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Fire and Bison Grazing, Historic Strategies Used to Restore Custer State Park's Mixed Grass Prairie

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Introduction

Custer State Park (CSP) is located in the Black Hills of western South Dakota. The park is near the Wyoming border to the west and the Nebraska border to the south. Rapid City is the closest metropolitan area, located approximately 30 miles (49 km) northeast of the park. According to Walker et al. (1995), CSP includes 70,500 acres (28,530 ha), of which 17,860 acres (7,228 ha) is mixed grass prairie. Geography varies from steep granite spires in the northwest part of the park to forested hill land in the main body. Grasslands are found on the eastern and southern boundaries. Elevation ranges from 3,760 feet (1,146 m) to 6,700 feet (2,042 m) above sea level. Vegetation is dominated by a mix of *Picea glauca* (white spruce), and *Pinus ponderosa*(ponderosa pine) on north slopes at higher elevations. Ponderosa pine are interspersed with hardwoods such as *Quercus macrocarpa* (burr oak) on most forest lands. Mixed grass prairie plants such as *Ratibida tagetes* (prairie coneflower) and *Agropyron smithii* (western wheatgrass) are found on the prairie (Hays 1994).

The natural forest and prairie ecosystems historically found in CSP have been altered by fire suppression and overgrazing. Prior to restoration efforts, these two systems were in poor condition. With fire suppression the ponderosa pine forest had become dense and was rapidly expanding into mixed grass prairie and oak forest (Walker et al. 1995). At the same time *Bison bison* (bison) grazing was degrading the prairie. Prior to 1970 CSP's policy of using bison as a form of revenue for park operations lead to overstocking numbers on designated range sites, the park's prairie system (Walker et al. 1995).

CSP has taken steps to restore both their prairie and forest ecosystems by implementing a range management plan as part of their resource management plan. CSP's long term strategy to restore and maintain a natural mixed grass prairie has been ongoing for over 20 years, but has become more developed and targeted in the last 6 years.

My paper will focus on the prairie system. The literature reviewed considers techniques of grazing and fire management used to restore native mixed grass prairies. Bison grazing and fire now play an important role in CSP's prairie restoration efforts. These two natural disturbances have helped to recreate the historic mixed grass prairie ecosystem in CSP (Walker et al. 1995).

Restoration Goals and the Target System

CSP's restoration goal is to restore their mixed grass prairie to the native system that existed before degradation. The park's target system for restoration is a community dominated by native warm season grasses and forbs, relatively free of exotic plant species. Woody shrubs such as *Symphoricarpus occidentale* (western snowberry), are found in drainage bottoms and native wildlife populations can thrive in this sustainable landscape (Walker et al. 1995). Typical grasses found in the mixed grass prairie are *Agropyron smithii* (western wheatgrass), *Stipa viridula* (green needlegrass), *Bouteloua gracilis* (blue grama), *Bouteloua curtipendula* (side-oats grama), *Sorghastrum nutans* (Indian rice grass), *Psoralea esculenta* (Indian breadgrass). Typical forbs found on the prairie are *Tradescantia ohiensis* (bracted spiderwort), *Liatris punctata* (dotted gayfeather) and *Ratibida tagetes* (prairie coneflower) (Hays 1994). The park's mixed grass prairie system is adapted to natural grazing and fire.

Effects of Historical Disturbances

Fire favors prairie species in several ways. Presettlement data shows the Black Hills and surrounding prairie experiencing fire every 7 - 12 years (Frost 1998). Burning clears accumulated litter, permitting dense growth. Fire produces dark ash, which has a warming effect on the soil, giving the warm season prairie plants an advantage in the spring when there is more abundant moisture. Stimulated by fire, prairie species can out-compete non-prairie or invasive species (Schramm 1990). Fire can successfully arrest succession to pine forest. Prairie fires reduce woody species, whose majority of biomass (75%) is exposed to a fire disturbance. With 50% of their biomass below ground prairie species recover with quick vegetative reproduction after a fire (Hays 1994).

Most prairies were once grazed by herds of bison. Grazing rejuvenates forage production and alters vegetative species structure, maintaining a diverse natural prairie system. Results from a study by Harnett et al. (1996) show that bison grazing increases various components of floristic and spatial diversity in prairie systems. Their study at the Konza Prairie Research Natural Area in northeast Kansas indicates that increased plant species diversity confers greater ecological stability in grasslands. Net primary productivity and species composition can rebound after drought, a frequent stressor in CSP.

Bison impact prairie species diversity in their selection of forage. The selectivity of bison grazing can be used as a technique to reduce the abundance of some species and thereby increase species diversity by allowing others to compete (Paulsen 1975). The mosaic habitat patches generated by bison grazing and non-grazing habits likely increased species diversity that would otherwise be excluded from the community by competition from the matrix grasses(Hartnet et al. 1996).

Creation of an Altered System

With the advent of fire suppression and poor grazing management, the forest and prairie's natural disturbance conditions were dramatically altered. In CSP the natural fire cycle had been largely eliminated through fire suppression. The large fires of 1988 and 1990 resulted from the suppression of the natural fire cycle causing an accumulation of fuel load. Today 39% of the undamaged forest area of the park is in a high or very high fire hazard condition (Walker et al. 1995). Nationally, 60% of ponderosa pine forest system's open character has been changed to that of a dense and growth retarded stand due to fire suppression (Frost 1998). Fire suppression in the forest carries over to an unhealthy situation in the prairie. Pine encroachment is a residual effect of fire suppression on the prairie system.

Serious overgrazing early in the park's history also had a negative impact on the system. As early as 1949 herds of buffalo and elk were reported to be increasing in the park. Drought conditions during the 1940s and serious overgrazing were beginning to affect range condition. The damaging bison stocking levels continued until the mid 1970s (Walker et al. 1995).

Restoration Efforts

Efforts by the park to restore this altered system to a more native mixed grass prairie have evolved into the 1995 range management plan followed today. The first step in the plan was to differentiate the prairie system from the encroaching ponderosa pine forest system. Soil classification was used as the determining factor. According to Walker et al. (1995), soil classification is the most reliable definition of rangeland. With the completion of soil surveys inCuster County in 1986 a tool became available to make definitive determinations of "what and where is rangeland in Custer State Park?" With pine encroachment the prairie portion of the park was found to have declined by several thousand acres. Once prairie and forest land had been identified by soil type, borders could be drawn between the two systems to guide restoration.

The park has divided their prairie system into three large grazing units: The east (E), southwest (SW) and RD. Each individual unit is further broken down into sites which are determined by major differences in

soil texture. Based on NRCS (National Resources-Conservation Service USDA) standards, each site (soil type) is rated by deviation from expected climax community. Condition of each unit based on expected climax community are ideally updated every two years (Walker 2001). Two of the three range surveys have recently been completed, with the results presented later in this paper.

CSP incorporates prescribed burns and deferred bison grazing to systematically prevent ponderosa pine encroachment and improve prairie productivity and diversity (Walker et al. 1995). In a study by Pfieffer et al. (1994), rhizomatous grasses on sand ranges responded positively to fire and grazing. Grazing management combined with prescribed burns may increase the standing crop of rhizomatous grasses at the expense of bunchgrasses. Combinationmanagement increases forage, since in unburned prairie, bunchgrass forage is underutilized due to the deterrent effect of standing dead tillers.

Prescribed burns are an integral part of the restoration work in CSP. The use of fire is outlined as systematic burning in the prairie and savanna of the park to prevent decadence, improve prairie productivity and retard encroachment of pine. Prairie burning is generally timed to occur in the late spring. Prescribed burn plans address specific objectives regarding species mix desired following the burn. Their objective is to introduce fire into the prairie system modeled after the historic seventeen year frequency of fire in the park. To reduce ponderosa pine encroachment the management plan has a yearly burn schedule of 1,050 acres (425 ha). They plan to burn a total of 15,750 acres (6,377 ha) over a fifteen year period (Walker et al. 1995).

According to the *Custer State Park Resource Management Plan* (Walker et al. 1995), bison grazing management is an important part of improving the prairie system. The function of deferments (managed rotation of a herd in multiple grazing enclosures) are to remove grazing pressure during the time when desired plants are actively building carbohydrate reserves. Adjusting stocking levels on the park's three deferment sites is used to improve prairie condition. One factor of adjustment is drought stress, which takes into consideration yearly rainfall records. An annual bison sale in the fall adjusts stocking load on a yearly basis.

Deferred grazing is an important tool used to improve prairie diversity and production. Selectivity of bison grazing improves diversity by reducing the number of some species while allowing others to compete. There is a fine line between improving or degrading the system with overgrazing. Paulsen (1975) suggests utilization of 30 to 40% of the current annual growth of the major forage grasses to provide sustained production of forage. Grazing in excess of 40% can damage the range. Non-grazing and non-removal of plant material results in reduced decomposition and a slower nutrient cycling process. Non-grazing degrades the plant vigor of the system and can reduce plant diversity. A study by Painter et al. (1989) in the Wind Cave National Park (adjacent to CSP) found that past site disturbance played an important role in how that area was grazed. Prior grazed prairie dog colony sites and exclosure sites (non-grazed) experienced a different pattern of bison grazing. The study used same species propagated from the two sites. Colony sites had higher plant vigor and were more preferentially grazed than exclosure sites.

Grazing improves the prairie system and controls ponderosa pine encroachment. Historical accounts of woody plant degradation conclusively suggest that woody plants fought a continual battle for survival in grasslands because of grazing, browsing and tramping effects of bison and because of recurrent wildfires. Bison were thought to be the "enemies of regeneration" of woody plants (Schaefer 1997). Edwards (1976) used a study in CSP where cattle were separated from buffalo into identical habitats to study pine encroachment impact. Ponderosa pines were found to heavily invade the cattle pasture. In the buffalo area of study, with the same seed sources, there was virtually no invasion of pine. Where they grazed in open grazing areas there was continual decimation of the

encroaching pine along the forest/prairie edges. Areas of CSP where the buffalo do little or no grazing are thick with woody invasion.

Condition Update

Condition evaluation of the park's range sites, as described, allows managers to make annual adjustments in their management prescriptions. In an assessment of the resource management program, the park determines the extent to which climax community is being achieved. They sample using the Daubenmire plot method. A plot frame is placed at five meter intervals on hundred meter transects. For each plot cover was estimated for each species using a 7 class system (for example 5-25%, 25-50%, 50-75% etc.). In turn, twenty transects were sampled per pasture (Hall 2001). Results of these assessments are given in Tables 1 and 2.

Almost 50% of the SW pasture is in excellent condition (similar to expected climax community) Sites rated excellent have a greater diversity of prairie grasses than those lower rated. On the silty and overflow sites western wheatgrass, *Andropogon gerardii* (big bluestem) and sedges are present in abundance. On the clayee site large percentages of western wheatgrass, blue grama and *Schizachyrium scoparium* (little bluestem) contribute to an excellent rating. On four of the seven sites there is a high percentage of *Poa pratensis* (Kentucky bluegrass). The presence of bluegrass with fewer number of prairie grasses and forbs contributes to a lower rating. Ten forbs are present, but in low percentages. The majority of the forbs in the SW pasture are found on a single site (Overflow).

In the E pasture, each of seven sites has a high percentage of Kentucky bluegrass. A variety of prairie grasses are present, but in much lower percentages than the bluegrass. Big bluestem, little bluestem and western wheatgrass are the predominant warm season grasses on each site. Twelve forbs are present in low percentages.

Both ranges evaluated have an abundance of western wheatgrass, big bluestem and little bluestem. *Psoralea linearifolia* (slimflower scurfpea) is the most prevalant forb. Kentucky bluegrass is present in substantially higher numbers than prairie grasses in both pastures. The jump from a poor or fair condition is made in the SW pasture, where a variety of forbs and warm season grasses are present to meet percent climax community standards. Based on the park's partial evaluation to date (i.e. 2 of 3 pasture sites) approximately 50% of the SW pasture is in excellent condition and 30% of the E pasture is in good condition. Evaluation of the RD pasture is planned in the near future.

Conclusion

Bison and the plant species they depended upon evolved together over a long period of time. The degradation that disrupted this fire and grazing dependent mixed grass prairie system in Custer State Park spanned many decades and will likely take that long to reverse.

The strength of CSP's restoration efforts lie in mimicking historic local disturbances of fire frequency and bison grazing. Ongoing monitoring that drives vegetative management decisions is an integral part of their plan. The park's efforts clearly show a recovering mixed grass prairie. The extent of recovery is seen in the percentage of land in good to excellent condition, indicated by increasing native species present. There is work yet to be done on the park's prairie. Reduction of cool season species, reversal of ponderosa pine succession and improvement of low rated sites will be ongoing.

The park is committed to a long-term restoration. CSP's long-term restoration commitment has resulted in a recovering mixed grass prairie, that should continue to improve over the next few decades.

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