Sheep Grazing as a Range Improvement Tool

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Summary

Grazing is an integral and natural process on rangelands. Long-term studies have concluded that grazing can be managed to manipulate the vegetative composition of rangelands. There are two principle criteria that must be implemented to achieve improvement. First, grazing must be managed by established goals and realistic specific objectives. Without achievable goals and clearly stated objectives grazing would be unmanaged and extensive experiences have illustrated that unmanaged grazing by domestic and wild herbivores can result in catastrophe. Basic principles for establishing these goals and objectives are well documented. Second, improvement should be defined as attaining desired objectives for the rangeland resource. In some instances, improvement will equate with increased forage available for grazing livestock. In other instances, improvement will be based on non-livestock forage criteria. In all cases the resource will be benefitted and livestock will maintain an integral role in the renewable use and sustained management of rangelands.

Key words: rangelands, sheep, range improvement, grazing management.

Introduction

Grazing herbivores impact basic rangeland ecosystem processes including nutrient cycling, primary production, decomposition and vegetative structure (Detling, 1988). Effects of these impacts upon vegetative composition can be highly varied (Trlica, 1977). There is extensive evidence, however, that grazing can be effectively managed and that grazing by domestic livestock can be a mechanism to attain management objectives for vegetation composition and diversity (Box and Malechek, 1987). Of equal importance for rangeland management is the recognition that many management technologies require substantial inputs of capital, labor and fossil fuels and therefore should not be regarded as sustainable (Barbier, 1989). Natural resource managers for both public and private lands are not well-equipped with technologies that are economically, ecologically or socially acceptable to improve rangeland resources. There is no "quick fix" for rangeland improvement (Williams and Shepherd, 1991). However, managed livestock grazing can be a principle tool for sustained use and improvement of rangelands.

Characteristics of Grazing

Grazing, or herbivory, is simply defined as the act of eating forage and is composed of three basic processes: 1) foraging, the search for forage; 2) defoliation, the removal of forage; and 3) ingestion. Typically, rangelands contain hundreds of different species of vertebrate and invertebrate animals which are wholly dependent upon plants for survival. This mixture of animal life includes soil invertebrates such as nematodes, small mammals such as voles, ruminants such as pronghorn antelope and granivorous birds such as white-winged doves. For some of these species the foraging process occurs in a below-ground environment scaled in microscopic units. For other species foraging occurs over air-borne miles. Classically, rangelands are defined, in part, as a type of land that has evolved with grazing. For example, fossil evidence supports a conclusion of coevolution of modern grasses and large hoofed mammals beginning at least 30 million years before present time (McNaughton, 1991). The obvious implication is that defoliation of vegetation by native herbivores is both an integral and natural process on rangelands. In fact, for many rangelands the removal of native herbivores would result in uncharacteristic ecological conditions (McNaughton, 1992).

As an intrinsic component of rangelands, grazing can have profound short-term consequences. Nematodes can literally destroy 50% of vegetation biomass (Andrzejewska and Gyllenberg, 1980). Similar levels

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of damage have been attributed to outbreaks of grasshoppers. Jackrabbits may prune two-thirds of above-ground biomass from desert plants, though actually consuming one-half of pruned materials (Chew and Chew, 1970). The occasional destructive habits of large mammals, including bison and feral horses, have been well documented.

Long-term effects of defoliation by native herbivores are typically mitigated within rangeland ecosystems through a variety of mechanisms. For example, bison will migrate large distances and subsequent regrazing of individual plants is infrequent. Jackrabbit populations are cyclical and as a result their impacts are temporally spaced. Insect damage is usually seasonal and often spatially localized. In these contexts grazing is usually not viewed as causing permanent vegetation alteration from the expected progression of change over time.

Conversely, unmanaged grazing as a disruptive force is usually attributed to effects of introduced herbivores or when mechanisms which dampen effects of native herbivores are removed or neutralized within an ecosystem. Documentation of the adverse effects of introduced herbivores is widely available. It is generally recognized that introductions of both domestic and nondomestic herbivores have resulted in significant uncharacteristic changes in rangeland vegetation even in relatively short periods of time (Lange, 1977). For example, the initial introduction of cattle and horses into the desert grasslands of the Southwestern U.S. in the late 19th century has been viewed as one principle catalyst for the extensive encroachment of arid shrub species, including creosotebush and mesquite (Buffington and Herbel, 1965). Though vigorously debated, many view the concentration of Rocky Mountain Elk in Yellowstone National Park as destructive (Patten, 1993). Both the loss of native predators and the confinement of the elk within park boundaries due to external pressures (such as hunting seasons and land development) are interpreted as principle disruptions to normal mechanisms that mitigate elk grazing impacts. In New Mexico, wildlife officials recently considered elimination hunts for non-native barbary sheep, oryx and ibex because of their negative impacts on native herbivore populations. For non-biological reasons, these officials eventually chose not to attempt to eliminate these species. Their debate further illustrated that unmanaged grazing by any herbivore can have severe negative consequences for rangelands. Unfortunately, there are numerous other examples of significant rangeland disturbances from unmanaged grazing.

Range Improvements: Expectations and Realities

Range improvements have been defined as special practices, including developments and structures, which improve the availability and use of range forages by grazing animals (Valentine, 1989). This definition implies that improvements to rangelands are done solely to benefit grazing animals. Given the diversity of uses and users of rangelands, a broader definition of improvement is required.

Classically, improvement of rangelands have been measured by success in recreating potential natural plant communities. This assessment has been based on the theory that original stable plant communities present prior to a disturbance, such as fire or overgrazing, will be naturally regenerated following removal or termination of the disturbance (Figure 1). This theory has been synthesized for management applications through the concepts of range condition and trend. For nearly 40 years the succession-and-climax model, developed on rangelands in the Great Plains (Dyksterhuis, 1949), has served both as a barometer of rangeland improvements and as a general blueprint for rangeland management. For example, it has been stated that U.S. rangelands are now at peak conditions for this century (Box and Malechek, 1987). Disturbances, primarily unmanaged grazing, during the later part of the 19th century caused deterioration of much of the western U.S. rangelands. In general, range conditions during the first part of this century were classified as fair or poor, meaning that less than one-half of the species present (by biomass) prior to the disturbance remained. Concurrent with this deterioration, or retrogression, was an increase in plant species that were not used as forage by livestock (especially shrubs) and an invasion of exotic species newly introduced to the region. By the mid-1930s rangeland conditions were at their worst. In the ensuing 60 years there has been a gradual and measurable change that has been generically described as overall improvement. Within the context of the succession-and-climax model these changes are viewed as movement toward potential vegetation communities present prior to the grazing disturbances of the late 1800s and early 1900s. Improved management with the use of special practices, such as grazing systems, brush control techniques and rangeland reseeding, have been credited for these improvements.

In reality, a considerable amount of rangeland has either not been treated with special improvement practices or has failed to respond to these treatments. Many of these practices require substantial economic inputs for fuel, materials and labor, and they have been reserved for lands with the greatest potential for positive response. For example, in the Southwestern U.S. the costs for full preparation of a seedbed and reseeding with grass of a deteriorated rangeland now dominated by undesirable shrubs may exceed $40.00 per acre. Costs are further increased by the use of more expensive native species in the seed mixture and the inclusion of non-use for a few years post-planting to allow for stand establishment. Relatively few rangelands would presently return sufficient grazing-related benefits post-treatment to justify these investment costs. Environmental conditions are such that even when these practices are applied the chances for failure of the treatment to create the desired effects exceed chances for success. It has been estimated that 1/3 to 1/2 of all reseeding treatments fail in the northern Great Plains (White and Lacey, 1985), and 1/2 to 3/4 of those attempted in the Southwest deserts fail (Cox et al., 1982). Erratic and low precipitation and high evaporative losses characteristic of many rangelands are principle causes of these poor statistics. Even with favorable climatic conditions and inexpensive inputs the use of special practices is restricted in an increasingly regulated environment. Conservation requirements of non-forage resources, such as cultural resources, wildlife habitat, water, aesthetic qualities and threatened species, can effectively halt the use of many traditional improvement practices as options for rangeland management. Many of the traditional practices are not environmentally benign, and their use for publicly-owned rangelands can conflict with current missions of the federal stewardship agencies. Many regulations apply to privately-owned lands as well.

It is also increasingly apparent that the succession-and-climax model does not apply to all rangelands. Today's ecological theory is that prior vegetative conditions will not be recreated given time and the removal of disturbance forces. Not only have there been broad changes in the global environment during the past century, but on a local scale there have been substantial changes in both biotic and abiotic factors. Unfortunately, introduced plant species including cheatgrass brome, medusahead, russian thistle, spotted knapweed and leafy spurge, are now permanent floristic components of western rangelands. Episodic erosional events have contributed to significant changes in edaphic characteristics and even alterations to landscape physiography. The environments that shaped the climax communities present in the 19th century have, to varying extents, been altered.

Figure 1. Generic illustration of rangeland succession-and-climax model.

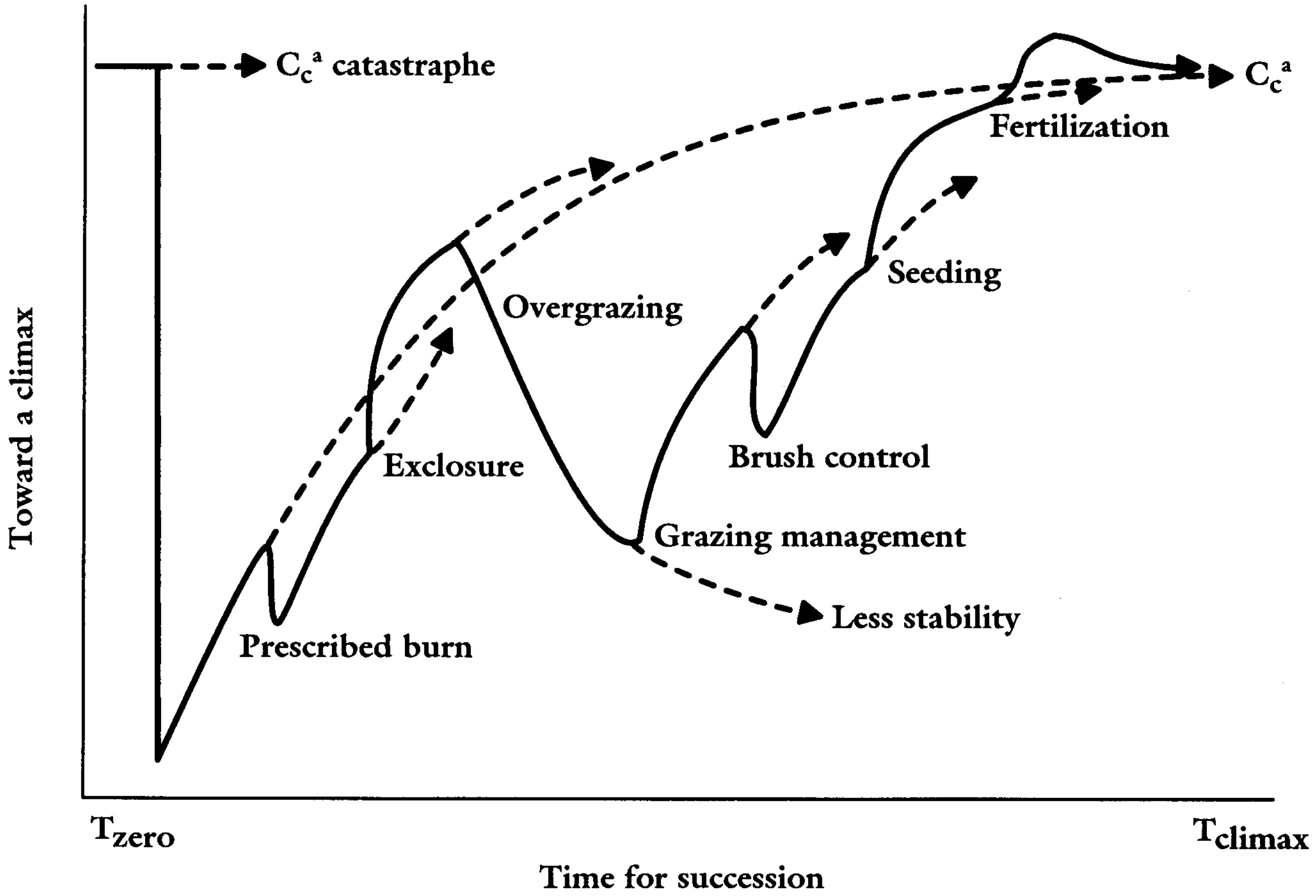


Figure is taken directly from Heady (1975). Illustration implies that following catastrophic change natural forces recreate prior vegetative conditions and that management activities can impede or accelerate these processes. Current evidence does not wholly support this successional theory, but directing vegetation change through grazing management is substantiated.

[a] C_c notation refers to Climax Community.

A model of transition-state can also be used to describe many rangelands (Westoby et al., 1989). Disturbances, both natural and human-caused, act as transitional forces which alter rangeland plant communities to new stable states (Figure 2). In the desert southwest, for example, stable desert shrub communities have existed for over 50 years following disturbance of the former desert grasslands. These shrublands can be viewed as self-augmenting states which neither represent former climax conditions nor short-term vegetation elements in an eventual successional return to former grassland communities. Other models have been recently proposed which also depart from the traditional view of predictable dynamics of rangeland recovery from disturbance (see Friedel, 1991, Laycock, 1991 and Lockwood and Lockwood, 1993). A common thread to these theories is that rangeland vegetation dynamics can be unpredictable. In many cases, vegetative states influenced by disturbances can be stable for long periods of time without regeneration of prior rangeland conditions.

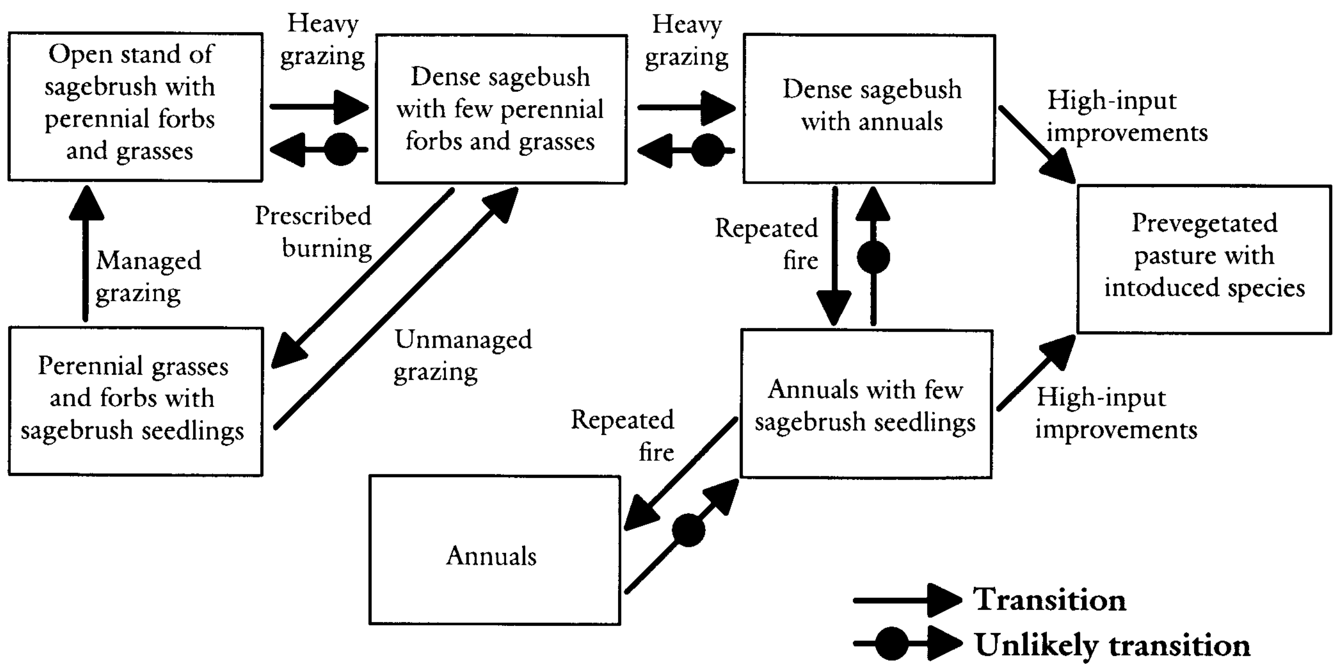
Within this ecological, economical, environmental and regulatory setting range improvement can no longer be viewed as use of special methods to recreate former grasslands to serve as forage for livestock. Range improvement must now be viewed as attaining specific vegetation goals through the use of special techniques. These vegetation goals should recognize ecological realities and not be subject to evaluation based on perceptions of historic conditions. Interestingly, one of the viable tools for sustainable vegetation improvement is the grazing animal. Domestic livestock can be managed to maintain or alter vegetation conditions to achieve specific goals.

Grazing as a Tool for Change

A tool is any device used in performing an operation in the practice of a profession. It is also defined as a means to an end. Though we typically limit our concept of tools to various machines and instruments, livestock can certainly be regarded as a tool that can be used to achieve management goals on rangelands.

During the past 5,000 years, woodlands on the eastern side of England have been cleared for agriculture and grazing animals. Both diverse and species-rich plant communities have developed in the region, typical of lowland heathlands of Britain and Europe. Many of the plant and animal species present in the heathlands (named for the presence of shrubs of the Heath family) are ecologically reliant upon effects of grazing to maintain their habitat requirements. During the later part of this century sheep grazing had diminished in this region and endemic rabbit populations declined severely with an outbreak of myxomatoses, a fatal viral disease. The lack of grazing by both domestic and native animals has resulted in significant habitat loss in the heathlands. Both bird and plant species have declined in this area during this century. Recently, sheep grazing is being used to restore heathlands managed for nature conservation (Dolman and

Figure 2. State-and-transition diagram for sagebrush-grass vegetation.



Adapted from Laycock (1991) after Westoby et al. (1989). Illustration implies that without application of specific transitional forces (prescribed burning, managed grazing, special improvement techniques) the natural regeneration of original vegetation conditions is unlikely.

Sutherland, 1992). Sheep grazing not only encourages increased plant diversity, but also appears to prevent further shrub encroachment and improve the suitability of habitats for rabbits.

Sheep grazing is also being used as a tool for habitat restoration in the Netherlands (Bakker et al., 1983). Marginal agricultural lands have been recently abandoned due to intensive labor requirements and inherent low yields. Specific restoration objectives are being achieved by manipulating stocking rates and flock management practices. For example, under high stocking rates tree seedlings are heavily utilized and the areas become more dominated by grasses.

These examples show that sheep grazing is a tool for restoration of areas where grazing has been a historic habitat influence. For various reasons, grazing within these habitats has been recently eliminated or at least diminished. Domestic animals have been effectively employed to restore a grazing element and effect vegetation change.

These examples may be viewed as atypical. For most U.S. rangelands grazing has been a historic element of the habitat and is still present. Native herbivores have maintained their presence. The concern is not the need to use domestic livestock to reintroduce grazing as a habitat element, but to manage livestock to achieve vegetation objectives within currently grazed environments.

There are research examples where sheep are used to effect desired vegetation change. There are also practical examples of sheep presently being employed on western rangelands as a tool for improvement. At the Boise National Forest, sheep are being managed to reseed forested lands. Seed for revegetation is broadcast in desired areas in the fall prior to the first snowstorms. A band of sheep is then brought into the area to trample the seed into the moist ground. Planting depth requirements for rangeland grasses are uniformly shallow (less than 6 mm) and this combination of broadcast and graze techniques has been particularly successful. (W. Payton and C. Richmond, personal communication).

In addition, sheep have been used at the Beaverhead National Forest in southwest Montana to reduce the availability of tall larkspur, a plant toxic to cattle. Sheep grazing of larkspur in the bolt to early flower stage prior to cattle grazing seasons has significantly reduced subsequent cattle losses. Both the riparian grazing management and larkspur grazing management programs have been effectively implemented without expansion of existing predator control programs (D. Pence, personal communication).

There are, though, vegetation conditions that will be insensitive to grazing management as a tool for change. In coastal California, effects of sheep grazing on vegetation composition of blue oak-dominated rangelands supporting annual grasses has been studied for a number of years. The general conclusion has been that nongrazing factors, especially climate, are dominant in affecting vegetation composition. The annual grasslands are essentially impervious to improvement through seasonal grazing management (Bartolome and McClaran, 1992). This is a logical observation given the ecological, physiological and morphological characteristics of annual grasses and their dominance in this Mediterranean type climate.

Examples of Vegetation Manipulations by Grazing

Dietary selection by livestock of plant species can influence the composition of rangeland vegetation communities (Brown and Stuth, 1993). However, other factors, including relevant environmental conditions and variations in plant species' resistance to defoliation, may be more important in determining vegetation responses to grazing (Bartolome, 1993). The basic management variables which influence responses of plants to grazing are: 1) the timing of grazing; 2) the frequency a plant (and its neighboring plants) is grazed; and 3) the intensity of grazing use (Trlica and Rittenhouse, 1993). A key to manipulating vegetation through grazing is understanding how these variables can be applied in specific rangeland environments to affect desired vegetative goals.

Classic examples of vegetation manipulation by grazing come from studies at the Desert Experimental Range in Utah (Holmgren and Hutchings, 1972). This region of the Great Basin had historically served as winter rangelands for sheep. In 1934, black sagebrush, a key shrub in sheep winter diets, had declined to 7% of the vegetation composition of an area that had been grazed all winter long for a number of years. Limiting grazing to only early-winter (November and December) resulted in substantial vegetation change (Table 1). Similar results, even under heavy grazing utilization, were observed for other principle shrubs (Table 2).

Long-term research in the sagebrush-grass rangelands of Idaho has shown similar vegetation responses to timing of grazing by sheep. Heavy late-fall grazing, combined with spring deferment of use, will restore perennial herbaceous plant diversity within a relatively short time period

Table 1. Response of black sagebrush to season of grazing use by sheep in Utah.[a]

		1963	
Plant	1934	Early winter grazing	Late winter/ spring grazing
Black sagebrush[b]	7	54	8

[a] Holmgren and Hutchings (1972).
[b] Percentage of perennial vegetation.

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