has an even greater impact than growing-season grazing, because there is less opportunity for regrowth. Nonetheless, because of the focus on production rather than structure and function, grazing management plans typically specify much higher limits (or no limits at all) on grazing intensity during the dormant season than during the growing season.[73]

Similarly, BLM and Forest Service range managers typically presume that the environmental effects of grazing can be mitigated by employing rotational grazing systems that allow rest periods for the regrowth of vegetation between incidences of grazing. They therefore permit higher utilization levels under such

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[68] *See* Holechek et al., *supra* note 65, at 12–15; McAuliffe, *supra* note 23, at 328–29.

[69] *See, e.g.*, BUREAU OF LAND MANAGEMENT, U.S. DEP'T OF THE INTERIOR, PROPOSED COMB WASH INTEGRATED WATERSHED PLAN AND SAN JUAN RESOURCE MANAGEMENT PLAN AMENDMENT AND ENVIRONMENTAL ASSESSMENT 6 (1997) (rejecting, summarily, the alternative of reducing dormant-season grazing, on the grounds that "[d]ormant season use is not comparable with growing season use").

[70] *See supra* note 23 and accompanying text.

[71] *See* McAuliffe, *supra* note 23, at 328.

[72] *See supra* Part III.

[73] *See, e.g.*, KAIBAB LMP, *supra* note 50, at 31–32 (specifying forage utilization limits that apply only during the growing season and specifying no limits for the dormant season).

rotational systems than in pastures that are subject to continuous, year-long grazing.[74] While these rest periods may allow individual plants to recover from the effects of grazing, they do not mitigate the loss of soil protection, thermal regulation, or water absorption and retention, or the alteration of plant competition that results from removal of biomass by grazing. It is perhaps for this reason that controlled studies have generally revealed that rotational grazing systems do not result in better rangeland conditions than those that result from continuous grazing at the same stocking rate.[75]

B. Use of Trend Measurements to Gauge the Long-Term Impacts of Grazing

While utilization measurements are used to gauge the intensity of grazing, the BLM and the Forest Service use vegetative trend measurements to gauge the long-term impacts of grazing on rangelands. There are a number of different methods of measuring vegetative trends, but each depends on counting the number of plants of each species along a series of transects or in a series of sample quadrants.[76] The agencies identify "key" or "decreaser" plant species (desirable native forage species that are susceptible to depletion if grazed too heavily) and "increaser" or "invader" plant species (less palatable or toxic plants that increase in abundance in response to grazing).[77] Rangelands are classified according to the relative abundance of decreaser and increaser species. Range condition trend is considered "upward" or "improving" if key species are increasing in abundance relative to increaser or invader species, "downward" if key species are decreasing, and "stable" or "static" if the species composition of the rangeland is not changing significantly.

There are a number of problems inherent in the use of such trend measurements. First, they do not directly measure soil compaction, desiccation, erosion, or loss of soil nutrients. These effects may be reflected in trend measurements only when they have progressed to an advanced stage. For example, studies of the effects of soil trampling by livestock have revealed that severe losses of microbiotic crusts, major increases in surface runoff, and drastic increases in soil erosion may occur without apparent damage to vegetation.[78] Eventually, of course, massive soil loss will lead to degradation of the vegetative community,

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[74] *See supra* notes 50–51 and accompanying text.

[75] *See* Holechek et al., *supra* note 65, at 14–15. Similarly, so-called "short duration" grazing systems, also known as "Savory systems," or "holistic resource management" have failed to improve rangeland conditions. *See, e.g.*, F.C. Bryant et al., *Does Short-Duration Grazing Work in Arid and Semiarid Regions?*, 44 J. SOIL & WATER CONS. 290, 296 (1989); David E. Brown, *Out of Africa*, WILDERNESS, Winter 1994, at 24, 27, 32.

[76] *See* Feller, *supra* note 25, at 578 & n.132.

[77] *See, e.g.*, D.D. Briske, *Developmental Morphology and Physiology of Grasses*, *in* GRAZING MANAGEMENT, *supra* note 27, at 85, 102–06.

[78] *See* NATURAL RESOURCES CONSERVATION SERVICE, *supra* note 29, at 8.

which will show up in trend measurements; but by the time that occurs it may be far too late to take corrective action.[79]

Second, trend studies are designed only to detect changes in rangeland condition from the status quo at the beginning of the study period. They do not reflect the extent to which that status quo itself may be a result of drastic grazing-induced ecological changes that occurred before the study began. A "stable" or "static" trend may simply reflect an ecosystem that has reached rock-bottom.

Third, BLM and Forest Service trend studies typically employ a handful of sample sites to monitor trends on an allotment measuring tens or hundreds of thousands of acres in size.[80] The use of such a limited number of sample locations presumes a degree of spatial uniformity, so that the trend at the sample locations may be used to infer the trend over a much larger area. This presumption is generally not valid. Grazing impacts typically vary dramatically from place to place within an allotment, depending on distance to water, terrain features, slope, elevation, exposure, soil type, and pasture movements.[81]

Finally, trend measurements completely fail to track the extent to which the external functions of rangelands are being maintained. Species counts do not reveal, for example, whether or not a sufficient height and density of biomass is being maintained to provide thermal and hiding cover and nest sites for all species of wildlife, or whether water quality and scenic beauty are being maintained.

V. AN AGENDA FOR PUBLIC RANGELAND MANAGEMENT THAT RESPECTS STRUCTURE AND FUNCTION

Several lessons can be taken from recent innovations in public forest management to help determine the principal features of a program of public rangeland management that respects the full spectrum of rangeland structure and function.

A. From Roadless Areas to Waterless Areas

The first lesson is to avoid degrading or destroying remaining ecosystems, or portions of ecosystems, that still retain a large measure of their original structure and function. In the case of forests, this has meant placing substantial tracts of the remaining old-growth forests into reserves in which logging is prohibited or severely restricted.[82] The most ambitious move in this direction has been the Clinton administration's recent action to protect the

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[79] *See* McAuliffe, *supra* note 23, at 325–26, 330.

[80] *See* Feller, *supra* note 25, at 579–80.

[81] *See id.* at 580–81.

[82] *See supra* note 13 and accompanying text.

majority of the remaining National Forest roadless areas from road building, logging, and other forms of development.[83]

At first glance, it would appear that it is far too late to protect old-growth grasslands from livestock grazing. Grazing is already permitted on virtually all public rangelands; indeed, grazing on almost all of these lands predates the existence of both agencies.[84] There are, nonetheless, portions of the public rangelands that have been spared many of the impacts of grazing. These include areas that are too distant from water sources, either natural or artificial, to receive regular livestock use. In the arid climate of the American West, livestock cannot travel more than a few miles from drinkable water; most livestock use is concentrated within one or two miles of water sources.[85] Water developments are to livestock grazing what roads are to logging; just as the roadless areas are where most of the remaining old-growth forests occur, the waterless areas are where most of the remaining intact grasslands are found.

Just as the Forest Service has historically sought to construct roads in order to open public forests to timber harvest, the BLM and the Forest Service have permitted and encouraged the construction of water developments to open public rangelands to livestock grazing.[86] With respect to roads, however, recent decades have brought an increasing recognition of the value of preserving remaining roadless areas. This recognition first appeared in Forest Service administrative policies protecting wild and primitive areas in the National Forests,[87] and later was reflected in the Wilderness Act of 1964, which gave permanent, statutory protection to selected National Forest roadless areas.[88] The provisions of the Wilderness Act were extended to BLM lands in 1976.[89]

The criteria for selection of areas to be designated for protection under the Wilderness Act are oriented toward scenic and recreational, rather than ecological, values. As a result, the roadless areas protected by the Wilderness Act tend to be concentrated in high mountains—the so-called "rock and ice"

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[83] *See* Administration of the Forest Development Transportation System: Temporary Suspension of Road Construction and Reconstruction in Unroaded Areas, Adoption of Interim Rule, 64 Fed. Reg. 7290 (1999) (to be codified at 36 C.F.R. § 212.13).

[84] *See* COGGINS & GLICKSMAN, *supra* note 1, § 19.01[2]; Joseph M. Feller, *'Til the Cows Come Home: The Fatal Flaw in the Clinton Administration's Public Lands Grazing Policy*, 25 ENVTL. L. 703, 703–04 (1995).

[85] *See* Jerry L. Holechek, *The Effects of Rangeland Water Developments on Livestock Production and Distribution*, *in* RANGELAND WATER DEVELOPMENTS, *supra* note 23, at 38, 46; McAuliffe, *supra* note 23, at 311–13.

[86] *See* McAuliffe, *supra* note 23, at 314; Gary W. Frasier, *Water Harvesting for Rangeland Water Supplies: A Historic Perspective*, *in* RANGELAND WATER DEVELOPMENTS, *supra* note 23, at 17, 18–19.

[87] *See* COGGINS ET AL., *supra* note 1, at 1012–14.

[88] *See* 16 U.S.C. §§ 1131–1136 (1994).

[89] *See* Federal Land Policy and Management Act of 1976, § 603, 43 U.S.C. § 1782 (1994).

wilderness areas—and do not contain many of the best remaining old-growth forests. But the recent administrative initiative to protect additional roadless areas has explicitly focused on protection of ecological values as a primary goal.[90]

This evolution in forest management—from aggressive roadbuilding, to protection of roadless areas for aesthetic and recreational purposes, to preservation of roadless areas for ecological reasons—has not been accompanied by any comparable evolution in rangeland management. Livestock grazing is permitted in wilderness areas.[91] There is not, and there never has been, any national policy for even inventorying the nation's remaining grasslands, let alone for protecting those that have so far been spared the impacts of livestock grazing because of the unavailability of water.

BLM and Forest Service range managers view livestock water developments as a near-universal solution to problems of overgrazing, particularly in riparian areas. The agencies typically characterize overgrazing in riparian areas as a livestock "distribution" problem, the solution to which is to construct new water developments to facilitate grazing away from the riparian areas. Areas of "underutilized" forage, i.e., less ecologically impacted habitats, are targeted for more grazing.[92] The result is the systematic elimination of America's last remaining old-growth grasslands. A comparable forest management policy—a systematic program of road construction in roadless areas to "redistribute" timber harvest from cutover areas to remaining old-growth stands—would be unthinkable to conservationists.

Therefore, as a first step in the development of a management policy that recognizes the importance of maintaining the structure and function of rangelands, we propose a moratorium on the construction of new livestock water developments on public rangelands.

B. From Forest Reserves to Rangeland Reserves

Just as the Clinton administration used the breathing space created by a moratorium on new road construction to develop a policy for permanent protection of roadless areas, a moratorium on construction of new rangeland water developments should be promptly followed by an inventory of the western rangelands for the purpose of identifying those areas that would be appropriate for

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[90] *See* Administration of the Forest Development Transportation System: Temporary Suspension of Road Construction in Roadless Areas, Notice of Proposed Interim Rule; Request for Comment, 63 Fed. Reg. 4351, 4352 (1998).

[91] *See* 16 U.S.C. § 1133(d)(4).

[92] *See* Feller, *supra* note 25, at 583–85.

inclusion in a system of rangeland reserves to be permanently protected from livestock grazing.[93] Candidates for reserves would include:

- areas that have escaped grazing or been subject to only light grazing in the past because of unavailability of water, remoteness, or other reasons;
- rangelands that are degraded but that have a substantial chance of recovery given long-term rest from livestock grazing;
- rangelands that include critical habitat for threatened, endangered, or grassland-dependent wildlife species; and
- areas where the costs of grazing administration and the environmental impacts of grazing are disproportionate to the economic benefits of livestock production.

C. From Extended Harvest Rotations to Extended Grazing Rotations

In areas of the public lands where livestock grazing is permitted to continue, grazing should be managed in ways that restore and maintain rangeland function. A key element of such management is the allowance of sufficient time between episodes of grazing to allow development of a full spectrum of vegetative structure and fire behavior. Again, modern developments in forest management provide an example of what it is needed.

In a forest managed exclusively or primarily for wood production, trees are cut as soon as they reach an age and size where their rate of growth is substantially less than that of younger trees.[94] On a rangeland managed primarily or exclusively for livestock production, plants are grazed as soon as they have physiologically recovered from the previous episode of grazing. In practice, this means that few public rangelands are rested from grazing for more than one year at a time, and many are grazed every year.[95]

In forests managed to maintain the full range of structure and function, extended harvest rotations are employed in order to allow portions of the forested landscape to develop those structural and functional attributes—large old trees, large branches, multi-layered canopies, snags, downed logs—that develop only after trees have reached physiological maturity, and to avoid the environmental impacts of frequent timber harvest.[96] A comparable rangeland policy would be to

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[93] For an ambitious proposal to create livestock-free ecological reserves on public lands, see generally DEBRA L. DONAHUE, THE WESTERN RANGE REVISITED: REMOVING LIVESTOCK FROM PUBLIC LANDS TO CONSERVE NATIVE BIODIVERSITY (1999).

[94] *See, e.g.*, Curtis, *supra* note 4, at 166–67.

[95] *See* R.K. Heitschmidt & C.A. Taylor, Jr., *Livestock Production*, *in* GRAZING MANAGEMENT, *supra* note 27, at 161, 173 fig.7.6. Heitschmidt and Taylor portray four types of grazing rotation systems. In three of the systems, each pasture is grazed at least once every year; in the fourth (Rest Rotation), each pasture is grazed two years out of three. *See id.*

[96] *See* Franklin et al., *supra* note 4, at 113–15; Curtis, *supra* note 4, at 167.

allow multiple years of rest between grazing episodes in order to allow rangelands to attain the structural attributes—full height of standing grass, accumulation of litter, multiple layers of large and small grasses and shrubs—that do not fully develop in one season or in one year.

D. From Light Harvest to Light Grazing

A final critical element of reformed grazing management would be a substantial reduction in permitted grazing intensity to well below the fifty percent utilization level that has traditionally been deemed acceptable. This reform would be analogous to the return to selective harvesting that has taken place in many National Forests.[97] Just as selective harvesting is used to retain a modicum of structure and function in forests outside of old-growth reserves,[98] reduced utilization levels could be employed to retain a modicum of structure and function on grazed rangelands.

VI. CONCLUSION

The arid and semi-arid grasslands of the western United States are in trouble. Studies using repeat photography and other methods,[99] as well as more than thirty years of personal observations[100] have demonstrated that the Southwest's grasslands in particular are not sustaining themselves. Moreover, over the last one hundred years, grassland wildlife species have declined disproportionately to brushland and woodland-adapted species.[101] While much of the loss of grasslands and grassland wildlife may be attributable to past abusive livestock grazing practices, current practices, as we have shown, are not adequate to stem the loss by restoring and protecting the structure and function of rangelands.

We believe in the principles of multiple use and sustained yield, but livestock grazing practices that imperil the last remaining arid and semi-arid

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[97] *See, e.g.*, Franklin et al., *supra* note 4, at 120.

[98] *See, e.g.*, RECOMMENDATIONS FOR THE NORTHERN GOSHAWK, *supra* note 12, at 28–29 (recommending limiting forage utilization to an average of 20% and a maximum of 40% in any area in order to maintain food and cover for birds and small mammals).

[99] *See, e.g.*, BAHRE, *supra* note 38, at 59–105; JAMES R. HASTINGS & RAYMOND M. TURNER, THE CHANGING MILE: AN ECOLOGICAL STUDY OF VEGETATION CHANGE WITH TIME IN THE LOWER MILE OF AN ARID AND SEMIARID REGION 111–82 (1965); McAuliffe, *supra* note 23, at 316.

[100] *See* Brown, *supra* note 66, at 123–31.

[101] *See* David E. Brown & Russell L. Davis, *One Hundred Years of Vicissitude: Terrestrial Bird and Mammal Distribution Changes in the American Southwest, 1890–1990*, *in* FOREST SERVICE, U.S. DEP'T OF AGRICULTURE, BIODIVERSITY AND MANAGEMENT OF THE MADREAN ARCHIPELAGO: THE SKY ISLANDS OF SOUTHWESTERN UNITED STATES AND NORTHWESTERN MEXICO 231, 231 (1994).

grasslands in the United States are not consistent with those principles.[102] Our proposals are designed to ensure the survival of the grasslands and of the ranching and wildlife communities that depend on them.

Some advocates have concluded that only the complete elimination of livestock grazing can save our remaining arid and semi-arid grasslands.[103] While our proposals stop short of this endpoint, they would result in a substantial reduction in grazing. Creation of rangeland reserves from which livestock are excluded, longer rest periods, and sharply reduced utilization limits would all translate to fewer cows on public rangelands. We recognize that these changes would have a substantial economic impact on those ranchers whose operations depend on the use of federal public lands. Adaptation to these changes would probably require consolidation of smaller ranching operations into a lesser number of large ranches, and the replacement of many cow-calf operations with intermittent grazing by steers.

From a regional perspective, however, the economic impact of these reforms would be very small. Once again, management of public forests provides a useful point of comparison. In the last decade, the volume of annual timber harvest from the National Forests has fallen to less than one-third of its previous level.[104] Yet the economies of the states most dependent on federal timber have not declined during this same period.[105]

By virtually any measure, the economic importance of livestock grazing on federal public lands is far less than that of timber harvesting on federal lands. The annual market value of all livestock production on BLM and Forest Service lands is around 100 to 200 million dollars,[106] whereas the market value of the

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[102] *See* 43 U.S.C. § 1702(c) (1994) (defining "multiple use" to preclude "permanent impairment of the productivity of the land and the quality of the environment"); *id.* § 1702(h) (defining sustained yield as the maintenance in perpetuity of outputs of renewable resources).

[103] *See, e.g.*, LYNN JACOBS, WASTE OF THE WEST: PUBLIC LANDS RANCHING 536–40 (1991).

[104] *See* NATIONAL AGRICULTURAL STATISTICS SERVICE, U.S. DEP'T OF AGRICULTURE, AGRICULTURAL STATISTICS 1999, at XII-31 tbl.12-37 (noting that timber sales have declined from 12.6 billion board feet in 1988 to 3.3 billion board feet in 1997) [hereinafter AGRICULTURAL STATISTICS 1999].

[105] Unemployment in Washington has declined from 6.2% in 1988 to 4.8% in 1997, while unemployment in Oregon remained unchanged at 5.8%. The average annual pay in Washington increased from $20,806 in 1988 to $30,768 in 1997, while the average annual pay in Oregon increased from $19,637 to $28,420. *Compare* U.S. DEP'T OF COMMERCE, STATISTICAL ABSTRACT OF THE UNITED STATES tbls.654, 700 (119th ed. 1999), *with* U.S. DEP'T OF COMMERCE, STATISTICAL ABSTRACT OF THE UNITED STATES tbls.629, 669 (110th ed. 1990).

[106] *See* Feller, *supra* note 25, at 559 n.15 (estimating the annual value of livestock production on BLM land to be eighty million dollars). The quantity of livestock production on Forest Service lands is about 60 percent of that on BLM lands. *See*

annual timber harvest on federal lands was over one billion dollars before the crash in timber harvest levels and approximately 500 million dollars after the crash.[107] Federal lands supply approximately two percent of the nation's livestock feed;[108] National Forests provide approximately ten percent of the nation's timber supply.[109] Federal timber harvest in the Pacific Northwest alone supports over 100,000 jobs;[110] federal public lands grazing across the West provides fewer than 20,000 jobs.[111] If the economies of western states and communities can withstand a two-thirds reduction in public lands timber harvest, they can certainly withstand a comparable reduction in public lands livestock grazing. Moreover, even for individually affected ranchers, the consequences of the loss of federal forage would often be less catastrophic than one might assume. For most ranchers, livestock raising is a supplemental, not a primary, source of income. Nationally, beef cattle producers receive almost eighty percent of their income from non-agricultural pursuits.[112]

Our public rangelands deserve the same respect and care as our public forests. And while ranchers also deserve respect as human beings, the understandable desire to preserve a relatively small number of ranching jobs should not prevent us from managing these rangelands in a manner that restores and maintains their structure and function, just as the desire to preserve a much larger number of timber jobs has not prevented a transformation in the management of our forests.

RANGELAND REFORM EIS, *supra* note 45, at J-1. Therefore, the estimated combined value is approximately $130 million.

[107] *See* AGRICULTURAL STATISTICS 1999, *supra* note 104, at XII-31 tbl.12-37.

[108] *See* RANGELAND REFORM EIS, *supra* note 43, at G-16, G-18 fig.5.

[109] *See* GEORGE CAMERON COGGINS ET AL., FEDERAL PUBLIC LANDS AND RESOURCES LAW, 1996 CASE SUPPLEMENT 103 (1996).

[110] *See* FEMAT REPORT, *supra* note 12, at VI-28.

[111] *See* Thomas Michael Power, *The Economic Importance of Federal Grazing to the Economies of the West*, SOUTHERN UTAH WILDERNESS ALLIANCE, Spring 1995, Insert at 5 tbl.2.

[112] *See id.* at 6 tbl.3.