



Influences of Precipitation on Bison Weights in the Northern Great Plains

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On the Ground

- We evaluated relationships between bison weights and prior precipitation during 1983 to 2015 for Wind Cave and 1998 to 2015 for Badlands National Parks.
- We generally found positive correlations between weights for most sex and age cohorts and precipitation during each of the preceding 7 years. The association was strongest for yearlings.
- We speculate that rainfall several years prior can improve forage, which affects the condition of cows, which affects neonatal weights and subsequent growth of young bison.
- Correlations were stronger for a moving average of previous precipitation, suggesting a cumulative effect.
- Our analysis demonstrates the importance of long-term monitoring for better understanding of grassland ecosystems.

Keywords: Badlands National Park, bison, *Bison bison*, precipitation, weight, Wind Cave National Park.

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Weather and, more specifically, precipitation, is an ecological driver of Northern Great Plains grasslands. Precipitation influences plant composition and productivity, which in turn might affect the growth and mass of herbivores such as bison (*Bison bison*). However, confirming and understanding the relationship between precipitation and bison weights requires long-term datasets.

Wind Cave National Park, located in the Northern Great Plains, has played a critical role in bison conservation.¹ For

almost a century the park has routinely rounded up and removed surplus animals for purposes of keeping the herd at desired abundance levels. Badlands National Park has managed bison similarly for nearly half a century. For the past several decades the parks have weighed the bison captured in the roundup operations.² The parks also collect weather data in collaboration with other agencies. We related these long-term datasets of bison weights to precipitation patterns to better understand the relationship and mechanisms between the two components of grassland ecosystems.

Study Areas

Wind Cave National Park lies about 6 km north of the town of Hot Springs, South Dakota, on the southern edge of the Black Hills. Fourteen bison were reintroduced to the site in 1913 and another six in 1916. The herd currently has access to about 11,330 ha within a woven-wire boundary fence. The park generally manages for a population of 350 to 500 bison. Park-reported estimates of the precull herd size from 1983 to 2015—derived primarily from periodic aerial counts, known cull sizes, and extrapolations using an estimated growth rate of 16%^{3,4}—averaged 445 bison (standard deviation [SD] = 47, n = 33). The herd has greater genetic diversity than most other bison herds⁵ with no apparent inbreeding depression.⁴ Although the herd appears healthy, the bison weigh less than bison at Badlands National Park in South Dakota and at Theodore Roosevelt National Park in North Dakota; the reasons for the disparity are not known.² Population estimates of other notable mammalian herbivores at the park from 1983 to 2015 include an average of 556 (SD = 64, n = 30) elk (*Cervus elaphus*), 67 (SD = 38, n = 22) pronghorn (*Antilocapra americana*), and 771 (SD = 217, n = 15) ha of black-tailed prairie dogs (*Cynomys ludovicianus*), based on park internal reports. However, these reported population sizes are of questionable quality. For example, the park surveys only about half the prairie dog colonies in a year; to derive an annual park-wide estimate they carry over values of the unsurveyed colonies

from prior years' surveys. Furthermore, routine monitoring of prairie dogs only began in the year 2000.

Vegetation within Wind Cave consists of a mosaic of mixed-grass prairie and ponderosa pine (*Pinus ponderosa*) forests. Dominant vegetation in the prairie includes blue grama (*Bouteloua gracilis*), western wheatgrass (*Pascopyron smithii*), and little bluestem (*Schizachyrium scoparium*). The bison pasture produces about 24.5, 18.7, and 12.8 million kg of forage during favorable, normal, and unfavorable precipitation-years, respectively (values and terms from Natural Resources Conservation Service⁶). Assuming 450 bison, 550 elk, and 75 pronghorn; forage intake rates of 2.2%, 2.1%, and 2.1% of body mass; and average biomass per individual of 375, 250, and 35 kg; respectively, the herbivores would take about 9.9%, 12.9%, and 18.9% of the primary productivity in favorable, normal, and unfavorable precipitation-years.

Precipitation averaged 51.0 cm (SD = 11.4, n = 33) annually during 1983 to 2015 at a weather station located within the park.⁷ Mean maximum July temperatures were 29.4°C in July and 3.9°C in January. An average of 306 ha was burned annually in the park during 1983 to 2015, although there was much variability among years (SD = 517, n = 30).

Badlands National Park is located about 11 km south of Wall, South Dakota. In 1963 to 1964, 53 bison were reintroduced to the site.⁴ Another 20 bison were added in 1984.⁸ The herd currently has access to about 19,500 ha, composing about half of the park's North Unit. The park

manages for a postcull population of about 700 animals, a target that is considered conservative.¹ Park-reported precull population estimates from 1998 to 2015—derived from ground counts, known cull sizes, and extrapolations using estimated growth rates—averaged 1,001 animals (SD = 405, n = 18). Other large grazers in the park include pronghorn and bighorn sheep (*Ovis canadensis*); their abundance within the bison pasture is not known, but is assumed to be small and their plant utilization negligible. Within the bison pasture are about 1,400 ha of black-tailed prairie dogs. As was done at Wind Cave, the park attempts to survey all the colonies over 2-year periods (although that was not always done) and started the monitoring program in the year 2000.

About a third of the area within the bison pasture is composed of sparsely vegetated badlands topography. In the prairie areas the dominant vegetation includes western wheatgrass, green needlegrass (*Nassella viridula*), and little bluestem. The bison pasture produces about 33.3, 26.2, and 14.9 million kg of forage during favorable, normal, and unfavorable precipitation-years, respectively.⁶ Assuming a herd of 1,000 bison, an intake rate of 2.2%, and an average biomass of 450 kg per bison, the herd would take about 10.8%, 13.8%, and 24.1% of the primary productivity in favorable, normal, and unfavorable precipitation years.

Precipitation averaged 48.2 cm (SD = 12.7, n = 18) annually from 1998 to 2015 at a weather station located at Interior, South Dakota.⁷ The station is about 35 km from the center of the

Table 1. Number of bison weighed at Wind Cave and Badlands National Parks

	Wind Cave NP (1983-2015)		Badlands NP (1998-2015)	
	Years with weight data	Average number per year with data	Years with weight data	Average number per year with data
Female				
Calves	10	31.7	10	84.6
Yearlings	25	35.1	11	76.9
2.5 year olds	25	14.1	11	40.8
3.5 year olds	23	11.2	11	26.3
4.5 year olds	24	8.5	11	20.9
5.5 year olds	24	56.1	11	137.8
Male				
Calves	10	30.8	10	83.2
Yearlings	25	37.1	11	75.7
2.5 year olds	24	13.8	11	37.5
3.5 year olds	24	5.8	11	17.9
4.5 year olds	18	2.6	11	11.2
10.5 year olds	14	5.2	11	10.7

NP indicates National Park.

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