

THE ECOLOGICAL IMPORTANCE OF BISON IN MIXED-GRASS PRAIRIE ECOSYSTEMS

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Bison congregating for the rut, Hayden Valley, Yellowstone National Park, Darrell Geist photo.

Bison play a keystone role in grassland ecosystem health

The northern Great Plains ecosystem of North America was once inhabited by free ranging herds of bison ranging in the millions. In the 1800s, human settlement in the area led to large scale slaughter of bison and conversion of much of the grass prairie to agriculture. Only relatively recently have restoration and conservation efforts led to protected tracts of mixed-grass prairie and bison herds. Since reestablishing this relationship, scientists have documented the many beneficial roles that bison play as a keystone species in their ecosystems. Through their unique grazing behavior, bison contribute to changes in plant and animal species composition, alterations of the physical and chemical environment, increased spatial and temporal heterogeneity in vegetation structure, soil resource availability and a variety of ecosystem processes (Knapp et al. 1999).

Grazing by bison increases native plant and wildlife diversity

One of bison's greatest impacts on mixed-grass prairie ecosystems is grazing. Bison tend to graze in patches, revisiting areas throughout the season and therefore leaving a mosaic of grazed and ungrazed areas. Because bison selectively graze on dominant grasses while avoiding most forbs and woody species, the resulting patchy distribution of vegetation favors increased plant species diversity by allowing forbs to flourish (Collins et al. 1998). The dynamic spatial and temporal nature of bison grazing allows the productivity of grasses to recover while the presence of diverse forbs enhances gas exchange, aboveground biomass, density and plant cover (Fahnestock and Knapp 1993, Hartnett et al. 1996, Damhoureyeh and Hartnett 1997). Photosynthesis rates are also increased by bison grazing patterns due to increased light availability and reduced water stress (Wallace 1990, Fahnestock and Knapp 1993).



Bison grazing, J Schmidt, NPS photo.

Finally, bison grazing increases animal diversity on the landscape. Bison grazed areas increase the foraging efficiency of prairie dogs which in turn are the main food source of ferrets (Krueger

1986). Prairie dogs also provide food for foxes, hawks and eagles and their colonies are home to other small mammals and reptiles.

Nutrient cycling benefits plant growth and species distribution

Bison also affect the nutrient cycling in prairie ecosystems. Nitrogen is an essential element for plant productivity that is found in both plant material and soils. By consuming plant biomass, bison then return labile nitrogen to the soils in the form of urine which is more effective than the slower mineralization of nitrogen from plant litter breakdown (Ruess and McNaughton 1988). At the same time, grazing increases the amount and quality of plant litter that is returned to the soil as well as the plant uptake of nutrients (Ruess 1984).

Fire, which is a natural component of prairie ecosystems, has also been a standard land management practice for years. Fire causes the loss of nitrogen by burning plant material. However, bison grazing limits the loss of nitrogen by reducing the aboveground plant detritus and increasing the patchiness of the fire (Hobbs et al. 1991). These changes in nutrient cycling and nitrogen availability in prairie ecosystems lead to increased plant productivity and species composition (Seastedt et al. 1991, Blair 1997, Turner et al. 1997, Gibson et al. 1993, Wedin and Tilman 1993).



Bison wallowing, Jim Peaco, NPS photo.

Bison wallows create unique habitats

Wallows are a unique ecological feature of prairie ecosystems created by bison. By rolling repeatedly in exposed soil, bison increase soil compaction in certain areas which aids in water retention. In the spring, these wallows produce temporary pools that can support ephemeral wetland species (Uno 1989). In the summer, the wallows support a different vegetation

structure and composition that is more drought and fire resistant (Collins and Barber 1986). The combined effect of bison wallows is an increase in spatial environmental heterogeneity and local and regional biodiversity (Hartnett et al. 1997).

Bison are a significant food source for predators

Bison are an important food source for predators and scavengers including birds, small mammals, gray wolves and grizzly bears. While wolves show a preference for elk, they also feed on bison particularly in the winter when bison are compromised or when elk are less abundant (Smith et al. 2000). In a study of ungulate use by grizzly bears in Yellowstone, researchers found that grizzlies were more likely to feed off of a bison carcass than an elk and they rarely used deer (Green et al. 1997). Furthermore, a decrease in grizzly bear mortality and an increase in their reproductive success in the mid 1980s were attributed to a shift in the bears' diet including the greater consumption of ungulate meat including bison (Gunther and Haroldson 1997).



Winter killed bison is an important food source for bears emerging from hibernation, John Good, NPS photo.

Bison carcasses fertilize soils

Decomposition of bison carcasses benefits the prairie grasslands. At an experimental site at the Konza Prairie in Kansas, scientists have studied the effects of naturally decomposing bison carcasses on the surrounding ecosystem. Initially, large amounts of nitrogen rich fluids are released that are toxic to the plants under the carcass. Within three years, however, the original carcass site is two to three times as nutrient rich as nearby sites and is dominated by early successional species (Knapp et al. 1999, Towne 2000). The remains of scavenged carcasses would have similar effects. Bison carcasses therefore create a unique local disturbance event that ultimately results in increased productivity.



Bison skull, J Schmidt, NPS photo.

Bison's unique ecology

Bison have a unique ecology that has profound effects on mixed-prairie ecosystems. Their grazing style provides spatial and temporal heterogeneity which benefits plant and animal species diversity. Bison also increase overall plant productivity by enhancing nutrient cycling and nitrogen availability. Their distinctive behavioral trait of wallowing further creates spatial patchiness of resource availability and boosts plant species composition. Finally, predators and scavengers benefit from consuming bison while the remains confer rich nutrients to prairie soils and plant communities.

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