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Grazing as a Technique for Prairie Restoration

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INTRODUCTION

Grazing was once a key component of the prairie ecosystem. After the fires burned off dead materials bison (*Bison bison*) roamed the prairie grazing on new vegetative shoots (Stevens 1993). When bison left the area in search of a new food supply, dead material was left as fuel for the next fire (Stevens 1993). These forces of fire and grazing created plant succession at different stages and in differing mosaics giving the prairie its diversity of life (Stevens 1993).

Since this time, disturbances such as agriculture, overgrazing, and repression of fire have reduced the prairie to a few fragments dotting the landscape. Restorations are now attemping to bring back these prairie ecosystems by restoring native plants and reestablishing fire. Ungulates, a historic part of prairie ecosystems, can also be used to restore the prairie in areas where an interaction between fire and grazing is desirable or in areas where fire management may not be feasible.

Prairie restoration may begin with a site that has been converted for agricultural use or it may begin in areas that have been severely overgrazed. Site preparation and consequent restoration may be different in each of these settings. The restoration of prairie from an area that was once farmed requires that the area be cleared of agricultural crops. Depending on the time since cultivation, a native seedbank may still be present in the soil. These seeds may be able to germinate after the disturbance (agricultural plowing) has been removed. The prairie grasses should be given a few years to establish themselves. During this time fire may be used a few times. After establishment of prairie grasses, grazing may be done to inhibit the growth of woody plants that may compete with the growing grasses. In an area that has been overgrazed, the primary tool in preparing the area for restoration is to remove the grazers. The degraded site may have to be cleared of undesirable species to prepare the area for seeding or planting of native prairie species. Despite overgrazing in the past, grazers may be reintroduced in these areas after prairie establishment.

Grazing by domestic cattle or native bison on the prairie has important implications for management and maintenance in prairie restorations. This paper will address grazing on prairie ecosystems. The literature reviewed considers grazing from the standpoint of bison vs. cattle grazing, fire and grazing interaction, and the effects of stocking rates on vegetation.

NATURAL GRAZING VS. DOMESTIC CATTLE

Restoration techniques often attempt to include native vegetation as well as historical conditions of disturbance. Grazing, along with fire, is thought to be an important aspect of the historical disturbance conditions on the prairie. While grazing may be an important part of the disturbance regime, it is important to consider how different grazers affect the prairie vegetation.

The benefits of natural grazing on prairie ecosystems has been explored by Tom Edwards in his piece, Buffalo and Prairie Ecology (1976). Edwards studied buffalo grazing on a mixed grass prairie and found that buffalo may have a pronounced effect on the composition of prairie species by balancing the competition between forbs and the dominant grasses. The dual relationship between buffalo grazing and fire on the prairie helped to inhibit the growth of forest species while favoring the prairie species. Edwards (1976) used a study area in Custer State Park, South Dakota where cattle were placed on one side of the fence with buffalo on the other, in a habitat area nearly identical on both sides. He found land grazed by cattle to be invaded by ponderosa pines (*Pinus ponderosa*), while the buffalo grazing area had few pines. In concluding, Edwards (1976) suggested that, under some environmental conditions, buffalo and other large herbivores such as elk were crucial in the maintenance of the prairie.

Plumb and Dodd (1993) did a study between the foraging ecology of bison and cattle on a mixed prairie. The mixed grass prairie study contains grasses of cool season (C3) and warm season (C4) forages. Plumb and Dodd found that standing crop biomass was not affected by the different foragers. Bison and cattle did, however, show different preferences between species. Bison generally preferred graminoids, while forbs and browse were preferred less than 10% of the time. C3 and C4 grasses were consumed in differing amounts throughout the season by both cattle and bison. Bison generally consumed more C4 grasses or C3 graminoids from a period between early June and August. Forbs were of greater importance to the diet of cattle than that of bison. Cattle also used browse species more often than bison. Bison were found to select areas with a dominance of grass species over patches of shrubs and forbs while cattle selected for patches of high-quality forbs and browse.

This study has important implications for the use of grazing in management of natural areas. Plumb and Dodd (1993) suggest that selection of bison or cattle may depend on the evolutionary history of the site. Most prairie areas were once grazed by roaming herds of bison. These species may be well suited to grazing on the prairie by regulating forage production and altering vegetation structure. Bison select higher quality forages and can influence the function and structure of grasslands. The authors suggest that this does not necessarily make bison the first choice for all grassland ecosystems. Both cattle and bison selected for C4 grasses and against C3 grasses in the time period from June through July. A change in preferences occurred in August when cattle preferred forbs in proportion to its availability while selecting for browse forage. During August bison selected against forbs and consumed browse in proportion to availability. These differences in grazing patterns during August may represent the primary differences in grazing selectivity between bison and cattle.

FIRE AND GRAZING

Historically, the fire and grazing disturbance regime interacted to create a mosaic of successional areas on the prairie. Prairies of great diversity were found in these areas. While fire is often used as a necessary tool in prairie management, the use of fire and grazing can also produce unique effects in prairie ecosystems.

Results from a study performed by Vinton, Hartnett, Finck and Briggs (1993) at the Konza Prairie Research Natural Area, show that interactions between fire and grazing are important components in the composition of the prairie. This study looked at a 469 ha area where bison were free to roam over five contiguous watersheds. These watershed areas offered a varied burning regime based on 2 yr, 4 yr, and 20 yr burn intervals. Vinton et al. found that bison graze non randomly in areas that have most recently been burned. In particular bison grazed recently burned areas more frequently in the spring, while areas that had not been burned were selected less often throughout the year. In areas where burning was less frequent, species such as *Andropogon gerardii* was dominant and these areas had a higher cover of forb species such as *Artemisia ludoviciana* and *Aster ericoides* than did areas that had been grazed. Overall, areas that were grazed, whether in high or low burn intervals, had less vegetative cover than ungrazed areas. In grazed areas that had been burned frequently, the species composition was similar to the available vegetation. In areas that had not been burned, bison were found to graze much more selectively leaving a species composition that was much different than those available. On a smaller scale, bison selected grazing patches where there was a high grass to forb cover ratio. This pattern occurred across all prairie patches regardless of the frequency of burning, but the size of these grazed patches was directly related to the fire regime.

Pfeiffer and Hartnett (1995) studied the selectivity of bison grazing and the impact specifically on *Schizachyrium scoparium* (little bluestem) in a tallgrass prairie. The study also tested the interaction between burning and bison grazing and species selection. Pfeiffer and Hartnett found that on unburned prairie, bison most often grazed big bluestem selecting little bluestem only 30% as frequently. On the burned prairie the bison increased their grazing selection of little bluestem by over 3-fold. This increase in little bluestem selection is explained by the plants' response to grazing and fire. Little bluestem accumulates a persisitent clump of dead tillers in response to grazing. The occurrence of little bluestem in a persistent clump with an increase in dead tillers deters bison from grazing on the unburned prairie. The inclusion of fire removes the canopy of dead tillers and exposes the plant to grazing. In this study bison selection on burned areas, also included size of little bluestem. On the burned watershed, smaller size classes of little bluestem were most frequent, but were grazed less frequently while the intermediate size classes of little bluestem were less abundant and were grazed more frequently.

Pfeiffer and Hartnett found that grazing and fire worked to produce different responses in little bluestem. Density of little bluestem was reduced by grazing, but was increased by fire. Despite grazing, fire increased the density of little bluestem, in grazed or ungrazed areas. Grazing tended to have a larger effect on little bluestem bunch size than did burning. The largest average bunch size was on the ungrazed, burned site. Burning and grazing also interacted to alter the size class distribution of little bluestem. Burning created a little bluestem population with a higher frequency of larger size class individuals. Grazing created a shift in the population to smaller size classes. This shift may result in higher mortality of little bluestem as smaller plants may be more susceptible to drought conditions (Pfeiffer and Hartnett 1995). This reduction in size could also effect the reproductive success of little bluestem. Pfeiffer and Hartnett (1995) believe these aspects may explain a decline in little bluestem populations on persistently grazed areas.

This interaction between fire and grazing may have implications for suggesting that fire may indirectly effect the selective grazing of ungulates. In areas that were left unburned, bison selected big bluestem as a grazing preference, avoiding little bluestem. After a burn, a shift in grazing selection by bison preferred little bluestem over big bluestem.

Collins (1987) conducted a similar study aimed at addressing the interaction between fire and cattle grazing on the tallgrass prairie. Four treatments were used: ungrazed/unburned, grazed/unburned, ungrazed/burned, and grazed/burned. Grazing and fire interacted in this study to influence the growth and form of species studied. Grazing had the impact of reducing perennials, regardless of fire regime. The cover of perennials was increased and cover of annuals decreases with the burned, ungrazed treatment. Species richness increased with increasing disturbance intensity. Grazing had a significant impact on species diversity which increased in response to grazing and fire. The highest diversity level was on the burned, grazed treatment. The increase in diversity and richness as a result of increasing disturbance is thought to be a result of increased survival of forbs as grasses are decreased by grazing.

Fire and grazing had different effects depending on the species. Fire increased matrix species while grazing decreased matrix grasses and increased cover of ruderal forbs. Grazing decreased matrix species such as big bluestem (*Andropogon gerardii)*. Collins speculates that although this study is conducted with grazing cattle, it is expected to predict similar effects with grazing bison. Although, bison are thought to further decrease the matrix grasses.

The interaction of fire and grazing has also been studied to determine the response of prairie species. Pfeiffer and Steuter (1994) conducted a study aimed at determining the effect of fire and bison grazing on four groups of prairie plants in the Sandhills prairie. These four groups were rhizomatous grasses, bunchgrasses, matrix forbs, and interstitial forbs. Four treatments were used on the prairie: spring burned/grazed, spring burned/ungrazed, unburned/grazed, and unburned/ungrazed. Two more treatments were added in the second year: summer burned/grazed and summer burned/ungrazed. Pfeiffer and Steuter found that rhizomatous grasses were not affected by burning alone, but in combination with grazing, rhizomatous grasses were reduced. Areas that were unburned and grazed experienced no detectable changes.

Bison grazing had a stronger influence on bunchgrass regrowth than it did on rhizomatous grass regrowth. This may be because rhizomatous grasses may be better adapted to grazing than bunchgrasses (Mack and Thompson 1982). The use of fire and grazing may lead to a reduction in bunchgrasses on the Sandhill prairie (Collins 1987). In this study, rhizomatous grasses responded positively to fire. Fire and grazing interacted to favor rhizomatous grasses to bunchgrasses. Forbs were not affected by bison grazing in this study, but responded more to fire.

Hobbs et al. (1991) studied the interaction between fire and grazing on the nitrogen budget of the tallgrass prairie. Their findings suggest that grazers are thought to create patches by grazing selection and to prefer these patches once they are created. Fire works to reduce this patch mosaic created by grazing. When fire is repressed, the patch mosaic persists causing grazing to continue on these same preferred areas. This influence of fire on grazing creates areas that are uniformly grazed on burned areas and are consistently patchy on unburned areas. This creates a diverse landscape mosaic between those that are burned and those that are not. This study suggests that the presence or absence of fire may significantly effect the spatial pattern resulting on grazed grasslands.

GRAZING AND STOCKING RATE

While grazing may be chosen as an important restoration technique or simply as a source of forage for ungulates, the effects of grazing animal stocking rate on the prairie must be considered. The size of the prairie areas may also necessitate varying degrees of stocking levels and rest periods.

Cassels et al. (1995) studied the effects of grazing management on standing crop dynamics in a tallgrass prairie. The experiment consisted of a random grazing system and stocking rate. Twelve grazing areas were divided into 2 experimental units, one assigned a rotational grazing system and the other a continuous grazing system. Within these grazing systems the units were assigned a stocking rate from moderate to heavy grazing levels. Cattle were used as the grazing animals and were rotated between rotational pastures every 3 to 7 days. Cassels et al. (1995) found a 17% increase in total herbage production in a deferred grazing system compared to a continuous grazing system. Stocking rate had the effect of decreasing total standing crop with increasing stocking rate. These standing crop-stocking rate relationships were linear. The end result was a herbage standing crop increase of 20% on rotational areas as compared to continuous grazing areas at the end of the growing season. Conclusions suggest that a higher standing crop would increase availability of winter forage and fuel for spring burning, while suggesting a lower impact of grazing on plant vigor.

Gillen et al. (1991) hypothesized that varying plant successional stages would be observed when paired with intermittent grazing tested under periods of rest of varying length. Short duration grazing of livestock were rotated between three grazing schedules and two stocking rates. The pastures of tallgrass prairie were burned before the start of grazing. Within each pasture, an area was enclosed as a control site for comparison of plant community responses on an ungrazed area. In this study, species composition did not differ between the grazing schedules. The composition of grass species was apparently not affected by stocking rates, while forbs increased slightly under a higher stocking rate. Grass species including big bluestem, little bluestem, and switchgrass (*Panicum virgatum*) did not differ between grazed and ungrazed pastures. Plant frequency was not affected by grazing schedule or stocking rate. Western ragweed (*Ambrosia psilostachya*) did show a marked increase in frequency on all grazed areas. The increase in frequency of ragweed was considered an indication of an undesirable species change.

Gillen et al. (1991) concluded the tallgrass plant community was little affected by grazing schedule and stocking rate. The fact that stocking rates did not show an effect was surprising because the stocking rates were over 50% above moderate rates.

Willms et al. (1990) conducted a similar study but developed the study in order to test the hypothesis that time-controlled grazing with high stocking rate and high animal densities would improve grassland conditions. Willms et al. found that species composition and root mass were not improved under grazed compared with ungrazed conditions thereby rejecting the study hypothesis. Conclusions made from the study suggest that grazing with high stocking rates results in grassland deterioration. As a result of this study, Willms et al. predicts a gradient of change on continuously grazed pastures between light and heavy stocking rates.

The results reported by Willms et al. differed from those of Gillen et al. (1991). Experimental design comparisons of these two studies show grazing differences in prairie types between tallgrass and mixed grass prairie species. This may account for some of the discrepancy, but the presence or absence of fire may also provide an explanation. Gillen et al. used fire to burn the prairie prior to the start of grazing. Willms et al. did not describe use of fire as part of the experimental design and did not mention the presence of fire prior to beginning the experiment. This absence of fire could explain the differences in results between the two studies. Previous studies have shown that fire and grazing may interact to create a healthy mosaic of diverse prairie vegetation.

CONCLUSION

Cattle and bison grazing both present a technique that can be used to restore and maintain prairie ecosystems. Grazing is an important part of restoring the native disturbance regime that once shaped the prairie, but the logistics of working with grazing animals require some thought. Bison and cattle may both work to effectively favor prairie species, but each requires different management. Plumb and Dodd (1993) suggest that the selection of bison or cattle grazing must depend on the landscape that encompasses these grazers and the scale-dependent goals of the grasslands. They suggest these criteria for selecting a preferred grazer for a prairie ecosystem. Bison should be chosen when the natural area is medium to large, economics are acceptable, and facilities are available to deal with the management of these animals. Catttle grazing is a more reasonable alternative in areas that are small, economics are poor, and fire return interval is more than a few years. Although size is not quantified here in terms of small, medium and large land areas, it has been suggested that the use of bison grazing on prairie areas requires large tracts of land of at least 1,000 acres (Thompson 1992).

Often a concern with the use of bison grazing is the issue of enclosing the bison herd. Tall fencing may be used in order to prevent the escape of bison, although organizations such as the Nature Conservancy, use fencing that is less than 5-6 ft. tall (Cuchna 1997). Primarily the fencing acts as a visual barrier (Cuchna 1997). At the Blue Mound State Park in Luverne, Minnesota the fencing enclosing a 56 animal bison herd is 51/2 to 6 ft. tall (Cuchna 1997). The bison herd grazes a 120 acre area with a winter and summer range. Supplemental feeding during the winter has been done here, but in areas owned by the Nature Conservancy this practice has not been used (Cuchna 1997). At this park, the bison are maintained in the enclosed area primarily as a visitor attraction. This area has been subject to overgrazing in the past and fire was not being used as a management tool. Currently the area has been burned and management is considering moving the bison ranges in the future while also incorporating both fire and bison grazing.

The use of grazing on the prairie has two primary functions: restoration and maintanence. Grazers can be used as a technique in early restoration to reduce the survival of some species and thereby increase species diversity by allowing others to compete (Vinton, Hartnett, Finck, Briggs 1993). After the prairie has become established, grazers can have

significant effects on species composition and structure (Vinton, Hartnett, Finck, Briggs 1993). Grazers can be used as maintenance on areas where fire may not be feasible because the area is urban, small, and/or public concerns outweigh the use of fire as management. Finally, the use of grazing management along with fire can be successful in recreating a truly historical native prairie.

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