Montana Fish, Wildlife & Parks

Background Information on Issues of Concern for Montana:
Plains Bison Ecology, Management, and Conservation

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On the Cover
Female bison and her calf
Photograph courtesy of USFWS

Background Information on Issues of Concern for Montana:
Plains Bison Ecology, Management, and Conservation

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Introduction to Plains Bison

Introduction

In 2010, Montana Fish, Wildlife & Parks (FWP) began a process to evaluate the opportunity for establishing a wild plains bison population somewhere within the state. As part of the evaluation process, this public background document was created to compile the current body of knowledge pertaining to bison with an emphasis on Montana. The purpose of this document is not to make management recommendations or decisions, but rather to create the foundation for an informed public dialogue about the future of bison in the state of Montana.

The Montana Comprehensive Fish and Wildlife Conservation Strategy (CFWCS), released in 2005, was developed by FWP to help secure long-term federal funding needed to conserve and manage species. The CFWCS is aimed at ensuring that the citizens of Montana make fish and wildlife management decisions to actively prevent species from becoming threatened or endangered, and public involvement was a critical component of its development (FWP, 2005). The CFWCS identifies bison as a Tier I species, or one in "greatest conservation need" (FWP, 2005).

Should FWP move forward with a formal evaluation of the potential for a bison restoration program, the evaluation would have to progress through the Montana Environmental Policy Act (MEPA) process, which includes extensive public comment opportunity.

Taxonomy and Systematics

The taxonomic relationship between bison and cattle has been a source of debate for several decades. The American Plains Bison was originally classified in 1758 by Linnaeus as a member of the *Bos* genus alongside domestic cattle (Forseman, 2001). It is speculated that bison and cattle both evolved from a common ancestor, *Leptobos,* though it is possible that *Leptobos* was a closely related taxon (McDonald, 1981). The two species are believed to have branched from *Leptobos* in the late Pliocene and continued to evolve to fill separate niches (McDonald, 1981). The two species have distinct adaptations, which indicate that they developed to adapt within separate habitat niches. Bison have adaptations associated with the savanna-steppe habitat, which include less selective feeding, the ability to digest coarse fiber, marked seasonality adaptations, large groups, class hierarchy, non-lethal fighting apparatus and technique, and migratory-nomadic behavior (Guthrie, 1980). Cattle fit woodland adaptations, which include selective feeding strategies, reduced seasonal adaptations, small groups, linear or modified linear hierarchy, territorial fidelity, conservative social organs, and lethal fighting apparatus (Guthrie, 1980).

In 1827 Hamilton Smith determined that the American and European bison were anatomically distinct and should be separated from the other members of the *Bos* genus

into their own subgenus, *Bison* (Skinner and Kaisen, 1974; Shaw and Meagher, 2000). The subgenus *Bison* was elevated to the level of genus in 1849 (Skinner and Kaisen, 1974). Recent advances in DNA analysis indicate that there should not be a distinction between the *Bos* and *Bison* genera (Douglas et al., 2010). Douglas et al. (2010) note that "the recent accumulation of molecular data, together with the fact that members of *Bison* can produce viable offspring with several species of *Bos* (van Gelder, 1977) indicate that the *Bison* and *Bos* genera should be reunited" (pp. 8).

Though recognizing that new DNA findings may have implications as to the taxonomic classification of bison, in keeping with the naming conventions used by the U.S. Fish and Wildlife Service (USFWS) and by the American Bison Specialist Group of the International Union for Conservation of Nature, this document will adhere to the recognition of the separate genus of *Bison*.

Traditionally, within the *Bison* genus there are two recognized subspecies, plains bison (*Bison bison bison*) and wood bison (*Bison bison athabascae*)(Skinner and Kaisen, 1974; van Zyll de Jong, 1986). Plains bison are the subspecies that historically occupied present-day Montana. The two subspecies are believed to have diverged approximately 5,000 years ago during geographical separation (van Zyll de Jong, 1986). Subspecies are defined as having numerous observable morphological differences, genetic divergences, and populations that reproduce in isolation from one another (Winston, 1999). It is possible for natural hybridization between subspecies; however, the hybrid may experience reduced fitness and fertility (Winston, 1999).

The two bison subspecies have a number of phenotypical differences (see Table 1) that support their distinction, and studies of DNA microsatellites by Wilson and Strobeck (1999) indicate that there is a greater genetic distance between the two subspecies than there is within each of the subspecies. However, the recent advances in the analysis of DNA indicating that there should not be separate *Bison* and *Bos* genera have also suggested that there is not a significant difference with respect to the mitochondrial genetic sequences of the plains and wood subspecies (Douglas et al., 2010). Based on these findings Douglas et al. (2010) note that plains bison and wood bison should not be considered separate subspecies. It is unclear as to whether wood bison were ever a genetically separate subspecies, or if it was the introduction of large numbers of plains bison into wood bison herds in the early 1900s that resulted in their similar genetic sequences (Douglas et al., 2010). While scientific debate continues as to whether the two subspecies of bison are unique enough to warrant separation, wood bison are an important source of genetic diversity for the species (Douglas et al., 2010), and therefore it is important to conserve the biodiversity within the species through the distinction of the subspecies. This document addresses the ecology, management, and status of plains bison. The term bison within this document, unless otherwise specified, refers to plains bison, *Bison bison bison*.

Plains bison *Bison bison* ***bison***	Wood bison *Bison bison* ***athabascae***
	
Pelage characteristics	
Dense woolly bonnet of hair between horns	Forelock dark, hanging in strands over forehead
Thick beard and full throat mane, extending below rib cage	Thin beard and rudimentary throat mane
Well-developed chaps	Reduced chaps
Well-demarcated cape, lighter in colour than wood bison	No clear cape demarcation, hair usually darker than plains bison
Structural Characteristics	
Highest point of the hump over front legs	Highest point of the hump forward of front legs
Horns rarely extend above bonnet	Horns usually extend above forelock
Smaller and lighter than the wood bison (within similar age and sex classes)	Larger and heavier than plains bison (within similar age and sex classes)

Table 1. Comparison of Structural and Pelage Characteristics for the Two Bison Subspecies. Originally published in Gates et al. (2010).

Species Description

Male bison. PHOTO CREDIT: S. ADAMS

Bison are the largest terrestrial mammal in North America; however, the weight and measurements of bison differ considerably by age and sex and among different populations (Reynolds et al., 2003). Males, referred to as bulls, average between 1,000 to 2,000 pounds, and females, known as cows, average between 800 and 1,000 pounds (Meagher, 1973; Reynolds et al., 2003; Burde and Feldhamer, 2005; Picton, 2005). Males attain their greatest mass between 10 and 15 years of age (Berger and Cunningham, 1994a). The shoulder height ranges between 5 feet 5 inches and 6 feet 5 inches in males, and between 4 feet 5 inches and 5 feet 5 inches in females (Meagher, 1978). Though similar in appearance, bull and cow bison are sexually dimorphic, and therefore do have observable morphological differences (Meagher, 1973; Reynolds et al., 2003). Birth weight for a free-ranging bison calf averages between 32 and 70 pounds, and on average calves gain 1.2 to 2 pounds per day until they are weaned (Feist, 1999; Burde and Feldhamer, 2005).

Despite their large stature bison are extremely agile, with the ability to reach substantial speeds of approximately 30 to 35 mph, and jump upward of 6 feet high (USFWS, 1997; Lott, 2002). A common misperception is that bison are plodding and cumbersome, though nothing could be further from the truth. The preeminent naturalist John J. Audubon was astonished by the agility of plains bison. Though people associate bison with the flat prairies, they possess remarkable climbing ability. “The activity of Buffaloes is almost beyond belief,” Audubon observed, “they can climb the steep defile of the Mauvaises Terres (Bad Lands) in hundreds of places where men cannot follow them” (Brink, 2008, pp. 29).

The unique physical characteristics that cause bison to be easily recognized played an important role in their historic success in North America. The large low-hanging head is equipped with a relatively straight row of incisors on a broad lower jaw. This adaptation allows bison to efficiently gather large amounts of low-growing vegetation (Geist, 1996; Picton, 2005). In order to support the large weight of their head, bison have a prominent rounded hump located above the shoulder, which contains muscles that are attached to neural spines that rise from their vertebrae (Picton, 2005). The forward position of the hump allows bison to utilize quick pivots combined with a disemboweling hooking defense against predatory attacks, and during male competition (Picton, 2005).

The head and the front legs of a mature bison are covered with dense chocolate-colored hair. The hair on the shoulders and hump averages 6 inches in thickness, and the hair on the forehead can be in excess of 8 inches in length (Meagher, 1973; Foresman, 2001). “Bison have about ten times more hair per square inch of hide than do modern

cattle. Bison hair is thinner than that of cattle, but is much denser" (Brink, 2008, pp. 172). This hair plays a crucial role in insulating the bison against extreme environmental conditions, as well as protecting the bison from predatory attacks and injuries that may occur during male competition (Meagher, 1973; Foresman, 2001; Picton, 2005). The remainder of the body is covered in coppery-colored hair that averages an inch in length (Meagher, 1973). Bison calves are a reddish tan at birth and begin to darken around three months (Meagher, 1973; Picton, 2005).

PHOTO CREDIT: S. ADAMS

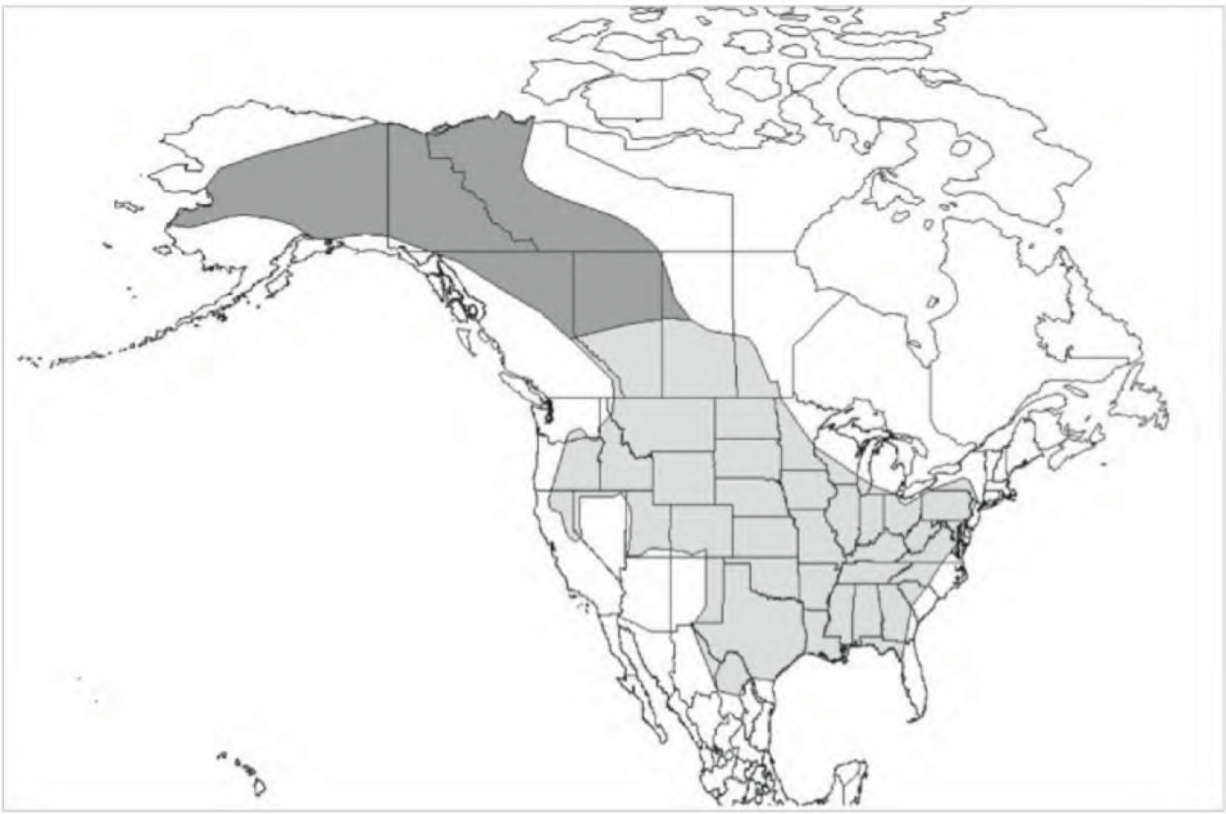
Both the male and female bison have short, upcurved, sharp horns, which are retained throughout their lifetime (Nowak and Paradiso, 1983; Long, 2003). A bull's horns can reach 20 inches in length, while the horns of the cow remain shorter (Burde and Feldhamer, 2005). The horns play an important role in defense against predation, as well as during competition between males over breeding rights during the mating season, referred to as the rut (Picton, 2005).

Prehistoric and Historic Distribution

The modern American Plains Bison descended from an ancestor that originated in southern Asia approximately two million years ago (Danz, 1997). This early ancestral bison was widely distributed throughout much of Europe and Asia (Shapiro et al., 2004). With the formation of the Bering Land Bridge during the Illinoian Ice Age, the steppe bison, *Bison priscus,* an early predecessor of modern bison, migrated into Alaska between 300,000 and 129,000 years ago (Shapiro et al., 2004; Picton, 2005). Ancestral bison flourished upon reaching the North American continent, and slowly evolved into the present-day forms, plains bison and wood bison.

The historic distribution of bison covered most of the North American continent (Hornaday, 1889; Gates et al., 2010). Guthrie (1980) notes that while historic forms of bison were found throughout North America, the greatest concentration were found along a line from Alberta to Texas, just east of the Rocky Mountains, and in the intermontane basins located just to the west. The largest concentration of bison occupied the Great Plains, which extends east to the Missouri River valley and west to the Front Range of the Rocky Mountains. The Great Plains also extends from Canada to Mexico, and is the largest biome in North America (Isenberg, 2000). Isenberg (2000) notes that the Great Plains consists primarily of short-grass and mixed-grass rolling plains, but also includes wooded river valleys and high, forested hills. Historically bison were also found eastward from the Great Lakes region to the eastern seaboard. Their distribution reached north into New

England and south into northern Florida. Bison also inhabited regions west of the Great Plain in parts of Nevada, Utah, New Mexico, Idaho, and the Cascade and Rocky Mountains. Their distribution extended north to the middle of Alberta, Saskatchewan, and Manitoba and south along the Gulf of Mexico and into Mexico (Hornaday, 1889; Reynolds et al., 1982; Danz, 1997; Picton, 2005; Gates et al., 2010).



Map 1: Original Ranges of Plains (light gray) and Wood (darker gray) Bison. Originally published in Gates et al. (2010); re-created by Boyd (2003) based on van Zyll de Jong (1986) and Stephenson et al. (2001).

Map 1 depicts one estimate of the early historic distribution of *Bison bison bison* (plains bison) and *Bison bison athabascae* (wood bison). There is archeological and historical evidence that bison and/or their ancestors were present in more regions of North America than are represented within this map (J. Fisher Jr. and T. Roll, Montana State University, personal communication).

Though bison were primarily located in the lower elevations of the plains, there are numerous reports of bison seasonally moving to high elevations within the Rocky Mountains, especially along the Front Range. Fryxell (1926) located skulls at approximately 9,500 feet, 10,500 feet, and 11,500 feet within the Snowy and Centennial ranges. Hornaday noted that bison had ranged to an elevation of 11,000 feet, based on a skull that was found at Two Ocean Pass within Yellowstone National Park (Fryxell, 1926).

Prehistoric and Historic Abundance

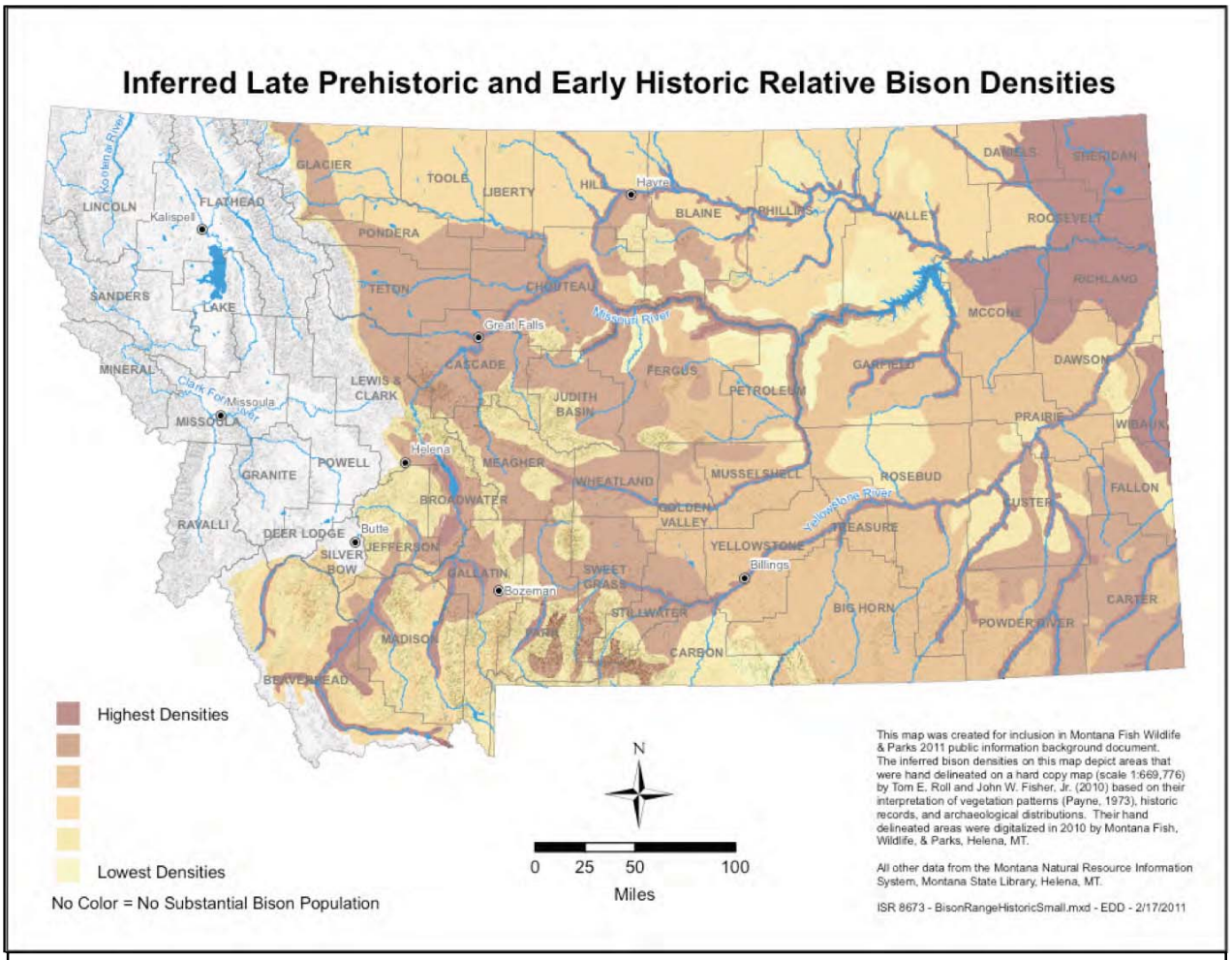
Historical estimates as to the abundance of bison present at one time on the Great Plains have ranged from 15 to 100 million bison (Dary, 1989; Shaw, 1995). These early estimations were derived by explorers upon seeing large herds of bison congregating during the summer mating season. "It is quite true that summer was the season of the great aggregation of herds on the Plains. Summer is the season when calves are dependent on their mothers and when safety from predators rests in large numbers. Likewise, nursing cows, who are weak and tied to their calves, need the protection of a large herd. Summer is the season when bulls want the company of the cows, to begin courting those they hope to include in their harem. Most importantly, summer is the season when grass is abundant and relatively nutritious, capable of supporting large herds in relatively small spaces" (Brink, 2008, pp. 61). In the summer of 1806, during his exploration of the Marias River, Meriwether Lewis remarked, "we passed immense herds of buffalo on our way; in short, for about 12 miles it appeared as one herd only, the whole plains and valley of this creek being covered with them" (Brandt, 2002, pp. 371).

Summer bison herd. PHOTO CREDIT: GYC

However, "summer was the only season in which massive herds blackened the Plains" (Brink, 2008, pp. 61). In the 1890s, Ernest Thompson Seton proposed the widely accepted estimate that the abundance of bison was actually closer to 60 million (Shaw and Meagher, 2000). Hornaday (1889) critiqued many of the early estimates and noted that "it would have been as easy to count or to estimate the number of leaves in a forest as to calculate the number of buffaloes living at any given time during the history of the species previous to 1870 (pp. 387). Recent studies of the environmental limitations of the semiarid grasslands that make up the Great Plains have lowered the estimated abundance of bison to no more than 30 million (Isenberg, 2000).

Prehistoric and Historic Distribution and Abundance in Montana

Map 2 illustrates the inferred late prehistoric and early historic relative distribution and densities of bison within the state of Montana. This map was created based on vegetation patterns (Payne, 1973), archeological records, and reports of historic human activities by Roll and Fisher Jr. Though populations of bison were found throughout much of the state, regions delineated as highest and higher densities had the highest estimated year-round populations.



Map 2: Inferred Late Prehistoric and Early Historic Relative Bison Densities. Created by Roll and Fisher Jr. (2010).

The observations of early travelers within the region, archeological records of a variety of bison kill sites, and the oral history of Native Americans support the distribution and abundance of bison within Montana. “What the long view of archaeology teaches us, that historical records cannot, is that nothing ever persists unchanged over great spans of time” (Brink, 2008, pp. xiv). Human hunters are believed to have hunted bison in Montana during the Early Prehistoric period (11,000 to 5,000 BC), though it was during the Middle

Prehistoric period (4,000 BC to 500 AD) that bison hunting was widely developed and the first evidence of bison "traps" was found (Arthur, 1966). Frison (1991) notes that radiocarbon dating of a bison bonebed at the Mill Iron archeological site outside of the town of Ekalaka in southeastern Montana dates back 11,000 years. The Powers-Yonkee archeological site in southeastern Montana dates back to approximately 3,000 years ago (Fisher Jr. and Roll, personal communication). Based on estimates of the number of humans and wolves within the region and on estimates of their respective consumption, there is evidence that during the Late Prehistoric period (1,800 to 200 years ago) humans were the most significant predatory pressure on bison in Montana, with rough estimates of annual human predation of 200,000 bison. In comparison, wolves were roughly estimated to have killed 25,000 bison annually (Fisher Jr. and Roll, 1998).

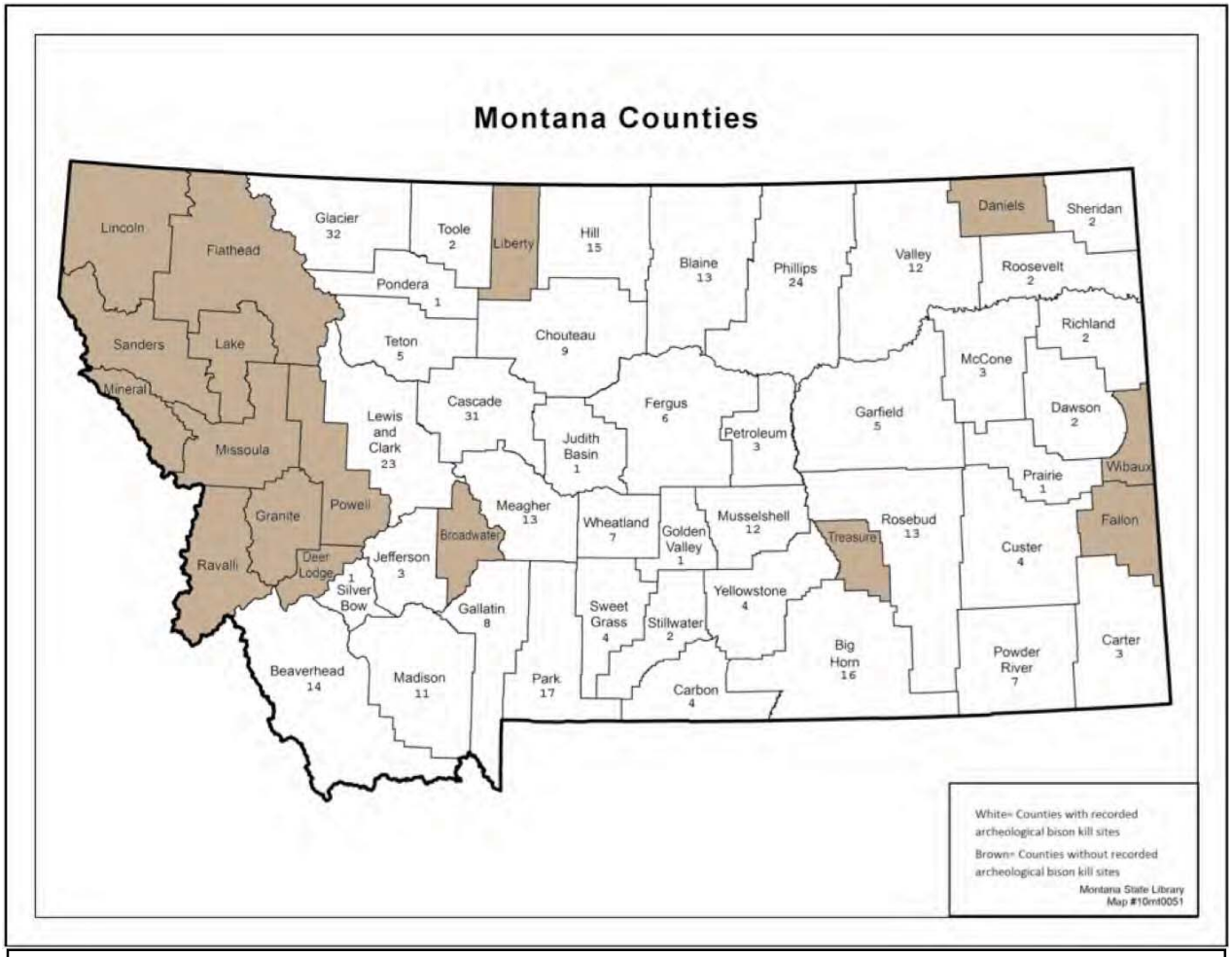
As of 2010, the State Historic Preservation Office of the Montana Historical Society had 320 bison kill sites on record, though it is estimated that these sites are only a small representation of the overall sites that once existed in Montana (data provided by D. Murdo, State Historic Preservation Office, May 2010). The recorded sites also do not account for individual bison kills, which would have represented the majority of bison harvested by humans (Fisher Jr. and Roll, 1999). The recorded kill sites illustrate the two types of hunting techniques employed by Native Americans. The first are bison jumps in which early hunters either on foot or horseback drove bison herds over a cliff (McHugh, 1972; Geist, 1996). These buffalo jumps were often used repeatedly and across generations. "If a herd of one hundred bison were run off a cliff at a single event (a number considered average), there is nothing in the four million years of human evolution when a comparable amount of food was procured at one time" (Brink, 2008, pp. 3). The First People's Buffalo Jump, formerly known as the Ulm Pishkun site, located southwest of Great Falls, is believed to have been used from 1,000 to 1,500 AD (Fisher Jr. and Roll, 1998). Buffalo jumps have been recorded throughout much of the northwest plains, with a substantial number in Montana, which is considered to be one of the main centers for buffalo jumps (Arthur, 1966).

The second type of archeological kill site found within Montana are bison pounds, in which bison were driven into a small area enclosed by either stones or logs and then slaughtered (Murdo, personal communication). Once bison had been driven into a pound, Grinnell noted, "The buffalo will not dash themselves against a barrier which is entirely closed, even though it be very frail; but if they can see through it to the outside, they will rush against it . . ." (Brink, 2008, pp. 88).

Bison kill sites are also sometimes referred to as *piskun* or *piskan,* which is a word in the Blackfeet language that is often described as meaning "deep bloody place" or "deep bloody kettle" (Fisher Jr. and Roll, personal communication). Frison (1991) notes that a variation of the classic buffalo jump involved stampeding a small herd over a low bluff or bank into a corral below. An example of this type of site is the Foss-Thomas site, located near Decker, in southeastern Montana (Frison, 1991). Cow and calf groups comprised the small herds that were targeted during communal hunting. "Bulls were, of course, hunted occasionally for a variety of reasons including food, but most of this was solitary, not communal hunting" (Brink, 2008, pp. 67). The fall and winter were the two seasons most

suitable to drive cow-calf groups, "but of the two seasons, fall stands out as the best of all. Not only are cows in the right place, of the right size groups, and at peak body condition in the fall, the weather is also most conducive" (Brink, 2008, pp. 67).

Both the buffalo jumps and pounds were communal hunts, which could efficiently slaughter large quantities of bison. "Teams of people worked together, the chores being too strenuous and the parts too heavy for individuals" (Brink, 2008, pp. 177). There are reports of hundreds and even a thousand bison killed in one hunting event (Krech III, 1999). Evidence from kill sites indicate that many of the large kills resulted in more bison killed than were actually processed and used by the Native Americans (Krech III, 1999). Many-Tail-Feathers, a member of the Blackfeet tribe, recalls that his father, Many-Tail-Feathers the elder, burned their piskan, near Choteau, after having a vision. In the vision he was told by a buffalo bull that "it is that with your piskans you are rapidly killing off us buffalo. If you keep doing it you will soon put an end to the very last ones of us." It is believed that this resulted in the end of the Blackfeet's use of piskans (Schultz, 1962, pp. 312–19).



Map 3: Distribution and Number of Known Archeological Bison Kill Sites. Created by FWP based on data provided by the State Historic Preservation Office of the Montana Historical Society

Based on data provided by the State Historic Preservation Office of the Montana Historical Society, bison kill sites have been recorded in 40 of Montana's 56 counties. The only counties in which archeological bison kill sites have not been recorded are Broadwater, Daniels, Deer Lodge, Fallon, Flathead, Granite, Lake, Liberty, Lincoln, Mineral, Missoula, Powell, Ravalli, Sanders, Treasure, and Wibaux (See Map 3). While the state records do not contain reports of bison kills sites in these counties, it is probably more a reflection of errors in the records than an actual absence of kill sites. For example, the Rinehart-Leavitt Site(s) were misreported and are actually located within Liberty County (Roll, personal communication). It is likely that many additional bison kill sites have been lost through erosion, geological processes, vandalism, bone mining, and development (Fisher Jr. and Roll, personal communication).

There is a large concentration of sites in the Upper Yellowstone Valley. The Long Ridge Jump, near Livingston, in south-central Montana, was one of the earliest sites used by the Crow tribe. Medicine Crow (1962) recalled that "it faced east toward the Yellowstone River. The runners got on top of the mountain and brought down elk, deer, and even rabbits, along with the buffalo" (pp. 47). Medicine Crow (1962) also noted that there were many sites used by the Crow tribe in Big Horn County. Some of the kill sites used by the Crow tribe were located near where Hoodoo Creek and Dry Head Creek split, along Grape Vine Creek, and near the town of Lodge Grass. Medicine Crow (1962) learned from his grandmother that the area near St. Xavier where Beauvais Creek and the Big Horn River meet is referred to as "place of many buffalo skulls or dried heads" and is now called Dry Head Country. The name came from the tribal practice of removing the heads of the bison and stacking them in one spot following a communal bison kill (Medicine Crow, 1962, pp. 37).

Native American Oral History and Records of Their Activity

Much of the record of the historic distribution of bison in Montana has been preserved through this sort of oral history of Native Americans, and in records of their activities. "Tipi rings," which are stones arranged in a circle, are the most frequently found archeological feature in Montana. It is believed that these rings were associated with the skin-covered pole lodges used by historic nomadic buffalo hunting tribes (Arthur, 1966).

As new technology became available to Native Americans, communal hunting techniques were altered from bison jumps and pounds to large horseback hunts. "The abandonment of traditional techniques can be traced to the sudden availability of new technology in Plains culture: guns and, especially, horses. The introduction of these two elements into traditional culture spelled the end of the pedestrian-based hunting methods and brought about dramatic changes for the Plains groups" (Brink, 2008, pp. 246). Father Pierre-Jean De Smet recorded a hunt he observed near the three forks of the Missouri. The party had camped on the middle branch of the Missouri (Madison) and the plains were abound with bison. "Finding themselves therefore in the midst of abundance, the Flatheads prepared to lay in their winter supply; they raised willow scaffolds about their lodges for drying meat, and everyone made ready his fore-arm, his bow and his arrows. Four hundred

horsemen, old and young, mounted in their best horses, started early in the morning for their great hunt . . . At a given signal, they rode at full gallop among the herds; soon everything appeared confusion and flight all over the plain; the hunters pursued the fattest cows, discharged their guns and let fly their arrows, and in three hours they killed more than 500" (De Smet, 1905, pp. 231–32).

The region between the Yellowstone and the Missouri Rivers was used as a bison hunting ground not only by regional tribes, but also by tribes that resided west of the Rocky Mountains (Farr, 2003). The Lemhi Shoshoni tribes would travel east to hunt bison, often joining with other bands of their own nation or with the Flatheads for added security against the aggressive tribes that controlled the eastern prairies (Teit, 1930; Farr, 2003). Teit (1930) noted that "others crossed the Rockies by passes farther north, and skirting the eastern foothills to the Gallatin Range, went north on both sides of it to Livingston and beyond. Some of them went to the Musselshell River, and occasionally as far as Lewistown and Fort Benton; but they did not seem to cross the Missouri" (pp. 305). Teit (1930) noted that the Bannock tribes also began to cross the mountains upon acquisition of horses, though they hunted alone and did not venture as far north and east into hostile territory as the Shoshoni.

When the tribes ventured into the plains to hunt bison, they faced threats from the fierce tribes who controlled the plains (Farr, 2003). Many tribes associated going to buffalo with going to war. For many western tribes, hunger was not the sole motivation for traveling east; they also viewed the buffalo plains as "their" hunting grounds (Farr, 2003, pp. 8). "After 1811, when the Salish and Kootenais acquired guns from the traders of the North West Company, these Indians resolutely attempted to recover the hunting grounds east of the mountains from which they has been driven by various Blackfeet tribes" (Farr, 2003, pp. 8). Trexler (1921) noted that "Hell Gate, just east of Missoula, is said to have been so named by the early whites on seeing the Indian skeletons lying about as the result of battles over buffalo meat and ponies" (pp. 358).

The Flathead tribes also ventured over the Rocky Mountains on horseback in search of bison. According to Turney-High (1937) the Flathead traveled on two annual hunts—the first was a brief summer hunt to obtain hides in which they usually went no farther east than Helena, while the second was a large winter hunt to the Musselshell River and the valley of the Yellowstone, as well as along the Missouri River occasionally as far south as Fort Hall. In the fall of 1838, Trapper Joseph "Joe" Meeks accompanied a group of Flathead and Nez Perce hunters east to procure winter meat. Meeks recalled that "we started off slow; nobody war allowed to go ahead of camp. In this manner we caused the buffalo to move on before us, but not to be alarmed. We war eight or ten days traveling from the Beaver-head to Missouri Lake, and by the time we got thar, the whole plain around the lake war crowded with buffalo, and it war a splendid sight" (Victor, 1870, pp. 248). Meeks commented on how the Native Americans prepared and executed the hunt, "a thousand men, all trained hunters, on horseback, carrying their guns, and with their horses painted in the height of Indians' fashion . . .by this time the buffalo war all moving, and we had come to within a hundred yards of them. Kow-e-so-te (a chief) then gave us the word, and away we went, pell-mell. Heavens, what a charge! What a rushing and roaring—men shooting,

buffalo bellowing and trampling until the earth shook under them! It war the work of half an hour to slay two thousand or may be three thousand animals" (Victor, 1870, p. 248).

The Native Americans of Lemhi Valley traveled to eastern Montana annually to obtain bison meat, which was the basis of their winter food supply (Thomas, 1991). Frank McCloed reported that his grandmother, who was a member of the Colville tribe of Washington, would travel with the Flatheads to the North Fork of the Sun River to hunt bison. During an interview in 1941, McCloed stated that his grandmother told him, "we made our camp at the mouth of the north fork of Sun River. Early the morning after our arrival, our men left camp for a hunt on the prairies. Empty handed, they returned late that night. They informed us they had seen many large herds stampeding in a northerly direction, but that they were unable to get within killing distance of the animals. They said that buffaloes were so numerous that the pounding of their hoofs made a noise like the rumble of thunder" (Whealdon, 2001, pp. 39).

Fleshing of a hide. PHOTOGRAPH BY L. A. HUFFMAN; FROM THE COLLECTION OF GENE AND BEV Allen

Louise Roberts reported that her mother, a Colville Indian, "used to go with her people on buffalo hunts east of the mountains. They would go to those regions in Montana that are now called the Sun River Country, Judith Basin, and often to that part called the 'Crow Indian Reservation'" (Whealdon, 2001, pp. 31). Francois Skyema, of the Flathead tribe, recalled that as a youth he had gone on buffalo hunts in the "Judith Basin country" (Arthur, 1966, pp. 53).

Oral history also indicates that there was a small bison presence in the western portion of the state. While accompanying a Salish tribe on a winter hunt in 1842, French missionary Father Nicolas Point noted that the tribe had "set out, and before the sun sank they had taken one hundred and fifty buffalo" south of Missoula near Hells Gate (Donnelly, 1967, pp. 150–55; Franke, 2005). In his study of the Flathead tribe of Montana, Turney-High (1937) noted that the Flatheads recalled that in former times, "bison did come in small numbers as far west as the Bitter Root Valley. A small but adequate supply could usually be taken on the low benches around Missoula. These were merely stalked, often in disguise, or ambushed" (pp. 115). Dr. Suckley, who traveled west on the Stevens expedition from 1853–55, wrote in December 1853 that "buffalo were formerly in great numbers in this valley (the valley of the Bitter Root, or St. Mary's River, one of the sources of Clarke's Fork of the Columbia), as attested by the number of skulls seen and by the reports of the inhabitants. For a number of years past none has been seen west of the mountains, but, singular to relate, a buffalo bull was killed at the mouth of the Pend d'Oreille River on the day I passed it. The Indians were in great joy at this, supposing that the Buffalo were coming back to them" (Hayden, 1877, pp. 516).

In 1941, Will Cave reported that the belief that there had never been bison around Missoula was false based on the stories he had been told by older Indians who had lived in the region, and by the fact that he himself had found a bison skull near the site of the Milwaukee depot (Whealdon, 2001). Cave also reported that in 1870 three buffalo lived in the hills of the Bitterroot Valley, located to the east of Stevensville, in Ravalli County (Whealdon, 2001). Joseph McDonald, who grew up in the Flathead Valley, noted that "my brother Duncan and I were of the opinion that during past ages, buffalo had roamed this part of Montana. Some of the old tales of our Indians support this belief. Years ago, while I was helping Duncan clear stumps and roots off his Ravalli ranch, we uncovered an ancient appearing buffalo head and other bones. Similar evidences have been found in other parts of our region" (Whealdon, 2001, pp. 105).

Analysis of the historic ecological makeup of the habitat of the western portion of Montana does not support the existence of large bison herds like those found to the east of the Rocky Mountains. For example, on the eastern steppes there were 34 species of *Onthophagus,* a genus of dung beetle that historically survived on the manure of bison, and then subsisted on the manure of the cattle that replaced the bison. Historically dung beetles were absent from the western steppes. Upon the introduction of cattle, the native decomposers of the western habitat were unable to rapidly assimilate to the large quantity of manure (Hayes, 1927; Mack and Thompson, 1982). This indicates the probability that the decomposers of the western steppes did not evolve with a substantial presence of large herbivores such as bison (Mack and Thompson, 1982).

Van Vuren (1987) suggests that large populations of bison did not occur west of the Rocky Mountains due to the lower carrying capacity of the western steppes, and the slow recolonization rates following local extinctions. The production of herbaceous vegetation was much lower on the western steppes than in the Great Plains, which greatly reduced the carrying capacity (Van Vuren, 1987). The Great Plains, east of the Rocky Mountains, consisted of nearly continuous suitable grassland bison habitat, which allowed significant connectivity between populations. While suitable habitat did exist west of the Rocky Mountains, it was not contiguous but part of a mosaic of habitats, many of which were not suitable for bison. This caused bison populations to be separated from one another, often by geographic barriers (Van Vuren, 1987). McDonald (1981) observed some indications of inbreeding in small bison populations west of the Rocky Mountains, which supports the theory of population isolation. The lack of connectivity between populations could have caused slow recolonization of regions following a localized extinction event, such as mortality from deep snow or from human predation (Van Vuren, 1987). Turney-High (1937) noted that the Flatheads within the Bitterroot Valley felt that "with the coming of the great hunting animal (the horse) the bison rarely came so far west" and "that the superior mounted hunting methods taxed the local supply too heavily" (pp. 115). While passing through the Upper Gallatin Valley, west of Bozeman, Sacagawea informed Clark that "a fiew years ago Buffalow was very plenty in those plains & Vallies quite as high as the head of Jeffersons river, but fiew of them ever come into those vallys of late years owing to the Shoshones who are fearfull of passing in-to the plains West of the mountains and subsist on what game they can catch in the Mountains . . . (Thwaites, 1904b, pp. 261).

Another potential constraint on the ability of bison to thrive in the habitat west of the Rocky Mountains was the life cycle of the historically dominant plants in the region. The staggered life cycle of the grasses that made up the eastern habitat would have supported the bison's increased nutritional needs during the calving and milk production cycle (Mack and Thompson, 1982). The growth cycle of the dominant grasses west of the Rocky Mountains, which remained in a dormant state during much of the summer, would not support the nutritional needs of lactating female bison (Mack and Thompson, 1982). Though it is possible that the reproductive cycle of bison may shift based on environmental conditions, Van Vuren (1987) noted that breeding and presumably calving occurred up to six weeks earlier in the southern herds than in the northern herds. It is probable that small herds could have inhabited the western steppes, but they would have had to remain near sites of permanent water during the summer (Mack and Thompson, 1982).

Accounts of Early Explorers, Trappers, and Settlers

Early Montana explorers reported sightings of bison throughout much of the state. During their famed expedition to the Pacific coast, Lewis and Clark kept detailed records of their travels throughout Montana. In late April 1805, upon their arrival into what is present-day Roosevelt County, Lewis observed that "the whole face of the country was covered with herds of buffalo, elk, and antelope . . . the buffalo, elk, and antelope are so gentle that we pass near them while feeding . . ." (Brandt, 2002, pp. 132). Lewis and Clark observed bison herds as the party navigated along the Missouri River and explored sections of the Yellowstone, Teton, Marias, Two Medicine, Sun, Milk, Gallatin, Madison, and Jefferson Rivers. On May 3, near the Porcupine River, Lewis noted, "we saw a vast number of buffalo, elk . . ." (Brandt, 2002, pp. 142). Later along the Milk River, on May 8, Lewis commented, "we saw a great number of buffalo, elk . . ." (Brandt, 2002, pp. 151). In the White Cliffs Area in early June, the party shot two bison (Ambrose, 1996, pp. 228).

Statue of Lewis, Clark, and Sacagawea. PHOTO CREDIT: J. PEACO; COURTESY NPS

On their approach to the great falls of the Missouri in June, Lewis noted that "the hunters now arrive loaded with excellent buffalo meat and inform me that they had killed three very fat cows about three-quarters of a mile hence" (Brandt, 2002, pp. 168). Shortly after, on June 14, Lewis commented that in the valley between the Sun and Missouri Rivers, "there was a herd of at least a thousand buffalo" (Brandt, 2002, pp. 172). During their portage around the great falls, near Portage Creek, Lewis noted that they saw "a vast number of buffalo feeding in every direction around us in the plains, and others coming down in large herds to water at the

river" (Brandt, 2002, pp. 178). Following the portage the expedition spent time camped near the White Bear Islands, which is close to where the Sun River flows into the Missouri River. There, Lewis commented on the "great number of buffalo in the plains" (Brandt, 2002, pp. 185). The party killed their last bison on the journey west on July 16, about 25 miles above the great falls of the Missouri, well within the foothills of the Rockies, "killed a buffalow on which we Brackfast" (Thwaites, 1904a, pp. 235; Trexler, 1921).

The expedition noticed a lack of bison once they crossed into the Rocky Mountains, though they still observed signs of the animal. On August 2, 1805, near Three Forks, where the Gallatin, Madison, and Jefferson Rivers intersect, Lewis noted, "the bones of buffalo and their excrement of an old date are to be met with in every part of this valley but we have long since lost all hope of meeting with that animal in these mountains" (Brandt, 2002, pp. 208).

Upon their return journey, after the party had separated, far up in the mountains in what is now Beaverhead County, near Ross' Hole, Clark noted, "I observed the appearance of old buffalow roads and some heads on this part of the mountain. Proving that formerly Buff. roved there & also that this the best route, for the Buff. and the Indians always have the best route & here both were joined" (Thwaites, 1904b, pp. 249–50; Trexler, 1921). Clark commented that "we appear to be in the beginning of the buffalow Country. Saw several herds of buffalo Since I arived at this Camp," as the party neared the Livingston area (Thwaites, 1904b, pp. 279; Trexler, 1921). Clark first noted that a buffalo had been killed shortly after crossing Bozeman Pass on his route to the Yellowstone River (Brandt, 2002). As Clark traveled down the Yellowstone River, he observed near the mouth of the Big Horn, some distance west of Billings, "emence herds of Buffalow about our (camp) as it is now running time with those animals" (Thwaites, 1904b, pp. 294; Trexler, 1921). In July 1806 on the Yellowstone River near present-day Billings, Clark noted, "for me to mention or give an estimate of the different species of wild animals on this river particularly Buffalow, Elk, Antelopes and Wolves would be incredible. I shall therefore be silent on the subject further" (Whittlesey and Schullery, 2011, pp. 24).

Two miles west of Lincoln, along the Blackfoot River west of the Continental Divide, Lewis wrote, "saw some sight of buffaloe early this morning in the valley where we encamped last evening from which it appears that the buffaloe do sometimes penetrate these mountains a few miles. We saw no buffaloe this evening. But much old appearance of dung, tracks &c" (Moulton, 1993, pp. 96). Lewis began to observe more bison soon after crossing the Continental Divide by way of Lewis and Clark Pass near Missoula (Danz, 1997; Brandt, 2002). During their descent from the pass they encountered signs of bison all around them, but it was not until the following day when the party crossed the Dearborn River that a bison was killed and Lewis wrote, "we feasted on the buffalo" (Ambrose, 1996, pp. 381). Soon after, while traveling down the Sun River the party proceeded along, as Lewis noted, "a level beautiful and extensive high plain covered with immense herds of buffalo . . . I sincerely believe that there were not less than 10 thousand buffalo within a circle of two miles" (Ambrose, 1996, pp. 381).

Following the Lewis and Clark Expedition, fur trappers traversing the region's rivers and streams in search of fur-bearing animals recorded accounts of bison. Alexander Ross was a fur trapper who led the Snake Country Expedition in 1824. During the expedition Ross spend almost a month trying to cross the mountains near Ross' Hole, which is now the town of Sula in Ravalli County. During that time some of his party traveled to the Big Hole Basin on snowshoes to hunt bison. Upon their return five days later, on March 28, Ross noted that "the buffalo hunters came back today, buffalo in plenty; thirty killed, six of the men brought over 140 pounds of dried meat but becoming snow blind could not secure the meat left behind" (Elliott, 1913, pp. 376; Koch, 1940).

Peter Skene Ogden was a trapper for the Hudson's Bay Company. In February 1825, his party crossed from the east side of the Continental Divide over Lemhi Pass, which is now a political boundary separating Montana and Idaho, and "encamped in a fine spot" where hundreds of buffalo were seen. Ogden noted that "as far as the eye can reach the plains appear to be covered with them (Cline, 1974, pp. 54). On the following day Ogden commented on his party's bison hunting, "many [buffalo] were killed this day not less than 30 . . . the temptation of running buffalo is too great for them to resist" (Cline, 1974, pp. 54).

Osborne Russell was a fur trapper who kept journals during his travels throughout Montana, Idaho, and Wyoming. Russell encountered numerous bison throughout much of the region. In September 1835, as he traveled along the Ruby River, Russell noted that "the Valley opened wider as we descended and large numbers of Buffaloe were scattered over the plains and among the hills" (Haines, 1955, pp. 33). Shortly after, upon entering the Centennial Valley, near Lakeview, just north of the Montana-Wyoming border, Russell noted that "this Valley as a Mountaineer would say was full of Buffaloe when we entered it and large numbers of which were killed by our hunters" (Haines, 1955, pp. 34).

About a year later, in September 1836, near Livingston, Russell observed that "the country lying on this stream (25 Yard River, now called Shields River) is mostly comprised of high rolling ridges thickly clothed with grass and herbage and crowded with immense bands of Buffaloe intermingled with bands of antelope" (Haines, 1955, pp. 47). On the Yellowstone River, just east of where it meets the Stillwater River, in mid-October 1836, Russell recorded that "the small streams being frozen trapping was suspended and all collected to winter quarters where were Thousand of fat buffalo feeding in the plains and we had nothing to do but slay and eat" (Haines, 1955, pp. 50). Soon after, on Beauvais Creek in Big Horn County, Russell commented that "this section of country is very uneven and broken but abounds with Buffaloe Elk Deer and Bear" (Haines, 1955, pp. 50–51). Later Russell noted that they "made havoc among the Buffaloe" for entertainment while encamped near where the Yellowstone and the Shields River intersect (Haines, 1955, pp. 56). The following year, in April, south of the Yellowstone River on the Clarks Fork, Russell noted that "the whole country here was filled with Buffaloe driven this way by the Crow Village" (Haines, 1955, pp. 55).

During naturalist John James Audubon's journey along the Missouri River to Fort Union in 1843, he kept a journal filled with observations of bison and their behaviors. While at Fort Union some of Audubon's traveling companions went on a bison hunt in the

surrounding region. “I observed, as we approached the Buffaloes, that they stood grazing with their heads erect, lashing their sides with their tails; as soon as they discovered what we were at, with the quickness of thought they wheeled, and with the most surprising speed, for an animal apparently so clumsy and awkward, flew before us (Audubon, 1900, pp. 62). Following the harvest of a bison, the hunter noted, “I think that I never saw an eye so ferocious in expression as that of the wounded Buffalo; rolling wildly in its socket, inflamed as the eye was, it has the might frightful appearance that can be imaged; and in fact, the picture presented by the Buffalo as a whole is quite beyond my powers of description” (Audubon, 1900, pp. 62–63).

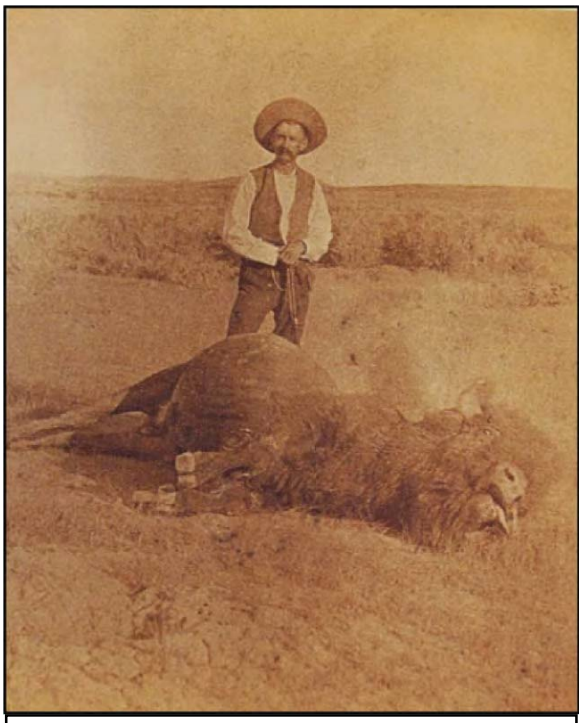
Bison skull. Photo Credit: J. Schmidt; Courtesy of NPS

As interest in the western territories grew, the U.S. government and eastern institutes funded more exploration of the West. Thaddeus Culbertson, a naturalist on an expedition funded by the Smithsonian Institution, noted in June 1850 that “a large band of buffalo cows with their calves were crossing just above the mouth of the Porcupine (now the Poplar River, near Poplar, in northeastern Montana) . . . The buffalo have been seen in great bands for several days past; last evening probably five hundred were in sigh(t) at one time on the river banks” (Montana Historical Society, 1976, pp. 21).

Isaac Stevens, who would later become Washington’s first territorial governor, journeyed west from 1853 to 1855 to survey a route for a railroad from the Mississippi River to the Pacific Ocean. As he moved through northeastern Montana, Stevens (1859) noted, in August 1853, that “the Three Buttes, or the Sweet Grass hills, some sixty miles to the northward of us, is a favorite resort of the Blackfeet, who say the Providence created these hills for the tribe to ascend and look out for buffalo” (pp. 81). In reference to the Little Rocky and Bears Paw Mountains, Stevens (1859) noted that “this region, from the Bear’s Paw to the north of Milk river between the Missouri and the Milk, is an exceedingly fine grazing country. It is well watered by the streams flowing into it, Milk River and the Missouri. The buffalo is found here in very large numbers, as well as on the Milk River itself” (pp. 213). Stevens sent men in his expedition to explore outlying regions. Stevens (1859) recorded in September 1853 that Lieutenant Mullan reported that within a level plateau between the Girdle and Judith Mountains he had “traversed by the numerous branches of Judith River and (found that region) covered with excellent and high grass. Innumerable herds of buffalo were feeding near the mountains . . .” (pp. 104). In December of the same year, Stevens (1859) reported that Lieutenant Mullan was exploring west of the Divide and commented on the large amount of bison skulls near Market Lake, which is across the Montana border in Idaho. On Mullan’s return, as he passed near the three forks of the Madison, Jefferson, and Gallatin Rivers, he noted that “the wooded mountains now gave place to low ranges of rolling prairie hills that lost themselves in the swelling prairies

that constitute the great plains of the Missouri and Yellowstone, upon which graze countless herds of buffalo" (pp. 148–49).

In 1859, Brevet Brigadier General W. F. Raynolds was dispatched to further explore the Yellowstone River. In July, in the valley of the second fork of the Little Missouri, near the drainage of the Powder River, Raynolds (1868) noted that "we are now in the buffalo region, and small herds are to be seen in all directions" (pp. 33). Though he commented on how barren the valley along the Powder River was, he also noted, "animal life has not entirely forsaken it, however . . . scattered bands of buffalo have been seen roaming among the barren hills in the distance, as if in search of food" (Raynolds, 1868, pp. 35). He felt that the bison used this barren landscape due to pressure from Native American hunters. Raynolds, (1868) postulated that "the presence of these animals in such large numbers in this barren region is explained by the fact that this valley is a species of neutral ground between the Sioux and the Crows and other bands nearer the mountains, or, more correctly speaking, the common war ground visited only by war parties, who never disturb the game, as they would thereby give notice to their enemies of their presence. For this reason the buffalo remain here undisturbed and indeed would seem to make the valley a place of refuge" (pp. 38). Later the same year, during his exploration of the Big Horn Valley, within sight of the mouth of the Little Big Horn River Raynolds (1868) noted that "about 11 o'clock a herd of buffalo was discovered and Bridger's skill with the rifle soon added two cows to our larder" (pp. 54).



Two year old taken, Tongue River, M.T., Photograph by L.A Huffman; From the Collection of Gene and Bev Allen

Another group that relied on the bison to support their communities and economy were the Métis, a cultural group made up of the descendents of Native American and European traders. The Métis hunted bison along the Milk River. In 1868, Turtle Mountain Métis Baptiste Gardipee moved his family to a hunting camp near Dodson, in north-central Montana. There his son Eli Gardipee noted that "the camp was in the midst of the buffalo herds and they hunted and worked hard during the day . . ." (Foster, 2006). The bison herds soon declined along the Milk River, and many of the Métis began to follow the bison to the Judith Basin in central Montana (Foster, 2006). A group of Métis settled in present-day Lewistown. Upon arriving in the area, one of the members of the group, Ben Kline, noted that the men were able to locate the bison herds and "killed lots of them" (Foster, 2006). Later Ben Kline and a hunting party traveled south of the Snowy Mountains to the "Gap in the West," most likely present-day Judith Gap, where Kline noted that they killed so many bison that it took "a whole week to dress and dry the meat" (Foster, 2006).

The discovery of gold brought an influx of settlers to Montana. Many of these groups traveled in wagon trains along the famous Bozeman Trail. The pioneers often recorded their sightings of bison in journals. While camped along the Little Big Horn River in 1866, William K. Thomas and Perry A. Burgess both commented on wanton hunting practices that occurred on the trail. Thomas wrote, "we saw hundreds of Buffalo to day and I believe some ten to fifteen killed. It is a shame to be so fatal and to kill off the poor Indians heard (herd) so we are camped in the little horn (Little Big Horn River) to night" (Doyle, 2000, pp. 543). Burgess observed that "Buffalo very numerous. Some of the men killed them and left them lay without even cutting off a piece of flesh. I think that they should not kill any more game than they want to eat" (Doyle, 2000, pp. 566).

Soon after crossing the Little Big Horn, the Bozeman Trail crossed through a countryside that was abundant with bison in the 1860s. In August 1866, Davis Willson commented while traveling by Pass Creek and Lodge Grass Creek that "wild game becoming more & more abundant. The hills ahead are perfectly cover with buffalo . . . (Upon startling a herd) it was a grand sight to see them running over the prairie, snorting at every step & leaping over the bluffs and ravines as they passed" (Doyle, 2000, pp. 607). Shortly after crossing the Clarks Fork of the Yellowstone, Willson remarked, "main chain of the Rocky mountains in the distance. Buffalo ahead" (Doyle, 2000, pp. 612).

Many wagon trains crossed the Big Horn River at the Spotted Rabbit Crossing, 8 miles north of the opening of the Big Horn Canyon, about 30 miles from Hardin. There John T. Smith noted in 1864 that "we reached the Big Horn on the 4th of July, which the boys celebrated by killing over a hundred buffalo" (Doyle, 2000, pp. 204). About 28 miles west of the Big Horn River ferry, near what is known as Devil's Gap, during August 1868, Abraham Polk Flory recorded that "started our journey again traveled 10 miles to small creek (Beauvais Creek, near Devil's Gap) & campt . . . Buffalo by the thousands has a big stampede in night" (Doyle, 2000, pp. 327). The journal of Samuel Finley Blythe from 1866 noted that, in August, near Joliet, "buffalo, deer, and antelope are quite numerous. We saw two large herds of buffalo to-day" (Doyle, 2000, pp. 642).

The above reports, observations, oral history, and archeological findings are but a small representation of the rich and diverse history of human and bison interactions throughout Montana. While most early settlers and explorers of the region noted a wide variety of species in their journals and memoirs, it was the herds of bison that seemed to have made a lasting impression and garnered the most attention. Punke (2007) notes that "for emigrants traveling west, sighting the first buffalo marked a signature moment in their voyage—true arrival on the frontier" (pp. 48).

Extermination of the Bison

Bison hides stacked for shipment. Photo Credit: J. Peaco; Courtesy of NPS

While early European travelers to the region disapproved of the traditional Native American practice of slaughtering small herds in their entirety, nothing would compare to the widespread decimation of plains bison that was soon to follow at the hands of both European and Native Americans. In 1832, George Catlin recognized that the bison population of the plains was headed toward destruction, stating that "so rapidly wasting from the world, that its species (bison) must soon be extinguished" (Isenberg, 2000). He urged the U.S. government to set aside land as a reserve in order to preserve the bison, but his pleas fell on deaf ears (Isenberg, 2000). In 1830, members of the American Fur Company located at Fort Union, near the junction of the Yellowstone and Missouri Rivers, were able to initiate trading with the Blackfeet, thereby bringing the region that is now Montana into the heart of the Missouri River fur trade (Foster, 2006). As herds were slaughtered in the east, hunters traveled west to harvest the vast herds that occupied the northern range. In 1858, Fort Benton, located in Chouteau County, shipped an estimated 20,000 bison robes to the eastern markets (Foster, 2006). In 1875, hunters in southeastern Montana, northeastern Wyoming, and western North Dakota were reported to have shipped between 50,000 and 100,000 hides (Gard, 1968). Hide hunting was seen as an opportunity to quickly prosper, and as the demand grew it attracted less-skilled hunters, thus increasing the amount of bison that were wasted (Krech III, 1999).

The bison population was at risk from a number of compounding factors including overhunting by both Europeans and Native Americans for hides, robes, tongues, and meat; regional drought; introduced bovine disease; and competition for range resources and water from domestic livestock and wild horses (Hornaday, 1889; Geist, 1996; Krech III, 1999; Isenberg, 2000). Settlers had begun raising cattle and domestic sheep in Montana in the 1850s and with their introduction came exotic livestock diseases, which infected the native wildlife (Picton and Lonner, 2008).

By the mid-1850s buffalo robes were increasing in popularity in the eastern markets, creating a high demand. Bison robes were created using the tanned hides of bison cows, which resulted in increased cow mortality and reduced calf production (Haynes, 1998). The rapid growth of industry in North America led to a high demand for leather drive belts for industrial machinery. Tanners began to soak hides in a strong lime solution to create elastic leather for belts. This created a demand for bison hides year-round, with

summer skins preferred for tanning and winter skins for robes (Branch, 1929; Krech III, 1999; Franke, 2005).

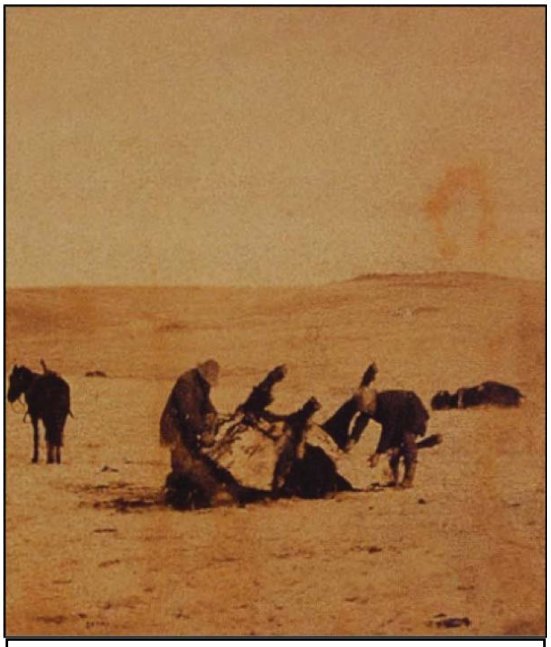
Bison and the Native Americans who depended on them were viewed as an impediment to the settlement of the West. President Ulysses Grant's Secretary of the Interior, Columbus Delano, stated in 1873 that "the civilization of the Indian is impossible while the buffalo remains upon the plains" (Geist, 1996). The U.S. government supported the slaughter of the bison as a means to subjugate the Native American tribes through starvation and the destruction of the basis of their barter system (McHugh, 1972; Geist, 1996; Danz, 1997; Isenberg, 2000; Gates et al., 2010). Mary Foreman Kelley, a resident of Deer Lodge who traveled the Bozeman Trail in 1864, reminisced in 1920 that "the buffalo supplied all his (Native Americans) wants—General Sherman well knew if he has the buffalo exterminated it would stop all Indian wars" (Doyle, 2000, pp. 336).

European-Americans were not the only ones to utilize the destruction of the bison as a means to reduce the strength of an enemy. While attempting to defeat the Sioux in 1867, General George Crook worried that the wanton slaughter of bison by his allies the Crow and the Shoshone would alert the Sioux to their presence. The Crow and Shoshone, however, stated that it was "better kill buffalo than have him feed the Sioux" (Finerty, 1994, pp. 78; Franke, 2005).

Within Montana the confinement of Native Americans to their respective reservations was not as strictly enforced as it was elsewhere in the United States, due to the recognition that Native Americans needed to continue to find buffalo in order to prevent starvation (Farr, 2004). The U.S. Army was unable to keep the tribes from leaving their reservations to pursue bison; therefore to reduce the conflict between the tribes and settlers, the army began to escort tribes to their traditional hunting grounds (Farr, 2004). General Sherman recognized that the treaty Native Americans needed to be able to hunt bison to support themselves, stating, "they must go for buffalo or starve" (Farr, 2004, pp. 42). "The army, by participating in the development of permits and escorts, not only tolerated, but stood by the treaty Indians, actually enabling and promoting off-reservation buffalo hunting to the consternation of the territorial newspapermen, settlers, miners, and stockmen" (Farr, 2004, pp. 42). Once the bison were exterminated, "destitution settled over the reservations and the northern plains like a fog. Indians could not find their way" (Farr, 2004, pp. 43). Following the extermination of bison in Montana between 1883 and 1884, 600 Blackfeet perished due to starvation (McHugh, 1972). "White Calf, one of the leaders of the southern Piegans, remembered the Blackfeet wandering around not knowing where they were going or where they were" (Farr, 2004, pp. 43).

In order to promulgate the settlement of the West, the U.S. government promoted hide hunting by providing support and protection for the railroads (Geist, 1996). The spread of the railroad into the western regions allowed the bison resource to be more economically and efficiently extracted to the eastern U.S. and European markets, where the demand for hides and robes was insatiable (Geist, 1996). In 1881, the Northern Pacific Railroad expanded across the plains of Montana, first to Glendive, and then to Miles City. With the railroad came an increase in the slaughter of Montana's bison herds (Hornaday,

1889; McHugh, 1972). Reports indicate that in 1881 an estimated 200,000 hides were shipped out of the large triangle formed by the Missouri, the Musselshell, and the Yellowstone Rivers (Gard, 1968). By 1882, there were over 5,000 bison hunters and skinners on the northern range. Taking note of their operations, one army lieutenant described "a cordon of camps, from the Upper Missouri, where it bends to the west, stretching towards the setting sun as far as the dividing line of Idaho, completely blocking the great ranges of the Milk River, the Musselshell, Yellowstone, and the Marias, and rendering it impossible for scarcely a single bison to escape . . ." (McHugh, 1972, pp. 277–78).



Skinning of a bison. PHOTOGRAPH BY L. A. HUFFMAN; FROM THE COLLECTION OF GENE AND BEV ALLEN

The U.S. government was reported to have also supported the bison hunting by providing free ammunition to bison hunters (Dary, 1989). The support was unofficial, but Dary (1989) notes that Mayer, a buffalo hunter, recalled that "the army officers in charge of plains operations encouraged the slaughter of buffalo in every possible way . . . It consisted of ammunition, free ammunition, all that you could use, all you wanted, more than you needed" (pp. 128).

Huge profit could be made through the harvesting of bison, and hunters and skinners flocked to the region to gain their share of the wealth. The bison hunters were incredibly efficient at their task. Punke (2007) notes that barring a misplaced shot, the number of buffalo that a skilled runner (hunter) could harvest in a stand was limited primarily by the capabilities of his skinners" (pp. 66). "We never killed all the buff we could get," remembered Frank Mayer, "but only as many as our skinners could handle." In his brutally blunt fashion, Mayer explained the governing economics: "killing more than we could use would waste buff, which wasn't important; it also would waste ammunition, which was" (Punke, 2007, pp. 66).

In Montana, Vic Smith is reported to have shot 107 bison in a single stand and boasted that he harvested 5,000 hides in one season (Gard, 1968). The tactic that experienced hide hunters like Smith utilized was called "tranquilizing" or "mesmerizing" a herd. It involved selectively firing to injure the lead cows in order to keep the herd in place. In a description of this practice, Punke (2007) notes that Smith's "first shot had found its precise target in front of the cows hip. When it hit in that spot, Smith knew the animal could not run off but instead would just stand there, all humped up with pain. As Smith intended, other members of the herd . . . were already starting to mill about, confused, some sniffing at the blood that seeped from the cow" (pp. xvi).

The hunters, both European and Native American, were mainly interested in procuring the hides of the bison and often left everything else to rot on the prairie. Granville Stuart, famed Montana rancher and miner, observed that "from the Porcupine clear to Miles City the bottoms are liberally sprinkled with the carcasses of dead buffalo. In many places they lie thick on the ground, fat and the meat not yet spoiled, all murdered for their hides which are piled like cord wood all along the way. 'Tis an awful sight. Such a waste of the finest meat in the world! Probably ten thousand buffalo have been killed in this vicinity this winter" (Peterson, 2003, pp. 247).

Commercial hunters were not the only ones who traveled west to engage in bison hunting. Wealthy individuals from the East and Europe went on lavish hunting forays into Montana. One infamous hunting expedition was that of Sir St. George Gore of Ireland. While the true extent of the game that was taken during Gore's 1854–57 expedition is unknown, it has been reported that "the British 'sportsman' slaughtered more than 4,000 bison, 1,500 elk, 2,000 deer, 1,500 antelope, 500 bear, and hundreds of assorted smaller animals and birds. Gore massacred half of those creatures in Montana's Yellowstone Valley during a ten-month period (1855–56)—most frequently leaving their carcasses to rot" (Walter, 2000, pp. 7). Led by famed guide Jim Bridger, Gore hunted along the Powder River to the Yellowstone and Tongue Rivers. It was a few miles up the Tongue River, on Pumpkin Creek, where "Fort Gore" was constructed, and the party remained and hunted almost daily from July 1855 until May 1856 (Walter, 2000). The Crow kept note of Gore's hunting and filed complaints about the devastation of their food supply, estimating "that his hunting tally included 105 bears, more than 2,000 bison, and 1,600 elk and deer" (Walter, 2000, pp. 15).

During his travels along the Missouri and Yellowstone Rivers in the early 1840s, John J. Audubon foreshadowed that the fate of the bison appeared grim. He recorded in his journal, "one can hardly conceive how it happens, so many buffalo are yet to be found. Daily we see so many that we hardly notice them more than the cattle in our pastures about our homes. But this cannot last; even now there is a perceptible difference in the size of the herds, and before many years the Buffalo, like the Great Auk, will have disappeared" (Punke, 2007, pp. 47–48). Shortly after, in 1851, famed artist George Catlin noted, "it is truly a melancholy contemplation for the traveler in this county, to anticipate the period which is not far distant, when the last of these noble animals, at the hands of white and redmen, will fall victim to their cruel and improvident rapacity; leaving these beautiful green fields, a vast and idle waste, unstocked and unpeopled for ages to come, until the bones of the one and the traditions of the other will have vanished and left scarce an intelligible trace behind" (Brink, 2008, pp. 237).

By the 1880s, the bison herds in Montana were rapidly becoming decimated. Laton Alton Huffman, famed photographer and illustrator of eastern Montana, captured the image of a small herd of bison grazing in the 1880s. In reference to this image, entitled *Buffalo Grazing In The Big Open 1880s,* Huffman remarked, "in the eighties it was still possible to see herds of six hundred to one thousand buffalo in many of the smaller valleys or high plateaus between the Yellowstone and Missouri Rivers" (Peterson, 2003, pp. 246).

In 1882, a herd that is estimated to have contained between 50,000 and 80,000 bison was observed crossing the Yellowstone River near Miles City (McHugh, 1972). In reference to what may have been the same herd, Huffman recalled, "I saw many thousands (of bison) while hunting for robes, leather, hides and smoked hump on the Big Dry, Smoky Butte, and Timber creek (these streams are between the Missouri and the Yellowstone in eastern Montana), but it was, I think late in April, 1882, that I saw the Rosebud valley (south of Forsythe, in eastern Montana) more or less black with them from near where Lee now is to the present Busby, a distance of 35 or 40 miles. Much has been said about this herd . . . and (it has been) variously estimated at 30 to 50 thousand, my own belief is (that it) was much larger than the last figure" (Trexler, 1921, letter to author from Mr. L. A. Huffman of Miles City, Montana, dated July 12, 1917). The bison hunters slaughtered almost the entirety of the herd during that season (McHugh, 1972). Anticipating an equally profitable hunt the following season, the bison hunters of Miles City were unable to locate a single herd, and were forced to end their efforts (McHugh, 1972). By 1884 less then 100 hides where shipped from the Miles City-Glendive area, which had shipped 40,000 the prior season (Kidder, 1965).

Buffalo Grazing in the Big Open 1880s.
PHOTOGRAPH BY L.A HUFFMAN; FROM THE COLLECTION OF GENE AND BEV ALLEN

The residents of Montana quickly noted the absence of bison. Harvey Spencer, a rancher in White Sulpher Springs, in south-central Montana recalled, "I remember seeing a great number of buffalo along the Musselshell in 1881 and 1882, by 1884 only a few were left. The Montana buffalo seem to have disappeared in a year or two" (Trexler, 1921). Many recall the last bison they encountered. Occasionally some of the remaining scattered bison were secured in "round-ups." C. B. Perkins of Valier, in northern Montana, "recalled that the last one taken in this manner in his part of Montana was found in Teton county, about a hundred miles north of Great Falls in 1886" (Trexler, 1921, letter to the author from C. B. Perkins, dated 1917). Vaughn, an early settler, noted that "now the buffaloes are extinct. Where they used to roam, flocks of sheep and herds of cattle now graze" (Vaughn, 1900, pp. 198). Huffman also recalled an account of the last wild buffalo he saw: "I saw two bulls in July 1887, near a ford not far from (the present town of) Birney (Tongue River) . . . I saw them fall into the breaks east and realized that I probably never would again see another wild (buffalo). I never have" (Trexler, 1921, letter to author from Mr. L. A. Huffman of Miles City, Montana, dated July 12, 1917).

Soon all that remained of the great bison herds of Montana were their bones, which lay scattered across the range bleaching in the sun. "Over the whole of this vast area their bleaching bones lie scattered . . . from the Upper Marias and Milk Rivers, near the British

boundary, to the Platte, and from the James River, in central Dakota, to an elevation of 8,000 feet in the Rocky Mountains" (Hornaday, 1889, pp. 508). Where bison hunters once flourished, now came bone collectors, who gathered bison bones for use in industry, as fertilizer, in animal feed, and as a carbon-filtering agent for sugar refining (Krech III, 1999).

Shipments of bone began in the Lower Yellowstone Valley in 1883 and spread throughout the entire region (Barnett, 1975). One group located near Miles City is reported to have shipped 200 tons of bones in 1885, and by the end of 1886 thousands of tons of bones had been shipped from east and central Montana (Barnett, 1975). The Native American tribes also participated in the collection of bone, with 150 tons gathered on the Fort Peck Reservation (Barnett, 1975). The bone collectors efficiently erased almost all evidence of the fact that bison once existed throughout much of Montana. Early cattleman H. J. Rutter recalled that "this wholesale collection of bones accounts for the fact that there are so few traces of buffalo remains around Hinsdale (in Valley County), a district that was once one of the greatest hunting areas in Montana . . ." (Montana Historical Society, 1976, pp. 125).

Bison bone collecting. PHOTO CREDIT: BUELL; COURTESY NPS

Early Recovery and Protection of Plains Bison

Hornaday estimated that in 1889, all that remained of the once immense herds in North America were 1,091 plains and wood bison (Danz, 1997). The citizens of Montana recognized that all wild game, including bison, were rapidly disappearing from the landscape. In 1872, the Montana territorial legislature passed an act that established a closed season for "mountain buffalo, moose, elk, black-tailed deer, white-tailed deer, mountain sheep, white Rocky Mountain goats, antelope or hare, between the 1st of February to the 15th of August" (Brownell, 1987). Though the intention of the 1872 Act was clear, its passage did little to guarantee enforcement. "In Idaho, Wyoming, and Montana, where protection laws were on the books, the animal was protected only on paper and not on the plains or rolling prairies or in the mountains" (Dary, 1989, pp. 125). One Montanan recalled that he did "not consider they (the laws) are worth the paper they are printed on for the simple reason that apparently no one is appointed to see that they are carried out" (Brownell, 1989). The lack of governmental enforcement prompted citizen groups such as rod and gun clubs to focus on supporting the protection of wildlife. The Helena Rod and Gun Club stated its primary purpose as "protecting and enforcing game laws," and the shooting club in Billings was formed for "social and sporting purposes, but particularly with a view of enforcing the game laws and protecting the game" (Brownell, 1989).

Congress passed a bill in 1874 "to prevent the useless slaughter of buffaloes within the Territories of the United States. The first section made it unlawful for any person not an Indian to kill a female buffalo and the second prohibited the killing of more males than could be used for food or marketed" (Allen, 1954, pp. 14). However, when the bill was sent to President Ulysses S. Grant, it was never signed (Allen, 1954; Dary, 1989).

In what is believed to have been an attempt to prevent federal intervention, the 1872 Act passed by the Montana territorial legislature was revised in 1876 to include a provision that prohibited the killing of animals "for the purpose of procuring the hide only," and "not making use of the carcass . . . for food, for himself or for the purpose of selling the same to others for food" (Brownell, 1987). Had enforcement of this act occurred, it would have had a large impact on robe hunters, who usually harvested only the bison hides, leaving the carcasses to rot.

A bill sponsored by a Helena-area rancher, Edward G. Brooke, was passed in 1879, protecting bison for a ten-year period in Lewis and Clark, Jefferson, Deer Lodge, and Madison Counties. This bill was not concerned with the slaughter of bison that was occurring on the Montana plains, but only with the protection of a small herd located in "Whitetail Park" in Jefferson County (Brownell, 1987). Ten years later, in 1889, the territorial legislature passed a law making it illegal to shoot any bison for ten years within the territory (Brownell, 1987).

The key to the protection of bison was the ability of the state to enforce game laws. In 1895 the legislature made it mandatory for county commissioners to appoint a game warden when presented with a petition signed by 100 residents of the county, but only four

of the 24 counties (Silver Bow, Gallatin, Lewis and Clark, and Fergus) had appointed a warden by 1900. More uniform protection came with the passing of an act in 1901 that provided for the appointment of a state game and fish warden, deputy game and fish wardens, and special deputy game and fish wardens, which were responsible for investigating and enforcing any violations of game and fish laws (Brownell, 1989).

A few hundred bison had found refuge in Yellowstone National Park (YNP), despite the fact the park lay outside of the plains bison's preferred habitat (Isenberg, 2000). Although set aside as the country's first national park in 1872, Congress had not appropriated any funding to run the park, and poachers viewed Yellowstone as their own personal hunting grounds (Dary, 1989). In 1886, Captain Moses Harris, First U.S. Cavalry, took over as superintendent of Yellowstone National Park and brought soldiers in to police the park (Dary, 1989). The only action that Harris could take against poachers was to escort them out of the park; he was unable to enforce stricter legal punishments (Dary, 1989). With such lenient repercussion, poachers continued to utilize the park and used Livingston as their headquarters. Several taxidermists set up shops along Park Street, and poachers would sell bison heads and hides to them, which the taxidermists would then ship east (Dary, 1989). The inability to prevent poachers from harvesting bison and other wildlife within the park led to a reduction in the YNP herd to fewer than 25 free-ranging bison by 1902 (Meagher, 1973; Geist, 1996). This small herd, coupled with a small herd that had found refuge in Texas, were all that remained of free-ranging bison in the United States (Geist, 1996). The National Park Protective Act, which took effect in 1894, imposed a jail sentence and fine for poaching within the national parks, and became the first law to provide specific protection for bison within the National Park System (Boyd and Gates, 2006). As of 1895, Seton estimated that only 800 bison remained worldwide (Danz, 1997).

Officers of the Sixth U.S Cavalry with bison confiscated from poachers in Yellowstone National Park circa 1894. COURTESY NPS

Outside of the two small free-ranging herds, there were a small number of privately owned bison. Six men have been credited with establishing the private herds, mainly with captured orphan bison calves, from which the majority of present-day bison have since descended (Geist, 1996). One of these men was Samuel Walking Coyote, a member of the Pend d'Oreille tribe. In 1873, Walking Coyote captured between four and seven bison calves while on a hunting trip on the Milk River, and held them in a corral at a trading post on the Marias River (Geist, 1996; Wood, 2000; Lott, 2002; Picton and Lonner, 2008). Most reports claim that Walking Coyote captured the calves near the town of Buffalo, but this town is not located near the Milk River. It is believed that the calves were actually captured

near “Buffalo Lake,” which is located in Glacier County near the Canadian border (Whealdon, 2001). Walking Coyote took the calves to the St. Ignatius Mission on the Flathead Reservation (Wood, 2000). There his herd grew to 13 bison by 1884. He sold 10 of them to Michel Pablo and Charles Allard, who formed the Pablo-Allard herd on the Flathead Reservation (Geist, 1996; Wood, 2000; Lott 2002). There is also speculation that Pablo and Allard had acquired additional bison from Jock Miller, who had a ranch on the Teton River near Choteau in Teton County. Miller is rumored to have captured three buffalo calves in the Teton Basin, near Freezeout Lake (Whealdon, 2001).

Horse being chased during the famed roundup of the Pablo-Allard herd. PHOTOGRAPH BY N. A. FORSYTH; COURTESY MONTANA HISTORICAL SOCIETY

The Pablo-Allard herd played a key role in the preservation of the bison, and bison from the herd were used to restock and supplement many of the public conservation herds, including the small herd in Yellowstone National Park. It was “thanks to a wildly improbable turn of chance, combined with the extraordinary vision displayed by a pair of tough, practical Montana cowmen, the buffalo did survive . . .” (Kidder, 1965, pp. 52). Tony Barnaby, Pablo’s son-in-law, stated that “Many people today, while appreciating the fact that Indian Samuel, Michael Pablo, Charles Allard, Sr., and Andrew Stinger, were the ones who saved the buffalo from extermination, question their motives. Some say that the plan was to build up a vast herd, that later could be sold at a great profit. Perhaps that is a very natural view; but we, who were associates of these four men, know it is erroneous. The acquisition of money meant little to men of their type, but the preservation of the bison was their duty, privilege, and pleasure” (Whealdon, 2001, pp. 83).

The Pablo-Allard herd became the largest herd in the United States, numbering 300 head. It is reported that although several men were employed as “buffalo herders” to keep the bison within their home range, these riders apparently had little to do, as there is no record that the bison ever attempted to leave the valley (Whealdon, 2001). The herd was split in 1896 following Allard’s death, and half of the herd was sold to Charles Conrad in Kalispell (Wood, 2000). Following his death Conrad’s widow, Lettie, sold many of the bison to zoos, conservation groups, government organizations, and private herds throughout the country. In 1902, around 20 of the Pablo-Allard bison were sent to restock Yellowstone National Park (Kidder, 1965; Geist, 1996; Wood, 2000). In 1908, 34 of the Pablo-Allard bison were selected by the American Bison Society to form the nucleus of the National

Bison Range (NBR) herd near Moiese, in northwestern Montana (Kidder, 1965; Wood, 2000).

The National Bison Range was established by an act of Congress in 1909. Montana Code 87-1-711 gives consent by Montana for the acquisition by the United States of land for the "establishment of an exhibition park for bison and other big game animals, reserving, however, to the state of Montana full and complete jurisdiction and authority over all such areas not incompatible with the administration, maintenance, protection, and control thereof by the United States under the terms of applicable federal regulations" (87-1-711). Montana Code 87-1-712 allows for the development of the National Bison Range, stating that "upon the acquisition or establishment of any such park in Lake County and Sanders County, the Fish and Wildlife Service, United States Department of the Interior, agrees to develop, improve, and maintain the park for the display of such native big game as are available on the national bison range" (87-1-712).

Pablo surveys his herd. PHOTOGRAPH BY N. A. FORSYTH; COURTESY MONTANA HISTORICAL SOCIETY

The U.S. government initiated plans to open the Flathead Indian Reservation, which was home to Pablo's herd, to homesteaders in 1906 (Kidder, 1965). Pablo sought but was denied a large grant of grazing land for his bison. He then attempted to sell his herd to the U.S. government, with the support of President Roosevelt. Congress, however, did not mandate the funds for this project (Kidder, 1965). Pablo eventually sold his herd to the Canadian government, which used the bison to establish their public herds (Wood, 2000; Boyd and Gates, 2006). During his observation of the wild roundup of Montana bison for shipment to Canada, Montana cowboy-artist Charlie Russell wrote, "if it has not been for this animal the west would have been the land of starvation for over a hundred years he fed and made beds for our frounteer (frontier) an it shure (sure) looks like we could feed an protect a fiew (few) hundred of them but seemes (seems) there aint maney (many) thinks lik (like) us . . ." (Kidder, 1965, pp. 63).

Other private herds were also started from bison captured in Montana. James McKay and Charles Alloway captured a few bison calves in 1873 and raised them in Deer Lodge. These bison were eventually sent to Canada (Wood, 2000). Fredrick Dupree (originally Dupris) captured nine bison calves near the Yellowstone River in Montana in 1882 and transported them to South Dakota (Geist, 1996; Wood, 2000).

The concern over the vast decline of bison led to the formation of the American Bison Society in 1905, which was a preservation organization (Isenberg, 1997). The American Bison Society worked with the U.S. government to establish several public herds including the National Bison Range in Montana (Isenberg, 2000; Boyd and Gates, 2006). The National Bison Range was established in 1908 on land that was originally part of the Flathead Reservation, and was the area in which the Pablo-Allard herd had flourished (Berger and Cunningham, 1994a; Isenberg, 1997). The area was partly chosen due to its accessibility for tourists, who could take the train to Ravalli (Isenberg, 1997). The bison that had been purchased for the range were fenced in 1909 (Isenberg, 1997; Lott, 2002). Pablo was unable to round up 75 of his bison for shipment to Canada, and these bison ranged freely on the reserve (Isenberg, 1997). The State of Montana later gained control of the free-ranging bison, declared them wild, and stopped Pablo from having a hunt, but was unable to prevent poachers from slowly eliminating them (Isenberg, 1997).

The plains bison slowly increased in numbers between 1900 and 1970, with most of the increase in public herds (Gates et al., 2010). Public herds were eventually established in Alaska, Arizona, California, Colorado, Illinois, Iowa, Kansas, Kentucky, Minnesota, Missouri, Nebraska, North Dakota, Oklahoma, South Dakota, Texas, Utah, Wisconsin, and Wyoming (Boyd, 2003; Gates et al., 2010).

Current Status, Distribution, and Abundance

General Status, Distribution, and Abundance

North American bison have been listed as "Near Threatened" in the International Union for Conservation of Nature's Red List of Threatened Species. The Near Threatened listing is given when a species does not currently qualify for Critically Endangered, Endangered, or Vulnerable, but is close to qualifying for, or is likely to qualify for, a threatened category in the near future (Gates et al., 2010). As of 2008, Gates et al. (2010) estimates that there are currently 20,504 plains bison in 62 conservation herds within the United States and Canada. Of the 62 conservation herds, 87 percent are believed to be within the original range of plains bison (Gates et al., 2010). There are two types of conservation herds in North America. The first are captive herds, which reside within a perimeter fence and are often actively managed (Boyd, 2003). The second are free-ranging herds, which are herds that are not contained within a fence, but may have restricted movement due to topographic or sociopolitical barriers (Boyd, 2003). As of 2003, 13 herds were considered free-ranging and accounted for 8,337 bison (Boyd, 2003).

An important factor in the evaluation of the current status of bison is an evaluation of the minimum viable population (MVP). The MVP is the minimum number of individual animals in a population that is required to maintain a viable population (Soulè, 1989). Gross and Wang (2005) used a simulation model to demonstrate that under ideal management conditions a bison population of 400 was likely to retain 90 percent of its current genetic diversity with a 90 percent probability for 200 years. In order to ensure that management does not impact the viability of a herd, it is recommended that its size should be closer to 1,000 bison (Freese et al., 2007; Dratch and Gogan, 2010; Gates et al., 2010). Currently 74 percent of plains bison conservation herds have populations of less than 400 individuals, with 32 percent having fewer than 50 (Boyd, 2003; Gates et al., 2010). There are five plains bison conservation herds that have over 1,000 animals: Yellowstone National Park; Custer State Park in South Dakota; The Nature Conservancy's Medano-Zapata Ranch in Colorado and the Tallgrass Prairie Preserve in Oklahoma; and British Columbia's Pink Mountain (Boyd, 2003; Gates et al., 2010).

Mexico

Historically bison were found within five states in northern Mexico, but until recently wild bison were only found in the borderlands between the Janos region of Chihuahua and southwestern New Mexico (List et al., 2007; Gates et al., 2010). Bison were added to Mexico's red list of endangered species in 1994, and the most recent version, published in 2002, lists the Janos-Hildago herd as "endangered wildlife," whose management falls to the National Commission of Protected Natural Areas (Gates et al., 2010). The Janos-Hildago herd is legally protected within Mexico, but when it crosses into New Mexico it is considered livestock (Gates et al., 2010). "The Institute of Ecology of the National University of Mexico is advocating legal protection of the herd in both countries,

including protection under international treaties on migratory wildlife species between Mexico and the U.S." (Gates et al., 2010, pp. 64).

The large grasslands of the Janos-Casas Grande in northwestern Mexico has been identified as the best location for bison conservation within Mexico, and a series of stakeholder and science workshops have been held in the boundary region to identify conservation needs and potential strategies for advancing bison recovery (Gates et al., 2010). One of these strategies is to reintroduce a plains bison conservation herd to the region. The U.S.'s National Park Service (NPS) donated 23 bison from Wind Cave National Park to the Working Group for Recovery of Bison in Mexico, which is led by the National Commission of Protected Natural Areas (Gates et al., 2010). In November 2009, the 23 bison were transferred from Wind Cave National Park to The Nature Conservancy's Rancho El Uno Ecological Reserve, which is located in the Janos Biosphere Reserve in Chihuahua State. "These bison are the foundation stock for a breeding herd that will be used to repopulate other areas, with the ultimate goal of restoring the ecological role of bison in the grasslands of northern Mexico. The bison will provide opportunities for ecological research and will serve as a focal species for educational outreach" (Gates et al., 2010, pp. 83). In the Columbia Valley, in the State of Coahuila, there is a privately owned herd that ranges over a large region with minimal management. Gates et al. (2010) suggest this region could be an important area for bison recovery within Mexico.

Canada

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) ranks plains bison as threatened, meaning "a wildlife species that is likely to become endangered if nothing is done to reverse the factors leading to its extirpation or extinction." It also gives them a D1 +2 ranking, which indicates that the population is estimated to have less than 1,000 mature individuals and a very restricted region of occupancy (less than 20 square kilometers) or number of locations (less than five), "such that it is prone to the effects of human activities or stochastic events within a very short time period in an uncertain future, and is thus capable of becoming endangered or extinct in a very short time period" (COSEWIC, 2009). The report also notes that as of May 2004, plains bison could be found in British Columbia, Alberta, and Saskatchewan (COSEWIC, 2009). COSEWIC is in the process of reviewing the status of bison within Canada. Further information pertaining to the distribution and status of bison in Canada can be found on page 115.

Current Status, Distribution, and Abundance in Montana

As of 2010, bison are listed by the Montana Natural Heritage Program (MNHP) and FWP as a "species of concern" (MNHP, 2010; FWP, 2010a). Species of concern "are native Montana animals that are considered to be 'at risk' due to declining population trends, threats to their habitat, and/or restricted distribution" (MNHP, 2010). FWP and MNHP have given bison an S2 state ranking and a G4 global ranking (MNHP, 2010; FWP, 2010a). An S2 status means the species is "at risk because of very limited and/or potentially

declining population numbers, range, and/or habitat, making it vulnerable to global extinction or extirpation in the state" (FWP and MNHP; 2010b). The G4 global ranking means that the species is "apparently secure, though it may be quite rare in parts of its range, and/or suspected to be declining" (FWP and MNHP, 2010b). The Montana Comprehensive Fish and Wildlife Conservation Strategy (CFWCS) lists bison as Tier 1, which are species in "greatest conservation need. Montana Fish, Wildlife & Parks has a clear obligation to use its resources to implement conservation actions that provide direct benefit to these species, communities, and focus areas" (FWP, 2005, pp. 32).

YNP bison on Horse Butte. PHOTO CREDIT: BFC

Within Montana there is currently one public captive herd, which resides within the National Bison Range and is co-managed by the U.S. Fish and Wildlife Service (USFWS) and the Confederated Salish and Kootenai Tribes. This is an actively managed herd, which is on a rotational grazing system and is annually rounded up to remove surplus animals and test for disease (Boyd, 2003). The herd is managed at approximately 400 bison on 18,500 fenced acres. Surplus bison are culled through livestock sales and transfer to native tribes (Boyd, 2003). Testing of the NBR herd by Ward (2000) found the presence of cattle DNA, both in mtDNA and in nuclear DNA.

The free-ranging bison that inhabit Yellowstone National Park exhibit limited seasonal movement beyond park boundaries into certain regions of Montana. This population is considered to be the only population of plains bison that has continuously existed in the wild in North America (Boyd, 2003). "After intensively managing bison numbers for 60 years through husbandry and regular culling, the National Park Service instituted a moratorium on culling in the park in 1969 and allowed bison numbers to fluctuate in response to weather, predators, and resource limitations. Abundance increased rapidly and large-scale bison migrations out of the park during the winter began in the late 1980s" (White et al., 2011a, pp. 17).

The bison that originate from the YNP herds have been designated as a "species in need of disease control" within the state of Montana and are managed under the Interagency Bison Management Plan (IBMP) (MCA §87-1-216). The primary goals of the IBMP are "to maintain a wild, free-ranging population of bison and address the risk of brucellosis transmission to protect the economic interest and viability of the livestock industry in Montana" (IBMP, 2000, pp. 1). Under the regulations set forth in the IBMP, bison originating within Yellowstone National Park are not permitted to maintain a year-round population or presence within Montana and are actively moved back into the park by government officials, with the exception of those found in the Absaroka-Beartooth Wilderness. Under the IBMP, bison may freely migrate into the Absaroka-Beartooth

Wilderness north of Yellowstone, including the upper portions of Hellroaring and Slough Creek, though the IBMP recognizes that due to the high elevations and rugged topography, few bison are expected to utilize this region (IBMP, 2000, pp. 1).

Bull bison outside West Yellostone. PHOTO CREDIT: S. ADAMS

During the winter a limited number of bison are permitted to migrate outside of Yellowstone's western boundaries onto limited U.S. Forest Service (USFS) and private land between Grayling Creek and the South Fork of the Madison River. The bison that move into this region are hazed back inside the boundaries of the park annually prior to May 15 (IBMP, 2008). The IBMP recognizes that on occasion bison do move into the Cabin Creek Recreation and Wildlife Management Area, the Monument Mountain Unit of the Lee Metcalf Wilderness, or into the Upper Gallatin River above the mouth of the Taylor Fork. The IBMP states that bison may winter in these areas with monitoring, but must return to within the boundaries of Yellowstone National Park in the spring. The IBMP notes that "bison may use these areas during all seasons provided they are not approaching the Taylor Fork cattle allotment" (IBMP, 2000, pp. 11–12). Through the work of regional conservation organizations, the permittee of the Taylor Fork cattle allotment has since transferred its cattle to another region and given up its allotment.

Under the original IBMP a limited number of bison are permitted to migrate outside Yellowstone National Park's northern boundaries in the Reese Creek area, west of the Yellowstone River and south of Yankee Jim Canyon. Within the original plan these bison were hazed back inside park boundaries prior to April 15 of each year (IBMP, 2000, pp. 8); however, through an adaptive process this date has been changed to May 1 (P. Flowers, Montana Fish, Wildlife & Parks, personal communication). Bison are also able to migrate into the Eagle Creek/Bear Creek region of Yellowstone's northern boundary and would not be hazed back into the park. However, "agencies will maintain a boundary at the Little Trail Creek/Maiden Basin hydrographic divide by hazing. Bison crossing the hydrographic divide will be subject to lethal removal" (IBMP, 2000, pp. 10).

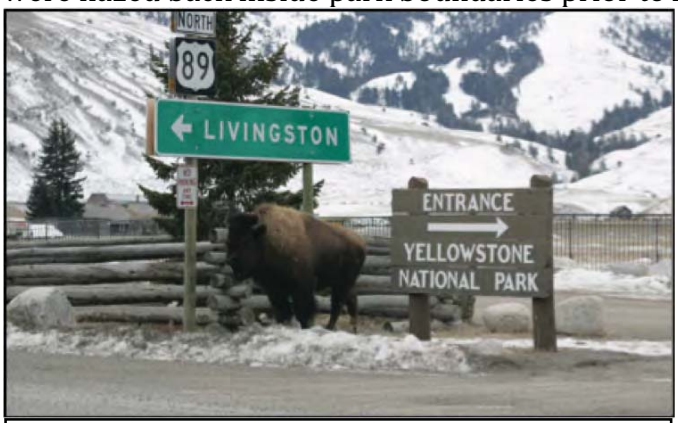


PHOTO CREDIT: J. PEACO; COURTESY NPS

In March of 2011, adaptive management adjustments were made to the IBMP that would increase the region where bison would be tolerated outside of the northern boundaries. The adaptive management adjustments "allow bison on habitat on U.S. Forest Service and other lands north of the park boundary and south of Yankee Jim Canyon. Bison would not be allowed north of the hydrological divide (i.e., mountain ridge-tops) between Dome Mountain/Paradise Valley and the Gardiner basin on the east side of the Yellowstone River and Tom Miner basin and the Gardiner basin on the west side of the Yellowstone River" (IBMP, 2011). The management adjustments ensure that the agencies will "evaluate the effects of these adjustments and modify as necessary to prevent bison from occupying lands north of the hydrological divide and minimize the risk of transmission of brucellosis to livestock" (IBMP, 2011). Following the release of these adaptive management adjustments, the Park County Stockgrowers Association and the Park County Commission both filed separate suits seeking to reverse the new management adjustments. Three conservation organization, Bear Creek Council, Greater Yellowstone Coalition, and Natural Resource Defense Council, under the representation of Earthjustice have requested permission from a court in Park County to intervene in state court, "asking the judge to reject the Stockgrowers' and county's demand to essentially keep bison confined to Yellowstone National Park" (Page et al., 2011).

Tribal and Privately Owned Bison in Montana

Tribal Involvement in Bison

Bison are and have been an essential and highly valued element of the rituals and traditions of many Native American cultures. Historically these tribes depended on bison for numerous materials and as a main food source. "The total array made the buffalo a tribal department store, a builder's emporium, furniture mart, drugstore, and supermarket rolled into one—a splendidly stocked commissary for the needs of life" (McHugh, 1972, pp. 109). Krech III (1999) notes that for many tribes, "from a purely material standpoint, it would have been virtually impossible to be out of sight, touch, or smell of a product fabricated from bison at any time of day or night" (pp. 128).

Historically bison were also an essential element of the spiritual and religious customs of numerous native tribes of Montana and surrounding regions. Verbicky-Todd (1984) notes that the following tribes had a strong dependence on bison: Assiniboine, Arapaho, Blackfeet, Cheyenne, Comanche, Crow, Gros Ventre, Kiowa, Kiowa-Arapaho, Plains Cree, Sarcee, and Teton Dakota. Though bison still hold cultural significance for many tribes, there is now the recognition that bison have a strong commercial value and pragmatic use as a food source, as the establishment of tribal herds would enable "control over food production and land, food security, tribal sovereignty, and decreasing reliance on outside sources for food" (Gates et al., 2010, pp. 11).

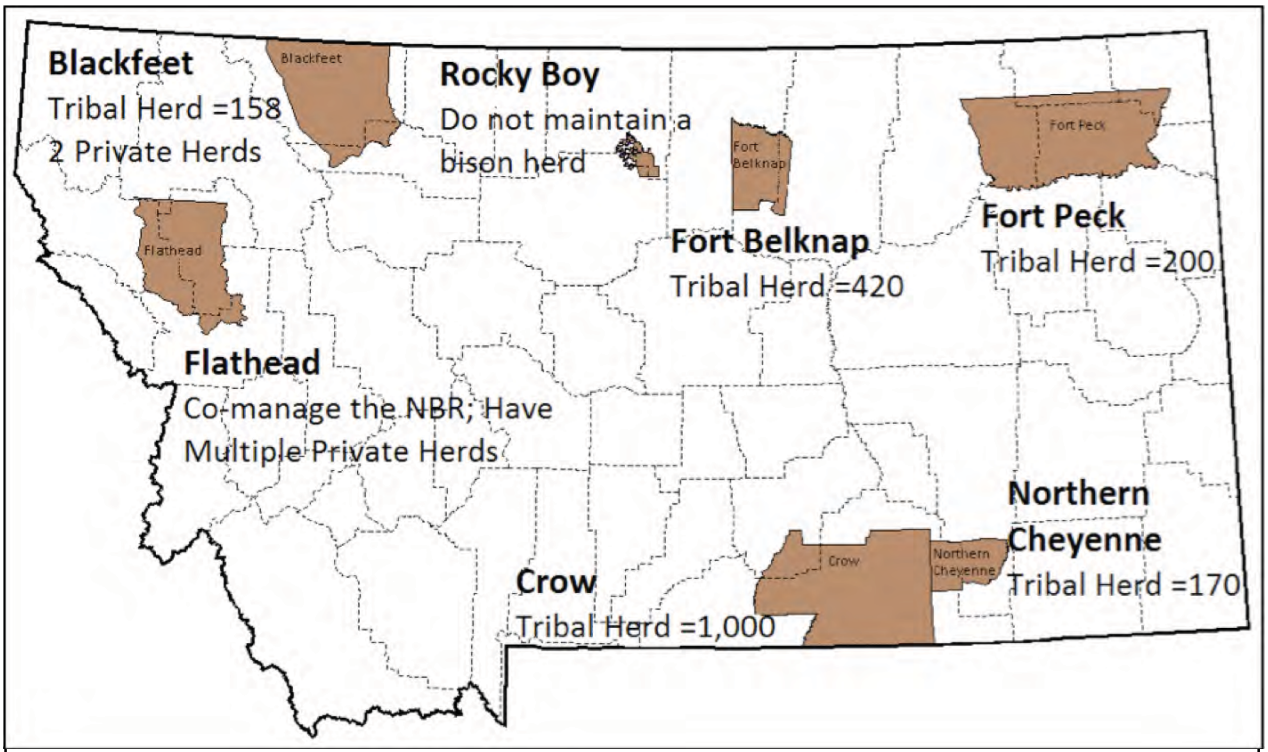
Decorated bison skull. PHOTO CREDIT: FWP

Increased concern over the high rate of diabetes on reservations has led to a movement toward returning to a more traditional bison-based diet. The value of bison meat as an addition to the diet of many Native American cultures is reflected in the Blackfeet use of the term *natapi waksin,* which means "real food," referring to bison meat, and *kistapi waskin,* which means "nothing food," for all other food (Zontek, 2007). Father Pierre-Jean De Smet noted that "(bison) cow-meat is the favorite dish of all the hunters, and as long as they can find it, they never kill any other animals (De Smet, 1905, pp. 231).

In order to facilitate and coordinate the return of bison to tribal reservations, the InterTribal Bison Cooperative, which is now the InterTribal Buffalo Council (ITBC) was formed in 1990 (ITBC, 2011). The goal of the ITBC is "reestablishing buffalo herds on Indians lands in a manner that promotes cultural enhancement, spiritual revitalization, ecological restoration, and economic development" (ITBC, 2011). As of 2011 the ITBC has a membership of 57 tribes and maintains a collective herd of over 15,000 bison (ITBC, 2011).

The manner in which the individual herds are managed varies. Some tribes maintain their bison with limited management, while others have more strictly managed herds.

Tribal herds are maintained on six of the seven Native American reservations in Montana. The herds range in size and in degree of management. In 2010 there were approximately 2,348 tribal herd bison, including the 400 bison on the National Bison Range, which is co-managed by the Confederated Salish and Kootenai Tribes of the Flathead Reservation and the USFWS. The majority of the tribes have expressed interest in expanding their herds if feasible, and many offer limited bison hunting opportunities. Some of the tribes are also in the process of exploring the potential to create separate cultural herds, which would be managed for different purposes and values than production herds.



Map 4: Locations of Native American Reservations and Approximate Number of Bison. Created by FWP (2010).

The largest of the tribal herds is on the Crow Reservation. The tribal herd is made up of approximately 1,000 bison and is managed within natural barriers on approximately 30,000 acres, with additional access to 120,000 acres in the mountains. There are plans to expand the herd, as a result of an increase in available acreage. Hunting tags are occasionally issued to the general public as a population management tool. There are no additional private herds remaining on the reservation (T. Jefferson, Crow Reservation, personal communication).

Adjacent to the Crow Reservation is the Northern Cheyenne Reservation. The Northern Cheyenne tribe maintains a tribal herd comprised of approximately 170 head of bison, with plans to expand in the future. Though there is a pasture for the bison, it is small, and the herd tends to be free-roaming on the reservation. Special tags are occasionally issued to tribal members for hunting. There are no additional private herds on the reservation (A. Clubfoot, Northern Cheyenne Natural Resource Department, personal communication).

The Assiniboine and Sioux (Nakota, Lakota, and Dakota) tribes of the Fort Peck Reservation manage a tribal herd that consists of approximately 137 bison (post hunting season), which are contained on approximately 9,000 acres (R. Magnan, Fort Peck Fish and Game Director, personal communication). There is a hunting program that is open to tribal and non-tribal members; approximately 50 tags were issued for the 2010 hunt. The tribe has expressed the desire to establish an additional cultural herd of around 150 bison on 4,000 additional acres. The Fort Peck tribes are working with Defenders of Wildlife to obtain some of the YNP bison that are in the quarantine program (J. Proctor, Defenders of Wildlife, personal communication). There are two additional private herds on the reservation. The first has approximately 100 head, and the second has around 50 head of bison.

R. Magnan examining the bison pasture fencing. COURTESY DEFENDERS OF WILDLIFE

The Gros Ventre and Assiniboine tribes of the Fort Belknap Reservation manage a herd approaching 420 mature bison in an enclosure that is approximately 22,000 acres. The tribes would be interested in expanding their herd if additional acreage was available. There are some limited hunting opportunities available to tribal members and the general public, mainly to cull older bulls. For the 2010-11 season five tags were issued at a price of $2,000 for a four- to six-year-old bull, and approximately five tags were issued at a cost of $3,000 for a seven-year-old-plus trophy bull (Fort Belknap Fish and Wildlife, personal communication). There are no additional herds on the Fort Belknap Reservation. The Fort Belknap tribes have requested some of the YNP bison that are in the quarantine program, and are working with Defenders of Wildlife to have these bison transferred to the reservation (Gates et al., 2010; J. Proctor, personal communication).

The Blackfeet tribe manages a tribal herd that is currently made up of 120 mature bison and 38 calves. The bison are managed on 1,400 acres in the summer and then moved

to a smaller winter enclosure where there is supplemental feed. The tribe hopes to expand the herd in the future, and does not sell hunting tags (M. Magee, Blackfeet Land Department, personal communication). There are two private herds on the reservation. The first is made up of about 10 bison, and the second maintains around 50 bison.

The Confederated Salish and Kootenai Tribes of the Flathead Reservation co-manage the herd on the National Bison Range. There was a separate tribal herd in the past and there is the possibility that one may be reestablished in the future. There are three known larger private herds on the reservation, which vary between 200 to 300 head of bison. In addition, many individuals on the reservation will occasionally have a few domestic bison (A. Fuqua, Confederated Salish and Kootenai Tribes, personal communication).

Private Herds

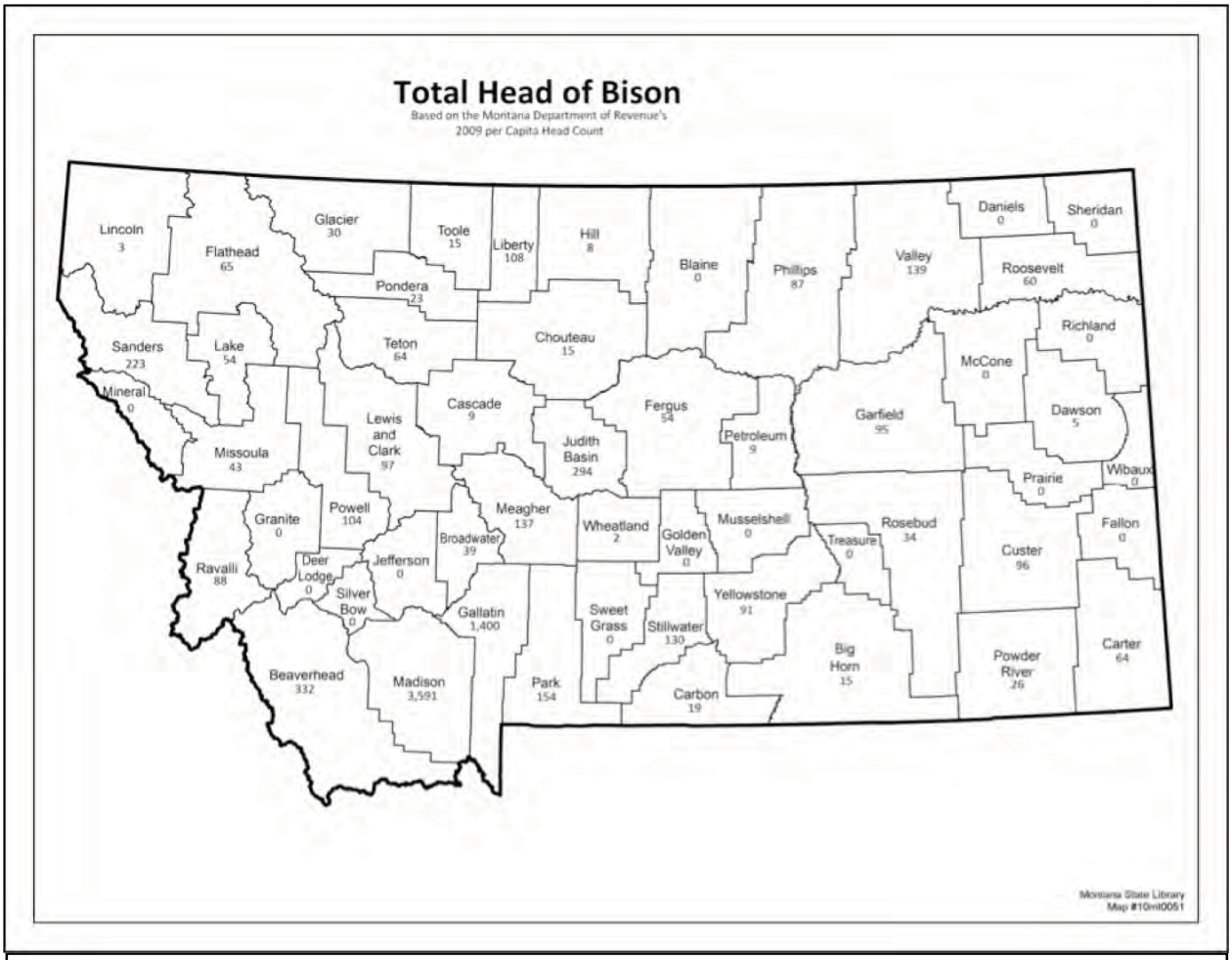
The number of bison in North America increased substantially in the mid-1980s as the commercial bison industry began to flourish (Freese et al., 2007; Gates et al., 2010). Bison meat became popular for its health benefits, and the industry began to market meat, hides, horns, skulls, and buffalo wool, which can be made into yarn that is similar to cashmere (Danz, 1997). Today domestic herds account for more than 93 percent of the bison in North America, and bison can be kept as livestock throughout the United States (Gates et al., 2010).

Domestic bison herd. COURTESY BOTANICAL PAPERWORKS INC

The National Bison Association was formed to promote the bison industry (Danz, 1997). The National Bison Association (2010) states that as of 2007 there were 4,499 private bison ranches and farms in the United States, and 70,000 bison were slaughtered under federal and state inspection in 2009. Gates et al. (2010) estimates that within the United States and Canada there are 400,000 privately owned bison on approximately 6,400 farms.

While the efforts of early bison ranchers may have been to conserve the plains bison, modern bison ranching is now driven primarily by commercial interests. The management of bison as livestock has led to the domestication of private herds. As Isenberg (2000) notes, domestication is not confinement or habituation to humans, but is instead "selective breeding: humans deciding which individuals will produce the next generation, and choosing them to produce a next generation that will better serve human goals" (pp. 198). In order to create more manageable and profitable bison herds, private ranchers selectively breed for desired traits. During domestication the traits that were

favored in the wild and increased the bison's survival there are slowly bred out of the herd, especially if the natural traits increased the difficulty of handling and decreased the production value (Geist, 1996). Ranchers selectively breed for traits that include docility, growth performance, conformation, and reduced agility (Isenberg, 2000; Gates et al., 2010). The artificial selection of preferred traits alters the natural genetic variation of the herd. The large number of domesticated bison, which are found throughout the United States, may reduce the public's perception of the need for bison conservation (Freese et al., 2007). Yet domesticated bison have been altered morphologically, physiologically, and behaviorally.

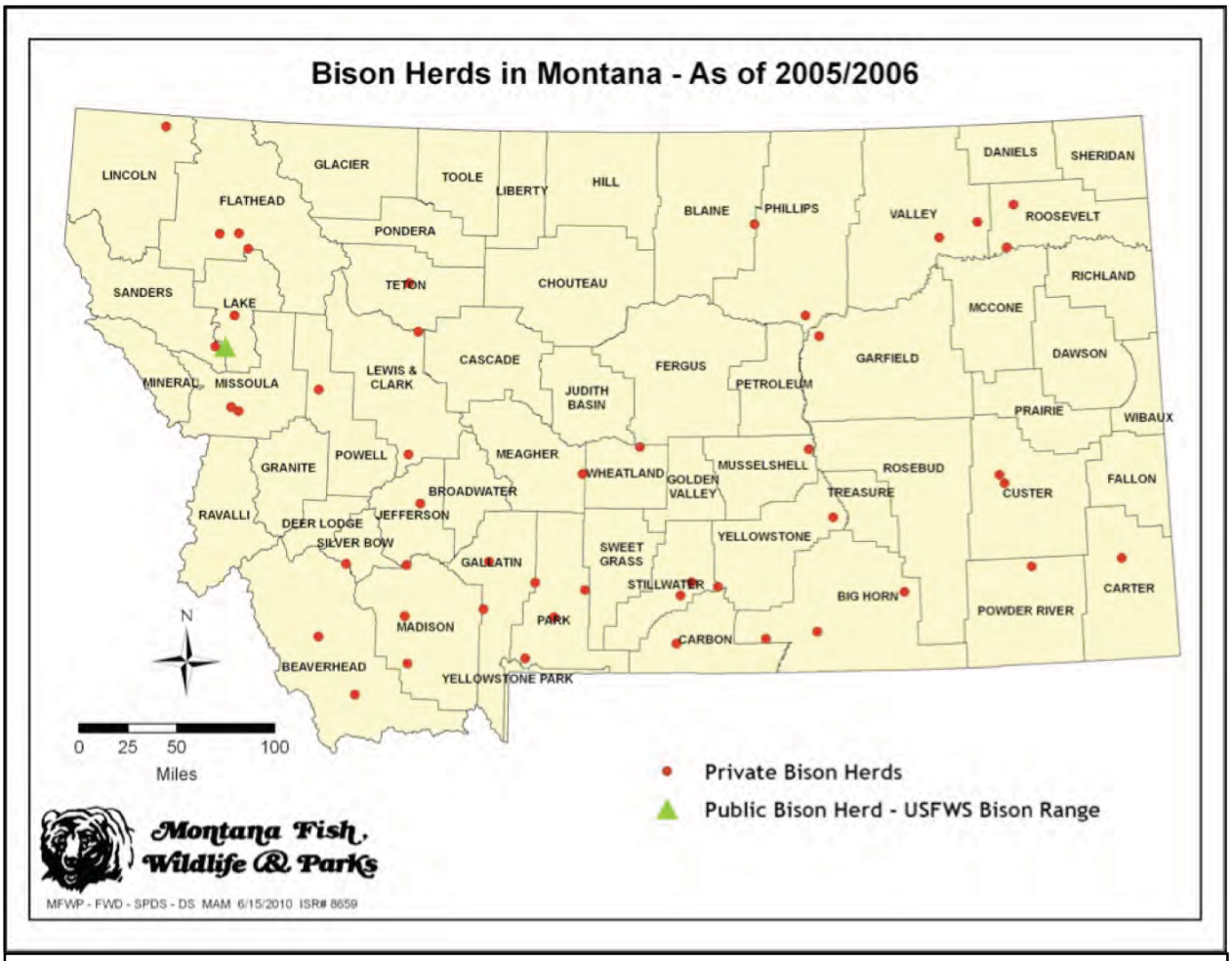


Map 5: Total Head of Domestic Bison. Created by FWP (2010) based on the Department of Revenue's final data from September 2009 per capita head count by county

Private herds, in which bison are managed as livestock, account for almost all of the bison in Montana. The majority of the domestic bison are raised for market. The 2007 U.S. Department of Agriculture's agriculture census determined that the state of Montana had 133 bison farms with 14,565 bison (National Agricultural Statistics Service, 2007). This is a decrease from 2002, when there were 190 bison farms in Montana containing 19,515 bison (National Agricultural Statistics Service, 2007). Per MCA 15-24-921, the State of Montana is

authorized to collect per capita fees to cover the expenses of enforcing livestock laws. These fees apply to all livestock including domestic bison that are over nine months of age (MCA 15-24-9210). The per capita fee for bison is $4.17 per head, compared to $1.75 for cattle and $0.37 for sheep and goats (MDOL, 2010f). Per capita fees are "self-reporting," which means that livestock producers are responsible for reporting the number of livestock they own to the Department of Revenue. According to the September 2009 Department of Revenue per capita head count, there were 7,822 reported bison over the age of nine months in Montana, which generated $34,174 in per capita fees for Montana (MDOL, 2009).

The Montana Bison Association, which is an organization of bison producers and enthusiasts, listed approximately 60 members in 2010 (Montana Bison Association, 2010). As stated previously, private bison herds occur on the Fort Peck, Blackfeet, and Flathead Reservations. The American Prairie Foundation maintains a private conservation herd of around 200 bison in eastern Montana, and has expressed an interest in increasing the size of its herd (American Prairie Foundation, 2010).



Map 6: Location of Known Plains Bison Herds, as of 2005/2006. Map re-created by FWP (2010) based on data provided by Sanderson et al. (2008)

Life History and Ecology

Behavior

The size of a bison herd is heavily dependent on sex and age structure and on habitat and forage availability (Berger and Cunningham, 1994a). Early reports of travelers exploring the American West described immense herds of bison that stretched across river valleys and darkened the plains. These reports helped to fuel inflated population estimates and reinforced the idea that bison were an inexhaustible resource. The size of these historic herds were influenced by a number of factors including variation in forage quantity and quality, environmental influences, and pressure from human activity (Bamforth, 1987). The early reports of vast herds did not take into account the fact that bison tend to congregate in larger herds mainly during the summer breeding season, and only in favorable feeding habitat (Nowak and Paradiso, 1983; Bamforth, 1987; Berger and Cunningham, 1994a; Aune et al., 1998; Isenberg, 2000). Historically bison tended to divide into smaller herds during the winter as "the need to scatter was also dictated by the poor quality and reduced quantity of forage at this time of year, which could not sustain large groups of animals" (Brink, 2008, pp. 64).

Though bison will congregate into larger aggregates during the summer months, throughout the remainder of the year cows, calves, and immature males tend to form smaller "cow" groups with an average of 10 to 20 bison, though numbers can reach upward of 50 to 70 bison as smaller groups converge (McHugh, 1972; Nowak and Paradiso, 1983; Isenberg, 2000; Long, 2003; Picton, 2005; FWP and MNHP, 2010a). During a study of bison in northern Yellowstone National Park, Aune et al. (1998) observed that mean group size for cow groups was 27 in the winter and 32 in the spring. They also observed that females with calves may form "nursery groups" during the calving season, which may reach 100 to 200 animals (Aune et al., 1998).

Larger cow groups will separate into smaller groups of 10 to 20 in order to feed (Picton, 2005). During his study of bison in Utah, Van Vuren (1980) observed that cow groups expressed a high degree of fluidity, with groups tending to remain together for a few days before dividing and combining with another group. The degree of fluidity was contingent on proximity to other bison groups (Van Vuren, 1980). Aune et al. (1998) also noted that group fidelity appears to be temporal and that there appears to be a very fluid and dynamic social structure within cow groups. Older females tend to be more dominant within these smaller cow groups (Rutberg, 1986; Foresman, 2001).

Solitary bull. PHOTO CREDIT: S. ADAMS

The bulls tend to remain solitary or form small groups of up to five bulls during most of the year, joining with the cow groups

only during the breeding season (McHugh, 1972; Long, 2003; Reynolds et al., 2003). During observations of bison in Badlands National Park, Berger and Cunningham (1994a) found that even during more social months the mean bull group size was less than three, with one being the median throughout the year (pp. 75). Bull groups tend to consist of males over the age of four (McHugh, 1972).

The type of habitat that a herd occupies can also have an effect on its size. Group sizes tend to be smaller in mountainous or mixed terrain than in open prairie (McHugh, 1972; Gates et al., 2010). Berger and Cunningham (1994a) found that habitat seemed to have a greater effect on the size of cow groups than bull groups. They found that there was a 50 percent reduction in the size of a herd from prairie habitat to habitat consisting of ravines and rolling hills.

Bison are also known to congregate in larger groups around permanent sources of water, but then will separate to feed (Bamforth, 1987). Bison density averages from one to four per square mile depending on the range conditions (Long, 2003). Based on his observations of the bison herd that once freely roamed on the Flathead Indian Reservation, Andrew Stinger recalled that "contrary to a current idea, our buffalo in the Flathead Valley did not roam in one large herd; and I presume that was because there were no mass migrations during summer and winter, as had been the habit of the Plains bison. Here, a leader bull, and possibly a younger aspirant to that station, would head a band, composed of some 20 or 25 cows and calves" (Whealdon, 2001, pp. 62).

Activity of both Native Americans and Europeans is believed to have influenced the size of historic bison herds and their movements. The amplification of hunting pressure increased the overall mobility of the prey, and as individual bison fled it would have caused the entire herd and possibly surrounding herds to flee as well (Bamforth, 1987). Prior to the introduction of horses, Native Americans tended to slaughter entire small herds. Native American hunters believed that small herds must be slaughtered entirely or the surviving bison would flee and warn other herds, making them more difficult to hunt (Krech III, 1999; Picton, 2005; Brink, 2008). The reasoning behind this practice was supported by the observations of early European Americans that once a bison herd had experienced human predation, it would flee at the slightest sign or smell of man (Picton, 2005). Bison have a highly developed sense of smell, which is their primary defense mechanism, and "perhaps because they are not very keen of sight, bison are remarkably sensitive to any unusual movement in their environment" (Brink, 2008, pp. 100).

The use of horses caused bison herds to become more mobile and did not allow for the slaughter of whole herds as occurred with the use of a buffalo jump or pound. The removal of random individuals from a herd led to more frequent stampedes, as well as larger aggregations of animals in the vicinity of the hunting area (Bamforth, 1987). Human settlement and expansion into an area often prevented the bison from utilizing major water sources, trails, and resources, thus leading to an increase in bison in the neighboring region (Bamforth, 1987). It is speculated that the settlement of the east caused the bison to migrate into the western regions, thus increasing the density of the animals within the region and triggering increased herd size and mobility (Bamforth, 1987).

The home range of free-ranging bison varies with habitat productivity (Reynolds et al., 2003). The average home range of a bison herd extends from 18 to 62 square miles depending on the season and the quality of forage (Nowak and Paradiso, 1983; Long, 2003). Aune et al. (1998) observed that the average home range for female bison in northern Yellowstone National Park was approximately 208 square miles. Herds utilize smaller home ranges during the summer months and larger ranges during the winter (Foresman, 2001). Aune et al. (1998) found that home ranges within northern Yellowstone appear to become larger during severe winters due to the long-range movements bison undertake to reach winter habitats along the northern border of the park. When in habitat of lower productivity, bison will increase the size of their home range (Foresman, 2001).

As grassland ungulates, bison must modify their behavior to withstand wide spatial variations in resource quality and availability (Guthrie, 1980). "Temporal and spatial variations in range use are likely related to such factors as tradition, forage availability and nutritional quality, macroclimatic and microclimatic variations, open water, shelter, and insect harassment" (Reynolds et al., 2003, pp. 1023). Bison may have to travel extensive distances daily to find water, search for areas of recent precipitation, and follow phenological peaks in plant growth (Guthrie, 1980). "The patchy distribution of bison was a fact commented on by European travelers. Josiah Gregg recorded that "as they incline to migrate en masse from place to place, it sometimes happens, that, for several days' travel together, not a single one is to be met with; but, in other places, many thousands are often seen at one view." Edwin James camped on the Platte River with the plains around him covered with "immense herds of bison, grazing in undisturbed possession and obscuring, with the density of their numbers, the verdant plain." Surveying the same territory the next morning, he remarked with astonishment that "upon all the plain which last evening was so teeming with noble animals, not one remained."(Brink, 2008, pp. 229).

Within their home range, bison tend to move around 1.8 miles daily (Nowak and Paradiso, 1983; Long, 2003). Bison move frequently within their home ranges, and Van Vuren (1980; 1983) noted that herds within the Henry Mountains seldom remained in one place for more then three days. Migration is closely associated with locations of permanent water and forage quantity and quality due to seasonal changes and precipitation patterns (Bamforth, 1987). Historically bison herds may have migrated a few hundred miles south in search of higher-quality winter habitat (Nowak and Paradiso, 1983; Long, 2003). During her study of bison in Yellowstone National Park, Meagher (1973) observed that during the spring bison moved from lower wintering valleys to higher summer ranges, and would then reverse this altitudinal migration in the fall. Van Vuren (1980) observed in Utah that during the summer, bison followed a pattern of using the northern part of the range in early summer, with a gradual southward shift as the summer progressed.

Historically a large number of bison wintered on the northern plains, "just not on the flat and exposed windswept prairies" (Brink, 2008, pp. 62). "As the air turned crisp and ice began to form on the edges of ponds and streams, their instinct told them that it was time to head for sheltered areas . . . These areas weren't necessarily any warmer or less snow-covered, but they all had one thing in common—they provided refuge from the wind.

Typical winter sheltering spots for bison included deep valleys of rivers, creeks, and coulees, thick groves of trees and brush, and hilly or broken county where there are options to move out of the wind" (Brink, 2008, pp. 62–63). During the winter in Yellowstone National Park, bison spend the majority of their time locating and consuming forage, and spend almost one-third of this time displacing snow in order to reach the underlying vegetation (Bruggeman, 2006; Bruggeman et al., 2009; White et al., 2011b). "Thus, snow is the primary factor that reduces foraging efficiency and bison prefer patches with minimal snowpack compared to the surrounding landscape" (Bruggeman, 2006; White et al., 2011b, pp. 11). Bison would begin to move back out onto the plains as winter transitioned to spring. "By March the grip of winter loosened and the Plains once again became a tolerant friend. Herds moved out of sheltered valleys and hilly country but stayed close enough to move back in case of all-too-common late winter storms" (Brink, 2008, pp. 64).

Bison engage in a wallowing behavior that provides evidence of their movements on the landscape even after they are physically absent from an area. During his stay at Montana's Fort Union in 1843, John J. Audubon observed that "the buffalos, old and young, are fond of rolling on the ground in the manner of horses, and turn quite over; this is done not only to clean themselves, but to also rub off the loose old coats of hair and wool that hangs about their body like so many large, dirty rags" (Audubon, 1900, pp. 36). There are reports of soil depressions visible on the landscape today that have been attributed to relic bison wallows. Coppedge et al. (1999) examined soil depressions on The Nature Conservancy's Tallgrass Prairie Preserve to determine if they were actually bison wallows or if they were from geological processes. Their examination found that "these soil depressions, and possibly other 'relict' bison wallows, are not persistent soil disturbances resulting from bison wallowing, but small patches of landscape and soil heterogeneity resulting from variation in underlying geological materials" (pp. 382). The lifespan of bison wallows has not yet been established, nor has the role that different soil types play in the persistence of wallows (Coppedge, et al., 1999).

Cow bison wallowing. PHOTO CREDIT: J PEACO; COURTESY NPS

Bison of all ages and sex classes roll in soft dirt while scraping their horns and hooves against the ground (McMillan et al., 2000; Reynolds et al., 2003; Gates et al., 2010). This behavior forms a circular to oval-shaped bare soil depression (Coppedge et al., 1999). Meagher (1973) observed that bison tend to utilize the same wallows annually. Wallowing is associated with the relief of insect and parasite irritation, shedding, and potentially as a means of thermoregulation, as bison can lower their body temperature through contact with cooler soil (Nowak and Paradiso, 1983; McMillan et al., 2000; Lott, 2002; Reynolds et al., 2003; Picton, 2005). Wallowing is also associated with reproduction. Bulls will urinate in a wallow and then both the bull and cows will roll in the urine. The pheromones in the

urine induce the cows to come into estrus, helping to coordinate the estrus cycle of the females within the herd (Bowyer et al., 1998; Picton, 2005). The urine may also advertise a bull's fitness level to other competing bulls (Bowyer et al., 1998; Lott, 2002).

Bison wallows increase the heterogeneity of the landscape. The soil within a wallow becomes exposed and compacted. This compacted shallow bowl collects rainwater and creates a microenvironment in which seeds can sprout. The seedlings of sedges and rushes that are otherwise absent in the prairie occur in wallows (Coppedge et al., 1999; Knapp et al., 1999; Lott, 2002).

Roughly 3,000 head of bison are managed with minimal contact on approximately 113,000 acres within Turner Enterprises Inc.'s Flying D Ranch, located in southwest Montana. Though there are some concentrated wallows, there are not a large number of wallows across the landscape and negative impacts from wallowing have not been observed. The wallows are approximately eight to 10 feet in diameter and tend to occur on flatter ground consisting of finer texture soils. Ranch management notes that wallows have been a minimal issue (Turner Enterprises Inc., personal communication).

Bison of all age and sex classes also engage in a behavior referred to as horning, which involves the rubbing of an object with the head, horns, neck, or shoulders (McHugh, 1958; Coppedge and Shaw, 1997). Horning is believed to be associated with relief from insect irritation, though it may also be a behavioral display or associated with coat shedding (McHugh 1958; Coppedge and Shaw, 1997; Gates et al., 2010). Horning typically involves rubbing on a shrub or small tree, though bison may utilize man-made objects as well (Gates et al., 2010). Bison prefer to horn aromatic shrubs, saplings, and treated utility poles, which may contain insecticidal or insect-deterring properties, to gain relief from insects (Coppedge and Shaw, 1997). Bowyer et al. (1998) hypothesized that female bison may rub trees to advertise estrus. They observed that females rub trees more often than males, which they felt indicated the behavior was related to the reproductive status of a female during the rut. Robert Vaughen, one of the first pioneers in Montana, observed near the Sun River that "in the grove some of these monarchs were rubbing against the trees, and, I should judge, were enjoying themselves immensely" (Vaughn, 1900, pp. 77).

Habitat

Bison evolved through natural selection as a "dominant grazer" on complex landscapes (Fuhlendorf et al., 2010), and historically occupied a variety of habitats. Bison were found throughout the prairies, arid plains and grasslands, meadows, river valleys, aspen parklands, coniferous forests, woodlands, and openings in boreal forests (Long, 2003; Burde and Feldhamer, 2005; FWP and MNHP, 2010a).

PHOTO CREDIT: GYC

Bison utilize the woodlands in the summer for shade, and in the winter when the accumulation of snow prevents feeding in more open terrain (Meagher, 1978; Burde and Feldhamer, 2005). Berger and Cunningham (1994a) observed that bulls are more common in breaks, woody draws, and ravines than females. The cow groups are more common on prairie habitat. Currently most managed bison preserves confine bison to small reserves of land that are often outside of the short-grass plains, which was one of their main historic habitats (Isenberg, 2000). Within the National Bison Range in Montana, the bison occupy Palouse prairie and montane forest (FWP and MNHP, 2010a).

Foraging Ecology and Diet Composition

Within this section the diet and foraging ecology of bison is often compared with domestic cattle. It is important to keep in mind that bison have mainly evolved through natural selection on complex landscapes, whereas cattle have been artificially selected for agricultural production and human use for thousands of years (Fuhlendorf et al., 2010). Therefore, Fuhlendorf et al. (2010) note that while "it is a reasonable prediction that when these species are managed as wild populations on complex landscapes, there could certainly be differences in how they handle threats and limited resources. It is less reasonable to predict differences in ecological effects when both species are compared within an agricultural setting" (pp. 5). It is also important to keep in mind that the term "cattle" represents a wide variety of cattle species that have different abilities to adapt to the landscape and have differing ecological needs (Fuhlendorf et al., 2010). The differences and similarities of bison and cattle on complex landscapes have not been adequately studied, and there are few studies that directly compare bison and cattle (Fuhlendorf et al., 2010). Many of the studies in this section compare the two species within agricultural settings, not in direct comparison, or in limited environments, and while these studies help to draw a general hypothesis, there needs to be further testing with stricter experimental controls.


PHOTO CREDIT: FWP

Bison are a diurnal and crepuscular species, meaning that they are mostly active during the day and at twilight (Nowak and Paradiso, 1983; Long, 2003; Reynolds et al., 2003). Though depending on the season and the quality of forage, bison have been observed to be active on moonlit nights (Long, 2003; Reynolds et al., 2003).

Bison are ruminants with a four-chambered stomach system that allows them to effectively digest plant material. Bison have a mutually beneficial, or symbiotic, relationship with microorganisms including bacteria and protozoa, which allow an increased utilization of plant material than would occur in the microorganisms' absence (Feist, 1999; Picton, 2005; Gates et al., 2010). Bison typically forage between 9 to 11 hours

daily, but will increase their foraging if the quality of food is low (Picton, 2005). Bison alternate between active foraging and passive ruminating to allow time for the microorganisms to break down the plant material (Foresman, 2001). The large size of the bison allows for a larger digestion vat, thereby allowing bison to utilize lower-quality forage than other ungulates, such as elk, cattle, or deer. This ability to utilize lower-quality forage is one of the reasons why when bison occur on North American grasslands they can be major influent animals.

Reynolds et al. (2003) note that "much of what is known about bison digestion and nutrition has been extrapolated from beef cattle requirements and digestive physiology," and that "specific energy, protein, mineral, and vitamin requirements have not been developed for bison" (pp. 1019). Within an agricultural setting, on average the total digestive tract retention time for bison is 78.8 hours, compared to 68.7 hours for cattle (Feist, 1999). This increase in digestion time allows bison to digest 64 percent of sedge hay and 74 percent of grass hay, compared to cattle, which digest 58 percent of sedge hay and 62 percent of grass hay (Feist, 1999). In a study comparing the diet compositions of bison and cattle on short-grass plains, Peden et al. (1974) found that "bison appear to have a greater digestive power than cattle when consuming low protein, poor quality forage . . ." (pp. 497). Plumb and Dodd (1993), however, found in a comparison of bison and cattle grazing on mixed prairie that their results "do not completely support the hypothesis that bison have the ability to digest lower quality forages better than cattle" (pp. 63). Bison and cattle were managed within enclosed pastures in both studies.

In a study that compared the foraging behavior of bison and cattle in Utah, Van Vuren (2001) observed that bison and cattle differ in the elevation and degree of slope in which they graze, with bison more often grazing at higher elevations. Topography and the degree of slope are contributing factors in the grazing pattern of cattle. Cattle will not generally graze on slopes with a grade exceeding 4 degrees while bison have been observed grazing on slopes up to 32 degrees (Van Vuren, 2001, pp. 119). In addition, cattle and bison display different foraging behaviors, with bison behaving more as energy maximizers. Bison are more likely than cattle to expend energy to obtain richer rewards at concentrated feeding sites that require long-distance movements (Van Vuren, 2001). Cattle behave as central place grazers, with foraging centered on water sources (Van Vuren, 2001). During a study of bison in Theodore Roosevelt National Park, Norland (1984) observed that bison did not center foraging activities around permanent water sources, but were instead highly mobile to utilize different water sources. Bison also used temporary water sources, went without water for at least one day, and utilized snow instead of water when available.

Van Vuren (2001) found that the location of bison foraging was relatively unaffected by the availability of water in comparison to cattle, and that bison were less likely to graze close to water. During his observations of the free-ranging herd of bison in the Henry Mountains in Utah, Nelson (1965) observed that "very little time was spent at the water hole. As soon as their water needs were satisfied, they immediately began grazing and moving away from the water and did not show a tendency to hang around the area as is common with cattle" (pp. 35–37).

The increase of vertical distance from water caused a steep decline in cattle foraging; however, the situation resulted in only a slight decrease in bison foraging (Van Vuren, 2001). While observing grazing behavior of cattle and bison in northeastern Colorado, Peden et al. (1974) observed that cattle selected areas for grazing that were located within swales or shallow depressions, where soil moisture is higher than in the surrounding upland vegetation where the bison grazed.

In a study on The Nature Conservancy's Tallgrass Prairie Preserve, Fuhlendorf et al. (2010) attempted to compare bison and cattle in a way that incorporated factors found within complex landscapes, including fire. The study found that both species had a high preference for regions that had recently been burned (Fuhlendorf et al., 2010), but the study found two key differences between the two species. The first was that cattle preferred regions with woody vegetation, but bison avoided them. The researchers felt that this behavior is related to thermal regulation, but that further investigation is required (Fuhlendorf et al., 2010). A second key difference was that "selection for sites closer to water was also greater in cattle than bison; in fact, bison spend less time near water than cattle" (pp. 16). Fuhlendorf et al. (2010) note that this difference "occurred in a well watered landscape and may be even more important in landscapes with greater distance between ponds and streams" (pp. 16).

The diet of the plains bison consists primarily of grasses, though bison will consume forbs and woody vegetation when their preferred vegetation is not readily available (Nowak and Paradiso, 1983; Foresman, 2001; Long, 2003; Burde and Feldhamer, 2005; Picton 2005). The study of the diet of bison, cattle, and sheep on short-grass vegetation in northeastern Colorado by Peden et al. (1974) found that bison have a greater preference for warm-season grasses, which are grasses that grow during the summer and mature in the late summer or fall. The study found that bison consumed more warm-season grasses than cattle or sheep, with these grasses making up approximately 80 percent of their diet except for during late winter and early spring. Peden et al. (1974) observed that the percentage of cool-season grasses, which are grasses that grow during the spring and flower in early summer, was in general greater in the diets of cattle than in bison. The study also found that the diets of sheep and cattle "frequently had relatively high proportions of forbs"; for example, warm- and cool-season forbs combined made up 72 percent of sheep and 47 percent of cattle diets in June, whereas the diet of the bison consistently contained less then 13 percent forbs (Peden et al., 1974, pp. 493).

On the National Bison Refuge, 88 percent of the bison's diet is made up of Idaho and rough fescue and bluebunch wheatgrass (Foresman, 2001). Meagher (1973) found in an analysis of rumen samples that sedges are the most important forage for bison in Yellowstone National Park, with sedges, rushes, and grasses making up 96 percent of their diet throughout the year.

Bison's nutritional needs change seasonally and are related to the length of the day. A mature bison gains and loses weight cyclically, with weight loss occurring in the fall and winter, and weight gain occurring in the spring and summer (Feist, 1999). On average

bison tend to lose 10 to 15 percent of their body weight during the winter (Feist, 1999). The shorter daily period of daylight during winter increases the concentration of melatonin that is produced by the pineal gland, which inhibits the secretion of growth hormone and thyroxin, and therefore lowers the bison's metabolic rate (Feist, 1999). This decrease in metabolic rate reduces the bison's forage intake to 1.4 to 1.8 percent of body weight, compared to the 2.0 to 3.0 percent intake that occurs during the remainder of the year (Feist, 1999). An experiment was conducted in which the calves of bison, yak, and Scottish Highland cattle were placed in a refrigeration chamber and temperatures were lowered to -22° F (-30° C). Each showed a marked increase in metabolic activity in an effort to raise body temperature, except for the bison, which lowered its metabolism. "As it got colder, bison slowed their metabolic rate" (Brink, 2008, pp. 172).

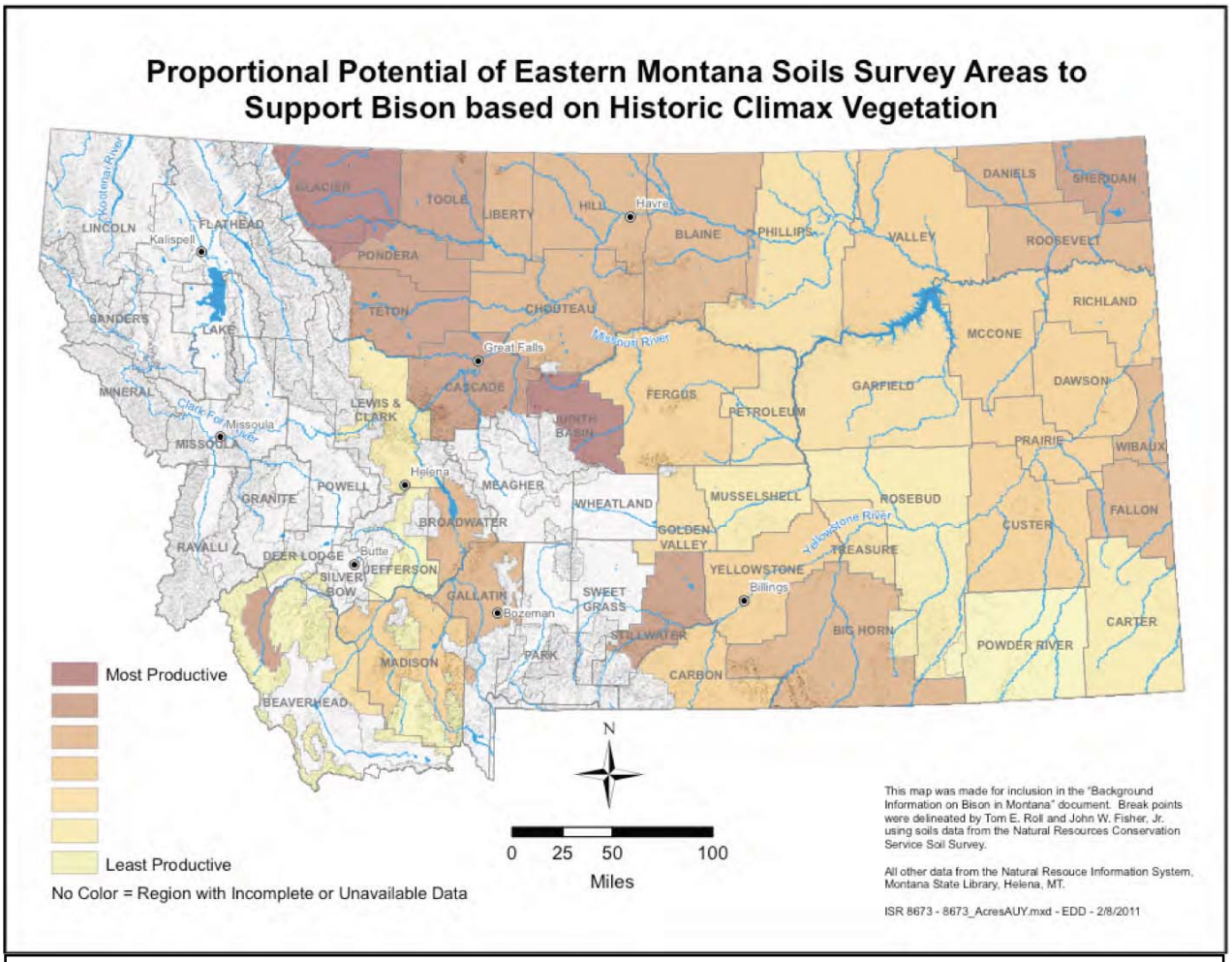
Bison have evolved the ability to plow away up to 18 inches of snow with their large low-hanging head in order to access the underlying vegetation (Meagher, 1978; Picton, 2005). This adaptation allows bison to effectively feed on natural sources during the winter season in conditions that may limit the forage ability of other wild ungulates and may require the diet of domestic livestock to be supplemented (Meagher, 1978).

In order to better determine agricultural stocking rates, animal grazing is measured by animal unit month (AUM). An animal unit (AU) is based on one mature domestic cow, which weighs about 1,000 pounds, and a calf that is as old as six months, or their equivalent. An AUM is the amount of forage required to support an AU for one month (NRCS, 1997). It is important to recognize that AUMs were developed as an agricultural tool for estimating stocking rates, and were not directly developed to determine the range impact of native ungulates. The *Montana Guide to Range Site, Condition and Initial Stocking Rates,* published by the Montana State University Extension Service, notes that "different animals also use different areas or forage species within a pasture. Thus AUM equivalents for sheep and wildlife have been omitted, because their food and habits differ from cattle" (Lacey and Taylor, 2005, pp. 3–4). Scarnecchia (1986) cautions against using AUMs to compare different species, because "animal-unit equivalents are simple values expressing the demand of animals in animal-units; they are not substitution rations" (pp. 471). Scarnecchia (1986) and Hobbs and Carpenter (1986) both caution against generalizing AUMs among species, and note that the differences in diet selection and forage behavior must be examined for each species.

In practice there are often differences in the actual capacity of the land to support native ungulate grazing than is indicated by AUM estimates due to the differences in foraging behavior between cattle and bison. It is also important to recognize the distinction between the ecological potential of a site and actual production of a site as influenced by the existing conditions. In order to determine the actual ecological potential of a site and its ability to support a bison herd, the following factors must be examined: the existing conditions of the range, the seasonal range and its utilization by all species, and how a site's potential would differ based on whether it was supporting a confined herd versus a free-ranging herd. The following process would need to occur to examine these factors. First, a rangeland assessment should be completed to examine the utilization of the site in specific areas and to estimate the utilization of the site by different ungulates. There would then

need to be the completion of a habitat inventory and an estimation of carrying capacity. The seasonal ranges and the seasonal range use by different wildlife would need to be identified. Finally, the overall influences of other ungulates would need to be determined.

Map 7, created by T. Roll and J. Fisher Jr. (2010), is a projection of the proportional potential of regions in Montana east of the Continental Divide to support bison during normal precipitation conditions.



Map 7: Proportional Potential of Eastern Montana Soils Survey Areas to Support Bison Based on Historic Climax Vegetation. Map created by T. Roll and J. Fisher Jr. (2010) based on soil survey data from National Resource Information System and National Resource Conservation Service

Reproductive Biology

A female bison's ability to produce viable offspring is dependent on a number of factors including age, physical condition, and disease status. The age that a female first conceives varies among location and even within a herd (Reynolds et al., 2003). It is

possible for female bison to conceive as yearlings and thus produce offspring at two years of age; however, this occurs in less than 4 to 5 percent of females (Berger and Cunningham, 1994a; Gates et al., 2010). It is more common for females to conceive at two years of age and thus produce their first calf when they are three years old (Reynolds et al., 2003). In Badlands National Park, Berger and Cunningham (1994a) observed that 58 percent of three-year-olds produced a calf. Prime breeding years differ between herds, but tend to range from four to ten years of age (Berger and Cunningham, 1994a; Aune et al., 1998; Gates et al., 2010). Under ideal conditions pregnancy rates for three-year-old cows will be about 70 percent or greater, and rates for prime age cows will normally average between 70 to 90 percent (Gates et al., 2010). Berger and Cunningham (1994a) found that calf production was highest from ages 5 to 13, with 75 percent of 10- to 11-year-olds annually producing calves. They observed that fewer than 30 percent of cows that were 14 and older produced calves (Berger and Cunningham, 1994a). Within Yellowstone National Park's northern herd, Aune et al. (1998) found that the highest reproductive potential occurred in females that were between four and eight years old; there was reduced reproductive potential in older females.

Male sexual majority also differs between locations, with some herds having a low percentage of yearling and two-year-old males becoming sexually viable (Reynolds et al., 2003). The majority of males begin to reach sexual maturity in their second or third year; however, bulls that are less than six years old tend to not yet possess the social maturity to successfully compete with other bulls for the opportunity to breed (Meagher, 1973; Reynolds et al., 2003; Picton, 2005). Bulls that are between seven and eight years old are the most competitive males, and therefore have the highest breeding success (Meagher, 1978).

The breeding season of bison, which is referred to as the rut, tends to occur between July and September, with the majority of breeding occurring in July and August (Nowak and Paradiso, 1983; FWP and MNHP, 2010a). Cows are seasonally polyestrous, meaning that a female will come into heat multiple times during the breeding season if she does not conceive during the first cycle (Nowak and Paradiso, 1983; Long, 2003). During this time the males challenge one another to gain access to females (Berger and Cunningham, 1994a). Bulls determine the outcome of such challenges through a series of stages. The confrontation typically begins with posturing and parallel walking; it may advance to bluff charges, and finally charging and goring (Picton, 2005). While some interactions to establish dominance are determined without physical contact, when contact does occur there is often severe injury and occasional mortality (Dary, 1989; Geist, 1996; Picton, 2005). Picton (2005) noted that one study indicated that 50 percent of bulls showed

Bison bulls sparing. PHOTO CREDIT: D. LUTSEY; COURTESY GATES ET AL. (2010)

evidence of previously fractured ribs. Males also use bellows and vocalizations as threats and displays to other males during the rut (Berger and Cunningham, 1994a).

A male bison will attempt to breed with as many females as possible during each breeding season in order to increase the number of viable offspring that carry his genes (Long, 2003). Males do not form harems, but instead form temporary "tending bonds" or "guarding bonds" with females, allowing the bulls to breed with a number of females sequentially (Meagher, 1978; Berger and Cunningham, 1994a).

Gestation length and calving season may be highly variable, with bison achieving reproductive synchrony through gestation adjustments (Berger and Cunningham, 1994a). Gestation and calving seasons can be influenced by factors such as location and climatic conditions (Aune et al., 1998; Reynolds et al., 2003; Gogan et al., 2005). Gestation in bison can range from 9 to 9.5 months (Nowak and Paradiso, 1983; Reynolds et al., 2003; Picton, 2005; FWP and MNHP, 2010a). Within Badlands National Park, Berger and Cunningham (1994a) observed that the median of births occurred from May 2 to May 8, with 50 percent of births occurring within 19 to 23 days. Gogan et al. (2005) observed that within the two YNP herds the majority of births occurred in April and May, with 50 percent of all births occurring within 13 to 43 days and 80 percent of births occurring within 33 to 82 days. Jones et al. (2010) found that within the YNP herds the earliest newborn was seen in late March or early April each year and the last observed birth tended to occur in late May or early June. Similar findings of synchrony within the YNP herd were observed by Jones et al. (2010), who observed that 50 percent of births occurred within 15 days and 80 percent occurred within 32 days. Approximately 50 percent of births occurred by the 6th of May, 80 percent by the 16th of May, and 95 percent by the 27th of May (Jones et al., 2010).

BISON CALF. PHOTO CREDIT: S. ADAMS

Gogan et al. (2005) also observed that the availability of spring forage is a major factor in the timing of births. The effect that vegetation availability and nutrition may have on the timing of births is supported by the observation by Aune et al. (1998) that calving was earlier following a moderate winter and was delayed two weeks following a very severe winter. Aune et al. (1998) observed that most calves within Yellowstone National Park were born between mid-April and late May. Meagher (1973) reported that within Yellowstone most calving occurred in early May and was completed by late May, though indicated that as the population increases the calving season may extend. Pac and Frey (1991) found that the calving season is more prolonged than previously reported within the park, with most of the calving (76 percent) completed by early June. This evidence supports Meagher's earlier observation. Calves that are born later have an increased risk of not surviving the following winter.

If vegetative cover is available, females will give birth in isolation; if cover is not available, isolation during birth is less frequent (Meagher, 1986). A cow delivers a single reddish tan calf, which is able to stand and suckle shortly after birth (Picton, 2005). Bison may produce twins; however it is extremely rare (Reynolds et al., 2003; Brodie, 2008). Aune et al. (1998) found that "bison birth sites were relatively clean and bison consumed membranes and occasionally the placenta" (pp. 69). Jones et al. (2010) also observed this behavior, noting that "bison birth sites covered small areas (e.g., 3 by 3 meters) and female bison meticulously cleaned birth sites by consuming all birth tissues, eating the vegetation, and licking the soil" (pp. 337). Calves begin to graze after their first month, and learn food selection through observing the herd (Picton, 2005). Most calves are weaned within 8 to 12 months (Long, 2003; Burde and Feldhamer, 2005).

Bison cows and calves. PHOTO CREDIT: E. AUSTIN AND H. JONES; COURTESY NPS

Demography and Population Dynamics

The rate of population growth is influenced by sex ratio, age structure, quality and quantity of forage and habitat, and the immigration and emigration rate combined with the reproductive and mortality rates (Gates et al., 2010). The survival rate of calves varies dramatically across different populations, whereas adult survival rates are generally higher and less variable (Brodie, 2008). Survival rates for prime age adults are approximately 95 percent, with the highest natural mortality rates occurring in calves and the oldest age class (Gates et al., 2010). Pac and Frey (1991) evaluated bison within Yellowstone National Park and found that the mean age was 4.96 and the oldest animal was 15 years old, which is consistent with other studies (Reynolds et al., 2003). Pac and Frey (1991) found that there were more males in the younger age class (1 to 4), more females in the older age class (5 to 9), and similar numbers of both sexes in the oldest age class (10 to 15). Studies of the central YNP herd by Geremia et al. (2009) found that there was reduced survival in this herd after 12 years of age. This is younger than the documented lifespan in other wild bison, and Geremia et al. (2009) speculate that it may be due to the geological features of this region of the park. Mortality may occur through predation, hunting, accidental drowning, parasites, and disease (Reynolds et al., 2003; Brodie, 2008).

Another major factor that causes mortality in bison is climate. Winters with above-average snowfall and long freezes result in mortality in bison, as these conditions reduce forage ability leading to poor animal condition and potentially death (Reynolds et al., 2003). Fuller et al. (2007a) found that population growth was negatively correlated with increased snowpack.

Population density can have an effect on survival, but usually only when it is combined with climatic pressures. Geremia et al. (2009) found that there was a significant decrease in the survival of adult females when the population in the central herd exceeded 2,000 to 2,500, with the decrease being intensified during winters of increased snowpack. Based on observation of the two herds within Yellowstone National Park, Fuller et al. (2009) discovered that bison tend to exhibit a spatial response to density dependence. They found that as increased density was combined with climatic variations, such as deep snowpack, there was increased pressure on resources. This increase in resource competition caused some of the central herd bison to emigrate to the northern herd, which had been reduced due to management practices.

Pregnancy and birth rates vary within different herds and are affected by multiple factors. Aune et al. (1998) found that within the northern YNP herd pregnancy rates were over 70 percent, which is high compared to many other free-ranging populations. "Although female bison get pregnant most years, they may not successfully calve or produce viable calves each and every year depending upon the severity of the previous winter" (Aune et al., 1998, pp. 69). Birth rates within YNP bison varied with age and disease status. Fuller et al. (2007b) found that birth rates for three-year-olds were 0.40 calves per female that had tested positive for brucellosis and 0.63 calves per female that had tested negative. Birth rates for females four years and older were 0.64 calves per female that had tested positive for brucellosis and 0.81 calves per female that had tested negative.

Another factor that can affect calf production rates is body condition of the female bison. On the National Bison Range, calf production has declined from the 1956 to 1987 historic average of 87 calves per 100 breeding age cows, to 32 calves per 100 breeding age cows (Borgreen, 2010). Borgreen (2010) found that decreases in body weight of female bison appear to be directly related to decreases in the production of calves. Borgreen (2010) notes that "from the historical trends, it would appear that the cause of anestrus during the breeding season is the result of body condition of cows at NBR, most likely due to range resources or other environmental factors" (pp. 60).

Fuller et al. (2007b) found that pregnancy and birth rates did not vary significantly with climatic changes, but the neonatal survival in the spring varied with both winter severity and warm-season growing conditions. This occurs because conception and gestation requires less energy than lactation (Fuller et al., 2007b). Calf survival varies drastically across different populations, but on average calf survival ranges from 40 to 90 percent, depending upon the severity of winter, predation pressures, and forage availability (Brodie, 2008; Gates et al., 2010).

Growth rate of bison populations is highly elastic to adult survival, with small changes in adult survival having large effects on population growth rate (Fuller et al., 2007b). Within Yellowstone National Park, Fuller et al. (2007b) estimated that the growth rate was λ=1.07, indicating an increasing population. Within free-ranging populations, growth tends to occur at a slower rate. The bison herd in Jackson, Wyoming, experienced a growth rate of 12.9 percent from 1969 to 2002 (Gates et al., 2010). Growth rate tends to be highest in captive herds where there is an absence of predation, supplemental feeding

occurs, most or all of the surplus bison are culled annually, and there is a skewed sex ratio with a much higher number of females to males than in the wild (Gates et al., 2010). A herd that is managed under these conditions in Oklahoma experienced a growth rate of approximately 50 percent (Gates et al., 2010).

Ecological Roles

Bison and grizzly bear. PHOTO CREDIT: FWP

Bison are a keystone species within plains and prairie habitats, meaning they play an important role by influencing the plant and animal communities around them (Knapp et al., 1999; Truett et al., 2001; Gates et al., 2010). The impacts of large grazers such as bison can be both positive and negative—the key is how the species is managed on the landscape. For example, the grazing and wallowing behavior of bison result in the creation of specific environments, which contain plant communities that have a greater diversity than the surrounding region. This increase in plant diversity is utilized by other animals and increases the diversity of wildlife within the region (Foresman, 2001; Picton, 2005; Gates et al., 2010).

A study completed by Frank et al. (1998) found that the presence of large herbivores, bison, and elk within Yellowstone National Park increased the aboveground plant production by an average of 43 percent, thus dramatically promoting energy capture within the ecosystem (pp. 519). This study found that "ungulates stimulate allocation to shoot growth while simultaneously enhancing light levels, soil moisture, and nutrient availability" (Frank et al., 1998, pp. 518). Frank et al. (1998) note that "because animals are continually on the move, grazing at any site, although often intense, never lasts long. Furthermore, because ungulates tend to graze grasslands early in the growing season, when forage is the most rich in minerals, and then migrate off sites while conditions are still favorable for plant growth, defoliated plants are provided with both sufficient time and suitable conditions to regrow" (pp. 519). Frank et al. (1998) conclude that "in contrast to most terrestrial habitats, where climate is the preeminent factors determining primary production and ecosystem energy flow, ungulates play a major role in regulating these processes in grazing ecosystems" (pp. 519). Thus, "ungulates in grazing ecosystems do not simply respond passively to ecosystem gradients of forage characteristics; they actually modify vegetation structure, with the result that herbivores increase their own foraging efficiency" (Frank et al., 1998, pp. 518).

The grazing of bison and their presence in a region enhances the availability of nitrogen to plants by increasing nitrogen cycling and by altering the form in which inorganic nitrogen exists. This increase in available nitrogen increases the productivity of vegetation (Frank and Evan, 1997). Bison can stimulate increased biomass production in a

grassland system by redistributing nitrogen and other nutrients through feces and urine deposition (Frank and Evan, 1997). The carcasses of bison also deposit nutrients into the soil and create a fertile area with higher biomass production as well as an increase in species richness and diversity (Towne, 2000).

Bison and prairie dogs have a mutually beneficial relationship. Prairie dogs utilize the same regions as bison; therefore keeping the grass short, and "the closer the blade is to the roots, the higher the percentage of protein and the lower the percentage of cellulose it contains" (Lott, 2002, pp. 128). This shorter vegetation attracts bison, whose droppings contribute needed fertilizer to the prairie dog colonies (Lott, 2002). Prairie dogs need lower vegetation to form colonies, and the grazing patterns of bison reduce forage height to levels that facilitate colonization by prairie dogs (Lott, 2002; Virchow and Hygnstrom, 2002; Gates et al., 2010).

Knapp et al. (1999) found that the grazing behavior of bison, which, in conjunction with wallowing and other ecological events such as fire, increase the diversity of the grasslands to provide suitable nesting habitat for a variety of obligate grassland nesting bird species (Gates et al., 2010). Grassland birds evolved alongside native grazers such as bison, and are dependant on the heterogenic mosaic landscape patterns that emerge from the grazing patterns of bison (Knopf, 1996). Some of the bird species that utilize bison-altered habitat are the upland sandpiper, grasshopper sparrow, mountain plover, McCown's longspur, ferruginous hawk, and long-billed curlew (Knopf, 1996; Gates et al., 2010).

Bison play an ecological role as an important food source for many predators and scavengers. Bison tend to turn and face an attacking predator, which increases the risk of injury to the predator (Meagher, 1978). Attacks on bison and bison calves tend to be infrequent and opportunistic, with predators often selecting older or weakened members of the herd or newborn calves (Varley and Gunther, 2002; Wyman, 2002). Historically bison carcasses supported wolves, grizzly and black bears, wolverines, bald eagles, ravens, coyotes, and swift foxes (Roe, 1970; Bogan, 1997; Truett et al., 2001). Wolf populations that were reintroduced to Yellowstone National Park that had not been exposed to bison in the past were able to adapt their behavior in order to utilize bison as a prey source, though bison have not become their preferred prey (Smith et al., 2000; Becker et al., 2009a, 2009b). In a study that monitored winter wolf kills in the northern range of Yellowstone National Park from 1995 to 2000, Smith et al. (2004) observed that in the early-winter study period bison made up approximately 2 percent of wolf kills. During the late-winter study period bison made up 6 percent of wolf kills.

In the northern range, bison have not become a significant prey source because elk, the preferred prey source, are more abundant and easier to hunt. Within central Yellowstone National Park, bison are utilized more frequently as a prey source due to the lower abundance of elk (R. Garrott, Montana State University, personal communication). In central Yellowstone National Park the kill rates of bison were primarily influenced by the abundance of bison calves and the severity of snowpack (Becker et al., 2009a, 2009b).

Becker et al. (2009a) were able to detect 606 bison and 151 elk killed by wolves within the Madison headwaters area from the 1996–97 winter to the 2006–07 winter.

Though the Sturgeon River Plains Bison Herd was reintroduced to Saskatchewan, Canada, in 1969, wolves did not begin to prey on these bison until the early 2000s (G. Vaadeland, Sturgeon River Plains Bison Stewards, personal communication). Predation began with one pack of wolves and there are now five packs that utilize the bison herd as a prey source (Vaadeland, personal communication). Prince Albert National Park has begun to study the predation of bison by wolves and is gaining a better understanding of this dynamic predator/prey relationship.

Bison evolved alongside other native ungulate species, such as elk, mule deer, and pronghorn. Knowles (2001) notes that "bison tend to ignore other ungulate species except when closely approached during a feeding bout. Interspecies aggression may be exhibited at this time but chase distances are typically very short as long as the other species exhibits flight behavior" (pp. 26). Due to the limited number of free-ranging herds, interactions between free-ranging bison and other native ungulates has not been extensively studied. Bison do co-exist with a number of native ungulates in parks, such as Yellowstone National Park.

Barmore Jr. (2003) examined the relationship between native ungulate species in the northern range of Yellowstone National Park between 1962 and 1970. Through combining his observations and relevant literature, he determined the amount of separation and the factors responsible for separation of the different species. Barmore Jr. (2003) found that the following ecological separations occurred between bison, mule deer, moose, bighorn sheep, and pronghorn antelope between 1962 and 1970, and probably during primeval times, based on major differences in four niche dimensions: spatial distribution, habitat selection, food habits, and tolerance of snow. Barmore Jr. (2003) observed that the factors responsible for the ecological separation of bison from mule deer and moose were major differences in spatial distribution, habitat selection, and food habits. He also observed that tolerance of snow was a factor responsible for the separation of bison and mule deer, but not bison and moose.

Barmore Jr. (2003) found that out of 953 bison-feeding observations, only 16 were in bighorn sheep range, and that bighorn sheep were never observed in areas consistently used by bison. Barmore Jr. (2003) notes that the factors responsible for the separation of bison and bighorn sheep were major differences in spatial distribution, habitat selection, and tolerance of snow.

The major factors responsible for the ecological separation of bison and pronghorn were major differences in spatial distribution, habitat selection, food habits, and tolerance of snow (Barmore Jr., 2003). Barmore Jr. (2003) notes that while historically bison may have ranged more extensively on the low-elevation pronghorn range, it is most likely that bison and pronghorn were separated ecologically by the major differences in their food habits and/or tolerance of snow. Barmore Jr. (2003) also notes that if the two species did occupy low elevations more extensively during the summer, a commensal interaction, in

which one species benefits and the other neither benefits nor is harmed, may have occurred, as the bison's feeding on graminoids, which are flowering plants including grasses, would have increased the forbs and shrubs that are preferred by pronghorn. Fahnestock and Knapp (1993) noted that within tallgrass prairies, the grazing behavior of bison increased the soil temperature, availability of light, and soil moisture that was available to forb species. During observations of the grazing of bison and pronghorn on short-grass prairies in northeastern Colorado, Schwartz and Ellis (1981) found that the dietary overlap between bison and pronghorn was generally low. There was almost no overlap in August when bison consumed warm-season grasses and pronghorn warm-season forbs. The greatest amount of overlap occurred in March and October when the diets of pronghorn included 70 to 82 percent grasses.

Barmore Jr. (2003) observed that there was a considerable amount of overlap in the distribution and food habits of bison and elk on Yellowstone National Park's northern range; however, there were apparent differences in their habitat selection. Bison tended to be generally more specific in their habitat selection than elk, with elk feeding on a wider variety of topographic sites than bison. Barmore Jr. (2003) observed that both elk (75 percent of the time) and bison (91 percent of the time) primarily fed in grassland vegetation types from fall to spring. In the fall, elk and bison both preferred mesic grasslands and sedge-grass meadows, with elk showing more of a preference for sedge-grass meadows than bison (Barmore Jr., 2003). In the winter, elk shifted from sedge-grass meadows and mesic grasslands to xeric grasslands and sagebrush grasslands, whereas bison shifted from mesic grasslands to sedge-grass meadows, which were highly preferred (Barmore Jr., 2003). Gentle and level slopes were more heavily used and more highly preferred by bison than by elk during the fall and especially during the winter. This probably partly reflects the bison's greater tolerance of snow, which is normally deeper on level to gentle slopes where the bison's preferred sedge-grass meadows are most abundant (Barmore Jr., 2003, pp. 348).

In the spring, elk and bison both heavily used and highly preferred xeric grasslands. Both species also utilized sagebrush grasslands and mesic grasslands, though only elk preferred mesic grasslands. Bison continued to feed extensively on sedge-grass meadows, whereas elk did not (Barmore Jr., 2003). During the spring, south slopes were extensively used and preferred by both species, while ridgetops were extensively used and preferred by bison but not by elk (Barmore Jr., 2003, pp. 348).

Barmore Jr. (2003) notes that "niche overlap between bison and elk was minimal, and competitive interactions were probably nonexistent during the late 1960s due to differences in habitat selection and feeding behavior that largely reflected the ability of bison to cope with deeper snow than elk and thus feed on preferred high-producing mesic grasslands and sedge-grass meadows after the areas became unavailable to elk. Competition for food was essentially nil because utilization of graminoids (both cured and spring growth) was low over most of the area occupied by bison in winter and spring" (pp. 348).

Genetics

Lamar Bison Ranch. COURTESY NPS

The plains bison that are presently in existence in North America are believed to have descended from fewer than 300 to 500 bison; 88 of which were captured by private citizens between 1873 and 1889—the 23 bison of Yellowstone National Park, the small herd in Texas, and some that had been maintained in various zoos (Geist, 1996; Isenberg, 1997). Although the number of bison has increased substantially, the fact that the modern population was established from a limited founder population could have a large effect on the genetic variation of present-day herds, both public and private. A number of factors have affected the genetic variability of modern bison. Bison have undergone artificial hybridization with domestic cattle, been selectively bred for certain traits in private herds, and been separated into small isolated populations (Gates et al., 2010).

The decrease of such a vast bison population to a small fraction of its original size in a relatively short time period may have caused a genetic bottleneck or founder effect. This occurs when the genetic diversity of a population is greatly reduced due to the small sample of bison, which were present in the surviving population (Geist, 1996; Boyd and Gates, 2006). Within this small population genetic variation may be reduced further due to the male dominance effect, in which there is a disproportionate genetic contribution by the most dominate bulls within the founder herds, and little to no genetic contribution of less dominant males (Geist, 1996; Isenberg, 1997). Genetic drift, which is the random fixation of genes within a population, may occur because the founder population represents only a limited selection of the genetic diversity that once occurred in the original herds (Geist, 1996; Gates et al., 2010). Another factor that could limit the genetic variability in bison is the maternal effect, in which bison captured from the same herd have a higher probability of being related through maternal descent, and would therefore have a lower amount of genetic diversity (Geist, 1996).

Recent studies have shown that reduction of the overall genetic diversity of bison may not have occurred to as great an extent as originally believed (Dratch and Gogan, 2010; Gates et al., 2010). Examination of the majority of the herds managed by the federal government has shown that the herds have retained significant amounts of genetic variation by the standard measures of heterozygosity and allelic diversity (Dratch and Gogan, 2010). Although the bison population did go through a severe bottleneck, it is believed that the population did not remain at low numbers for an extended period of time, and therefore modern populations appear to have retained a substantial amount of genetic diversity (Freese et al., 2007). The extensive movement and breeding between the historic

populations created a large amount of gene flow within the original herds (Berger and Cunningham, 1994a; Wilson and Strobeck, 1999; Dratch and Gogan, 2010). The potential that the flow of genetic information created one large gene pool within the original herd is supported by the fact that the genetic distance between current isolated herds is lower than expected (Wilson and Strobeck, 1999). It is also speculated that much of the preexisting genetic diversity may have been retained within the current herds since the bison that made up the foundation herds were collected throughout the bison's range and the herds were artificially mixed over time (Halbert, 2003; Geist, 2006). Recent studies of DNA microsatellites have shown that certain herds are genetically distinguishable from others (Wilson and Strobeck, 1999; Halbert and Derr, 2008). This raises the question of whether current conservation herds should be managed as separate populations to preserve these genetic differences, or if the herds should be managed as one large metapopulation to increase the gene flow throughout the population (Gates et al., 2010).

An important factor in the conservation of genetic diversity within a bison population is the size of the herd and the sex ratio. There is a greater loss of genetic variation when the number of breeding animals is low (Dratch and Gogan, 2010). It is recommended that in order for a population to be considered of sufficient size for genetic purposes there should be over 1,000 animals and the size of the population should remain stable over time (Dratch and Gogan, 2010). As many of the current herds reside in regions that would not allow populations of that size, it is important to develop a metapopulation structure that allows for movement of individual bison between herds, thus allowing genetic variation to flow between the herds (Dratch and Gogan, 2010). It is also important that there be a sex ratio that allows competition between breeding bulls (Dratch and Gogan, 2010).

An additional genetic concern that arises within small populations is the potential for inbreeding, which is the breeding of related individuals. Inbreeding may reduce fertility, juvenile survival, and lifespan (Frankham and Ralls, 1998). The reduction of genetic diversity that results from inbreeding increases the susceptibility of a population to extinction (Frankham, 2003). Though inbreeding can be difficult to assess, it remains a potential cause for some of the decrease in genetic variation in bison, despite the translocation of individuals among herds (Berger and Cunningham, 1994a; Gates et al., 2010).

It has been shown that most of the herds managed by the federal government do not show obvious effects of inbreeding despite having been founded with few bison and having been maintained at relatively low population sizes (Dratch and Gogan, 2010). Some herds have shown signs that are thought to be the result of inbreeding, which include high rates of physical abnormalities, reduced growth rates, and reduced fertility (Halbert et al., 2004; Halbert et al., 2005; Gates et al., 2010). The low levels of calf recruitment and high levels of calf mortality in the Texas state bison herd appear to be the result of inbreeding (Halbert et al., 2004; 2005). Inbreeding is also believed to have affected male reproductive success in a herd located in Badlands National Park in South Dakota (Berger and Cunningham, 1994b).

Extinction of a species can occur through two routes. The first is extinction brought about when the last individual of a species dies (Freese, 2007). The second is when the genetic makeup of the species is altered substantially over time either through natural evolutionary processes or through human manipulation (Freese, 2007). Human management of bison in both the public and private sector has led to the manipulation of bison genetics through hybridization and domestication.

Halbert and Derr (2007) note that "bison and domestic cattle do not naturally hybridize" (pp. 7). Hybridization of bison and domestic cattle was originally attempted by early ranchers as a means to create offspring that exhibited the ruggedness and winter forage ability of the bison and the meat production of the domestic cow (Boyd, 1914; Dary, 1989; Geist, 1996; Boyd and Gates, 2006). While free-ranging bison do not readily breed with domestic cattle, breeding can occur between the two species in captive and artificial settings. The majority of private bison producers no longer attempt to hybridize bison with cattle. Mossom Boyd, a rancher experimenting with bison hybridization in the early 1900s, found that it was possible for a male bison to mate with a female cow in captivity. However, the percent of failure when crossing a male bison with a female cow was extremely high, with an abnormal secretion of amniotic fluid occurring in every cow, which often proved fatal. Boyd's attempts to cross a male cow with a female bison were unsuccessful (Boyd, 1914). Boyd (1914) also found that almost no male calves were born during the first cross, and the females that were born were usually barren. The first generational backcross (breeding the hybrid female offspring from the male domestic cattle and the female bison back with a male bison) produced a female 75 percent of the time (Boyd, 1914; Hedrick, 2009). This was also the experience of Charles Goodnight, who was attempting to cross bison and cattle around the same time period as Boyd (Goodnight, 1914).

Hereford x bison hybrid. PHOTO CREDIT: BOB HEINONEN; FROM GATES ET AL., 2010

The breeding of bison and cattle has caused an introgression of cattle genes into bison herds, which is a gene flow between populations that results from the hybrid offspring being bred back to the parental population (Boyd and Gates, 2006). The genetic integrity and natural genetic diversity of the species is compromised, as the introgressed DNA replaces portions of the original genome (Gates et al., 2010). A significant number of both private and public herds were established or supplemented with bison that originated from herds that had a history of hybridization (Boyd and Gates, 2006).

When testing for cattle gene introgression in bison, there are two separate types of DNA that are analyzed. The first is mitochondrial DNA (mtDNA), which is located within the mitochondria and passed from the female to her offspring with little or no variation. Her female offspring then continue to pass this DNA along with little or no variation, which makes mtDNA a good source for observing ancestry. The second type of DNA that is examined is nuclear or autosomal DNA (nuclear DNA), which is DNA that is inherited equally from both parents. There is evidence of cattle gene introgression in both mtDNA and nuclear DNA within public and private plains bison herds (Polziehn et al, 1995; Ward et al., 1999; Halbert and Derr, 2007; Dratch and Gogan, 2010). However, there is a much larger amount of mtDNA, which can be partly attributed to the fact that the first crosses and the first generational backcrosses primarily produced females (Hedrick, 2009; 2010). Hedrick (2010) notes that of 22 herds surveyed there was an average of 13.9 percent mtDNA domestic cattle ancestry and 0.6 percent nuclear DNA. Hedrick (2009) notes that it is important to recognize the difference between mtDNA and nuclear domestic cattle ancestry, as the differences in inheritance could have management implications.

In herds where there are low amounts of cattle gene introgression, individual bison that have been identified as having domestic cattle ancestry through molecular markers have not been reported to be observably different than bison without domestic cattle ancestry (Hedrick, 2009). However, there are two unpublished reports that bison with cattle mtDNA show a smaller body size on average (Hedrick, 2009). Douglas et al. (2010) found that there are a large number of differences between the mtDNA genome of bison and the mtDNA genome of cattle. The study then compared the mtDNA genome of bison and of bison hybrids and found that there were numerous non-synonymous mutations. While further studies need to be completed, Douglas et al. (2010) note that "the critical nature of the mitochondria in cellular function and necessary interaction of multiple protein complexes for proper mitochondrial function suggests that the additive effects of such large numbers of non-synonymous mutations will likely affect the mitochondrial function and the overall fitness of the organism" (pp. 7).

Prior to July 2010, based on tests examining mtDNA and nuclear DNA, there were seven plains bison conservation herds that showed no evidence of the introgression of cattle DNA. These seven herds were Yellowstone National Park (Montana, Idaho, Wyoming); Grand Teton National Park (Wyoming); Henry Mountains (Utah); Sully's Hill National Game Preserve (North Dakota); Wind Cave National Park (South Dakota); Elk Island National Park (Alberta); and Mackenzie Bison Sanctuary (Northwest Territories) (Ward et al., 1999; Halbert et al., 2005; Gates et al., 2010). Only two

Captive bison in Yellowstone National Park circa 1906. COURTESY NPS

of the herds, Wind Cave and Yellowstone National Parks could be confidently considered free of cattle DNA (Halbert et al., 2005; Gates et al., 2010). Yet new technology, which uses DNA single nucleotide polymorphisms (SNPs), is changing the current base of knowledge and understanding of the extent of cattle gene introgression in bison. This new technology can provide higher resolution, detect recent hybridization, and identify individual bison within a herd that have domestic cattle ancestry (Dratch and Gogan, 2005). DNA technological advances are displaying a greater prevalence of cattle gene introgression than previously documented. Of the seven herds mentioned above, the only public herd that is currently considered free of cattle introgression is the YNP herd.

There is also a large amount of introgression of cattle genes within the private herds. Of the 100 herds tested by 2007, the only herd that had a high probability of being free of cattle genes was the Castle Rock herd on Turner Enterprise's Vermejo Park Ranch, which is a 590,823-acre property in northern New Mexico and southern Colorado (Freese et al., 2007; Turner Enterprises Inc., 2010). As of April, 2011 the Castle Rock herd is considered free of mtDNA cattle gene introgression, and further testing will be completed in the future (Turner Enterprises Inc., personal communication). The Castle Rock herd descended from bison that were translocated in the 1930s from Yellowstone National Park (Gates et al., 2010). As the only bison in existence today that are likely to be free of cattle genes, the bison in the YNP herd and the Castle Rock herd comprise only a fraction of the overall plains bison population.

Reportable Diseases

Wild bison corralled for disease testing. PHOTO CREDIT: J. PEACO; COURTESY NPS

As with any species, wild or domestic, bison may carry a number of pathogens or parasites. The diseases addressed within this section are the diseases that may infect bison, are transmissible to livestock, and are "reportable" within the state of Montana. These diseases of concern are livestock diseases that could restrict trade or pose a threat to human health (Gates et al., 2010). Under Montana state code 81-2-107, "a person, including the owner or custodian, who has reason to suspect the existence of a dangerous, infectious, contagious, or communicable disease in livestock or the presence of animals exposed to the disease in this state shall immediately give notice to the department (of Livestock)". The diseases of concern for bison identified by Gates et al. (2010) that are listed as reportable diseases in Montana are anthrax, bluetongue, bovine brucellosis, bovine spongiform encephalopathy, bovine tuberculosis, and malignant catarrhal fever (sheep associated), which require immediate notification of state officials and quarantine of the infected domestic animals; and bovine anaplasmosis, bovine viral diarrhea, and Johne's disease, which require notification of state officials within 30 days (ARM 32.3.104; Gates et al., 2010; MDOL, 2010d).

Anthrax

Anthrax is a disease caused by a spore-forming bacterium, *Bacillus anthracis,* (MDOL, 2010a). The bacteria can affect all mammals, but ruminants such as cattle, sheep, bison, and goats are the most susceptible (MDOL, 2010a). Anthrax is a zoonotic disease, which means that it is possible for humans to become infected with the cutaneous form, known as Wool-sorters disease, from close contact with infected animals or their by-products, such as heads or hides (Gates et al., 2010; MDOL, 2010a; J. Rankin, Montana Department of Livestock, personal communication). Anthrax spores exist in soil, and tend to grow and contaminate the soil surface following periods of precipitation and cooler weather that are followed by extended periods of hot, dry conditions (van Ness, 1971; MDOL, 2010a). Anthrax may be spread throughout a region by streams, insects, animals and birds, animal waste, and disturbed carcasses (MDOL, 2010a). Anthrax may also be spread through wastewater effluent from water treatment plants, which can contaminate downstream sediments and pastures (Gates et al., 2010). Inadequately sterilized bone meal and fertilizers made from contaminated material may also spread the anthrax spores (Hugh-Jones and Hussaini, 1975). An animal may become infected through the ingestion of

spores in contaminated food and water, or through inhalation (Gates et al., 2010; MDOL, 2010a).

Upon infection an animal begins to express clinical signs within three to seven days, depending on the number of spores that enter the body (MDOL, 2010a). The spores germinate and replicate within the bloodstream, releasing toxins that eventually lead to death (Dragon and Rennie, 1995). The infected animal may initially have an increase in temperature and excitement, followed by a decrease in coordination, depression, loss of consciousness, difficulty breathing, and convulsions (MDOL, 2010a). Anthrax infection can be determined through testing, and may be treatable in captive bison and livestock with antimicrobials, such as penicillin and oxytetracycline (MDOL, 2010a; Gates et al., 2010). Although anthrax is not treatable in free-ranging wildlife, there are effective vaccines for captive bison and livestock (MDOL, 2010a; Gates et al., 2010). If anthrax is suspected, the healthy livestock should be removed from the affected pasture and placed in quarantine for 42 days, livestock in the surrounding region should be vaccinated, and carcasses or material contaminated with body fluids should be burned or buried at least 6 feet deep (MDOL, 2010a; ARM 32.3.1001).

Anthrax outbreaks occurred in herds of domestic cattle in Montana in Roosevelt County in 2005, and in two isolated regions of eastern Montana in 1999 (MDOL, 2010a). An outbreak of anthrax occurred in domestic bison in 2008 on a private herd in Gallatin County, killing over 287 bison (Ronnow, 2008; Person, 2010a). The ranch began a program of vaccination, and did not experience additional deaths until July 2010, when anthrax was isolated from the carcass of a bison calf that had been killed by predators (Person, 2010a; J. Rankin, personal communication). There have also been reports of anthrax within free-ranging bison in southern Saskatchewan (N. Anderson, Montana Fish, Wildlife & Parks, personal communication). A measure utilized to prevent the spread of anthrax in free-ranging bison herds is the monitoring and disposal of affected carcasses, as carcass scavenging may result in environmental contamination (Nishi et al., 2002).

Bluetongue

Bluetongue is an insect-borne, viral disease that primarily affects sheep, but can occasionally affect goats, deer, and antelope and very rarely affect cattle (APHIS, 2010a). Bison are susceptible to the virus, and infection has been observed under field and captive conditions (Dulac et al., 1988). Infection of humans has not been reported (APHIS, 2010a). The disease is caused by a virus that belongs to the Reoviridae family (APHIS, 2010a). The virus is noncontagious and cannot be transmitted between species without the presence of the insect carriers, which are various species of *Culicoides* midges (Stelljes, 1999; APHIS, 2010a).

The distribution and prevalence of the virus is dependent upon seasonal conditions and the presence of the insect vectors and susceptible animals. The midges prefer warm, moist conditions, and are most prevalent after periods of warmth and precipitation (APHIS, 2010a). Bluetongue is less prevalent in northern regions (Gates et al., 2010). The virus does

not survive outside of the host animal or the insect vector, and is not transmitted through animal carcasses or products (APHIS, 2010a).

The clinical signs of bluetongue include fever, widespread hemorrhages of the oral and nasal tissue, excessive salivation, nasal discharge, lameness, stomatitis, and occasional reproductive failure (Howerth et al., 2001; APHIS, 2010a). There are subacute, acute, and chronic cases. In acute cases the lip and tongue may become swollen, and a limited number of instances present a blue tongue (APHIS, 2010a). The virus may cause mortality within sheep, but mortality rates within the United States have been reported at around 5 percent (Stelljes, 1999). There is no known treatment for bluetongue, but the prevention of infection can be increased by using a combination of quarantine and movement control, treatment and husbandry practices to control the insect vectors, and zoning to define infected and disease-free regions (APHIS, 2010a).

Infection of bison has not been widely reported in North America (Gates et al., 2010). The testing of several public bison herds has not found seroreactors for the bluetongue virus (Gates et al., 2010). The USFWS found that bison that were located near a recent outbreak of bluetongue in deer did not show signs of infection (Gates et al., 2010).

Bovine Anaplasmosis

Bovine anaplasmosis (anaplasmosis) is a disease caused by *Anaplasma marginale,* which is a rickettsia that parasitizes the red blood cells of host animals (Davidson and Goff, 2001; Gates et al., 2010). There are multiple species of *Anaplasma* within the order Rickettsiales that infect domestic cattle, sheep, goats, and a variety of wild ruminants including deer, elk, and bison (Davidson and Goff, 2001). Anaplasmosis survives and reproduces within a host. It is not infectious for humans (Gates et al., 2010). Anaplasmosis occurs throughout tropical and subtropical regions of North and South America, Africa, Asia, Australia, and Europe (Davidson and Goff, 2001). The disease is not contagious between animals, but is transmitted primarily through blood-sucking insects (Gates et al., 2010). The most prevalent spreading of the disease occurs through ticks since the rickettsia can survive and reproduce within the tick (Davidson and Goff, 2001). Transmission from biting insects, including flies and mosquitoes, occurs less frequently because the rickettsia remains viable for only a short period of time on the insect's mouthparts and does not survive and reproduce within the insect (Davidson and Goff, 2001). The level of Rickettsemia in the carrier animal's blood may affect its transmission potential through biting insects. A biting fly with a low level of Rickettsemia does not appear to be able to transmit the disease (Davidson and Goff, 2001). Transmission has also been reported to occur through vaccination needles, or dehorning and castration equipment (Davidson and Goff, 2001).

Most infections of anaplasmosis are subclinical, and therefore the subjects do not display obvious symptoms. All naturally occurring infection among wild ruminants has been subclinical, except for two reports of acute cases in giraffes (Davidson and Goff, 2001). Domestic livestock may have acute, subacute, or chronic infection (Davidson and Goff,

2001). The clinical symptoms of the disease in bison are similar to those in domestic cattle, which include anemia, jaundice, emaciation, and debility (Gates et al., 2010). It is thought that bison may be more resistant than cattle since experimentally infected bison calves demonstrated only mild clinical signs (Zaugg and Kuttler, 1985; Gates et al., 2010).

Tests have been developed to identify anaplasmosis within domestic livestock, but serodiagnosis tests have not been as reliable for wildlife, often generating false results. Modern molecular diagnostic procedures have been more reliable for testing wildlife, but are less practical for larger samples (Davidson and Goff, 2001). Anaplasmosis has been managed within domestic livestock including bison through vector control, vaccination, and antibiotic therapy (Davidson and Goff, 2001). These management programs are not logistically feasible for free-ranging wildlife, and have not been implemented since the disease does not tend to compromise the health of wild bison.

Anaplasmosis is a disease of international regulatory concern, and therefore impacts livestock trade between Canada and the north-central and northwestern United States (Gates et al., 2010). Bison are a known host of *A. marginale* anaplasmosis (Gates et al., 2010). Naturally occurring anaplasmosis infection has occurred on the National Bison Range, where 15.7 percent of the bison have tested positive (Zaugg and Kuttler, 1985; Gates et al., 2010)

Bovine Brucellosis

Bovine brucellosis (brucellosis) is an infectious, contagious disease caused by a bacterium of the genus *Brucella* (Thorne, 2001; MDOL, 2010c). *Brucella* has six species, each with their own principal host. Bovine brucellosis is caused by the species *Brucellosis abortus,* whose primary hosts are cattle and bison (Thorne, 2001; Gates et al., 2010). Elk (*Cervus elaphus*) are also susceptible to brucellosis, and appear to contribute to the interspecies transmission in the Greater Yellowstone Area (Davis et al., 1990; Rhyan et al., 1997; Gates et al., 2010). A study by Proffitt et al. (2010) found that despite high levels of spatial overlap between elk and bison within Yellowstone National Park, "rates of elk exposure to *B. abortus* in this population were similar to rates of exposure in other Greater Yellowstone Ecosystem free-ranging populations not in contact with bison, and lower than rates in elk populations associated with feeding programs" (pp. 287). Proffitt et al. (2010) note that it therefore "appears that the high degree of spatial overlap with bison during the period of transmission risk has little impact on elk exposure to *B. abortus*" (pp. 287). DNA genotyping has indicated that there is a relatively high genetic divergence between the *Brucellosis abortus* found in elk and that found in bison, which suggests that the disease is not extensively exchanged between the two species (Beja-Pereira et al., 2009; White et al., 2011a, pp. 17).

Brucellosis is transmittable to humans and causes undulant fever, which is treatable (Thorne, 2001; MDOL, 2010c). The disease is transmitted to humans through consumption of unpasteurized milk or, more frequently, through direct contact with infected animals during birthing, abortion, or in slaughterhouses (MDOL, 2010c). "Infection by *B. abortus* is

rarely fatal in humans, but can cause severe, reccurring, fever-like symptoms. Humans cannot pass the disease to animals or other humans" (White et al., 2011a, pp. 15–16).

There have been two reports of hunters becoming infected with brucellosis in Montana (MDOL, 2010c). The first occurred in 1986, when it is believed that a hunter had been exposed to the disease while field dressing three elk in the Madison Range (Bridgewater et al., 1997). The second report was from 1995, when a hunter was diagnosed with brucellosis three years after field dressing a bull elk in 1991 (Bridgewater et al., 1997).

Bison being hazed back into Yellowstone National Park from Montana. PHOTO CREDIT: J. PEACO; COURTESY NPS

Brucellosis does not appear to be able to replicate outside of a host, but it can survive outside the host in certain environments (Thorne, 2001). A study by Aune et al. (2009) found that soil, vegetation, and tissue at birth or abortion sites of infected bison remained infected for up to 43 days in April and 26 days in May. Brucellosis is perpetuated naturally through growth in the female reproductive tract, particularly in the membranes and fluids that surround a fetus (Cheville et al., 1998). Within cattle and bison, the disease tends to localize in the udder and reproductive organs (Cheville et al., 1998; MDOL, 2010c). Cheville et al. (1998) note that "bison with non-reproductive-tract infection rarely develop bacteremia, nor do they shed bacteria in salvia, urine, or other body secretion. Thus, even when such animals are in direct contact, bison-to-cattle transmission and even bison-to-bison transmission will occur rarely" (pp. 19). The disease is transmitted primarily though oral contact with an infected fetus, calf, or placenta; through contaminated feed or water; or through licking the genitals of an infected female after a birth or abortion (Thorne, 2001; MDOL, 2010c; Gates et al., 2010). It is possible that both cattle and bison can shed the bacteria in their fecal matter after ingesting highly infected placenta (Cheville et al., 1998). Studies have indicated that male bison who are infected with brucellosis do not appear to transmit the disease to a female through breeding (Thorne, 2001).

Incubation within the animal can be from one week to seven months, and the infection does not present many observable outward signs (Cheville et al., 1998; MDOL, 2010c). The most obvious indication of infection within a pregnant animal is abortion, birth of weak calves, and vaginal discharge (MDOL, 2010c). More than 90 percent of infected bison will abort during their first pregnancy; this rate decreases to an abortion rate of 20 percent after the second pregnancy, and to nearly zero after the third, due to naturally acquired immunity (Davis et al., 1990; Davis et al., 1991; Gates et al., 2010). Male bison experience inflammation of the testicles, seminal vessels, and epididymis, and possible sterility in advanced cases (Thorne, 2001; Gates et al., 2010). Both male and female bison can experience enlarged, arthritic joints, which can lead to lameness and possibly an increased vulnerability to predation (Tessaro, 1989; MDOL, 2010c; Gates et al., 2010).

There are tests to determine if an animal is infected with brucellosis; however, accurate testing can be difficult to achieve due to false negative cultures, which relate to the difficulties in isolating bacteria from chronically infected animals (Cheville et al., 1998; Gates et al., 2010). Brucellosis may be identified through the detection of antibodies in the blood; however, the presence of antibodies does not imply current living infection and can lead to an overestimation of the true level of infection (Cheville et al., 1998; Gates et al., 2010). New tests have been developed that do not look for the antibodies, but for the antigen/antibody complexes (K. Aune, Wildlife Conservation Society, personal communication). It is possible for a cross-reaction to occur in false positive results due to exposure to bacteria that is similar in structure to brucellosis (N. Anderson, personal communication).

YNP bison being gathered for disease testing.
PHOTO CREDIT: J. PEACO; COURTESY NPS

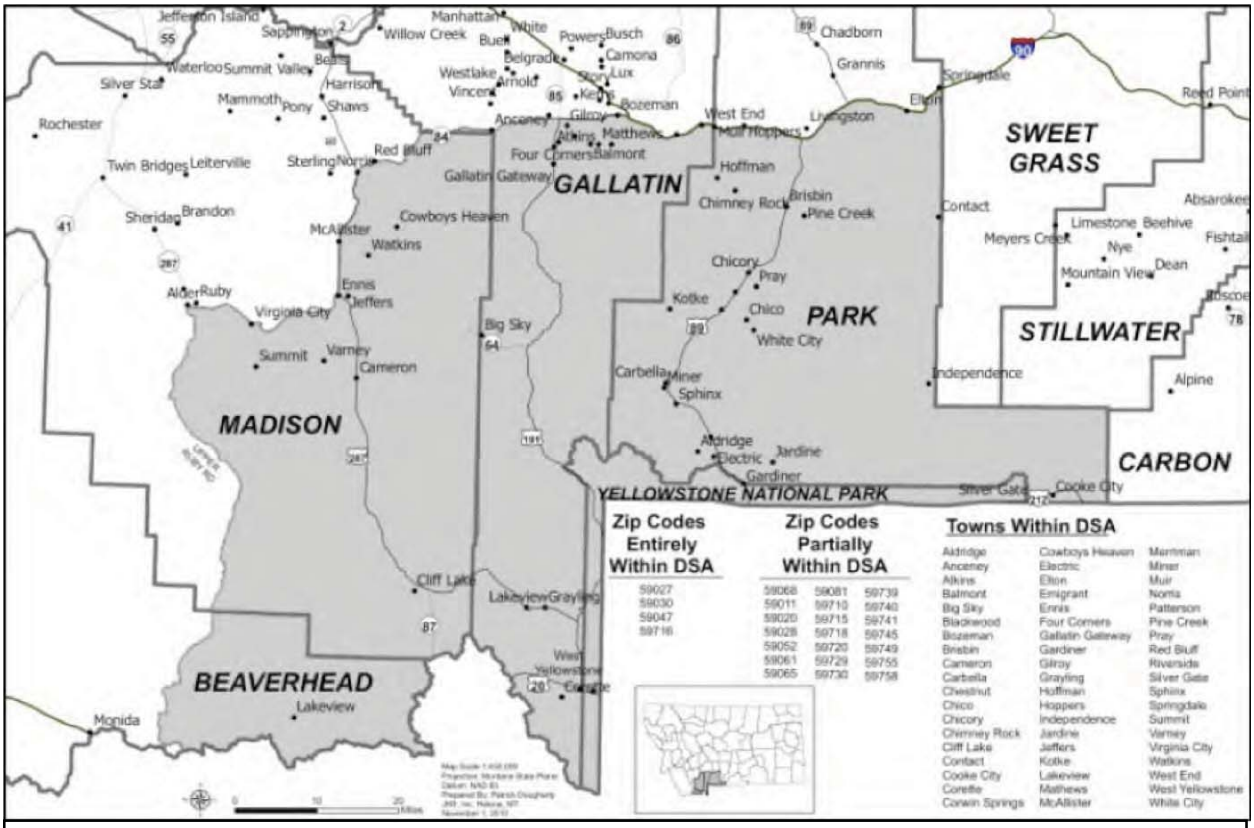
Currently there is no treatment for animals that have been infected with brucellosis (MDOL, 2010c). Many bison develop immune responses, but do not become free of the bacteria (Cheville et al., 1998). The MDOL (2010c) encourages the testing, vaccinating, and isolation of replacement stock, separation of domestic livestock from wild herds that are infected, maintenance of clean calving environments, and use of gloves when assisting in calving or abortions to reduce the transmission of brucellosis.

Through the vaccinating, testing, and culling of infected cattle, Montana was certified brucellosis free in 1985. The first cattle herd to test positive after 1985 was in May 2007 when seven cows that originated from a ranch near Bridger tested positive for brucellosis (Brown, 2007; J. Rankin, personal communication). A second herd tested positive for brucellosis following the detection of an elk serovar in a Paradise Valley cow (Brown, 2008; J. Rankin, personal communication). The detection of a second infected herd caused the state to lose its brucellosis-free status in 2008 (MDOL, 2010c; J. Rankin, personal communication). The state regained brucellosis-free status in July 2009 (J. Rankin, personal communication).

There are two vaccines for brucellosis in domestic cattle, and officials recommend the vaccination of female cattle in areas with heavy infection rates (APHIS, n.d.). Strain 19 was used from the 1930s until 1996, and was shown to be 65 to 67 percent effective in the prevention of infection and abortion in cattle (Cheville et al., 1998). Strain 19 was not as effective in bison and caused a high frequency of abortions (Davis et al., 1991; Gates et al., 2010). A new vaccine, Strain RB51, is now preferred to Strain 19 and does not have as many adverse effects on cattle as Strain 19, nor does it interfere with the accuracy of diagnostic tests as Strain 19 did (Cheville et al., 1998). Strain RB51 is approximately 50

percent effective in bison (Olsen et al., 2009). It has been shown to induce endometritis, placentitis, and abortion in adult bison, though it is believed that this may be related to the timing and location of the injection (Palmer et al., 1996; N. Anderson, personal communication). Strain RB51 does not appear to have significant adverse effects on bison calves (Roffe et al., 1999), and it has been provisionally approved for use in bison, though its safety and efficacy still remain unclear (Gates et al., 2010).

Montana Department of Livestock, Official Order No. 10-01-D



Map 8: Designated Surveillance Area from Official Order No. 10-01-D. Courtesy Montana Department of Livestock.

Official Order No. 10-01-D outlines the requirements for brucellosis vaccination and testing within Montana by establishing the surveillance requirements for brucellosis and a Designated Surveillance Area (DSA). Livestock owners within Beaverhead, Madison, Gallatin, Park, Sweet Grass, and Carbon Counties who have not submitted an Operation Specific Risk Survey to the MDOL, or completed a whole herd brucellosis test since January 1, 2009, must brucellosis-test cattle within 30 days prior to ownership with the following exceptions: Steers and spayed heifers and animals moving directly to slaughter do not need to be tested, and cattle that are being transferred to an approved Montana Livestock Market may be tested upon arrival.

Livestock producers operating within any part of Beaverhead, Gallatin, Madison, and Park Counties shall Officially Calfhood Vaccinate (OCV) all eligible animals, to include female cattle and domestic bison that are 4 to 12 months of age and sexually intact, prior to change of ownership. Female cattle or domestic bison that are not OCV eligible may become official adult vaccinates after completing a negative brucellosis test. This is by written permission of the Montana State Veterinarian.

In addition to requiring OCV of all eligible animals, livestock producers operating within the DSA are required to conduct annual whole herd testing of all sexually intact cattle or domestic bison. The current DSA boundaries, consisting of limited sections of Park, Gallatin, Madison, and Beaverhead Counties (See Map 8), were established based on the movement of elk herds that have exhibited some level of brucellosis seroprevalence. These boundaries are subject to change as more information is gathered on the extent of brucellosis in Montana elk herds (E. Liska, Montana Department of Livestock, personal communication). Producers within the DSA are required to test all age-eligible animals, which includes sexually intact male and female cattle over 12 months old, within 30 days prior to movement out of the DSA or within 30 days prior to a change of ownership. The following exceptions apply to the above testing requirements: Steers and spayed heifers or animals moving directly to slaughter do not have to be tested, and animals being transferred to an approved Montana Livestock Market may be tested upon arrival.

Brucellosis Management

In November 2010 the first report of a brucellosis infection in domestic bison occurred in Gallatin County. A seven-year-old bison cow from a closed herd showed signs of infection (Person, 2010b). The wild bison of Yellowstone National Park are considered to be chronically infected with brucellosis (Cheville et al., 1998), and quarantine protocols have been developed to eliminate all of the bison that have been exposed to brucellosis. A quarantine program such as this was successful in eliminating brucellosis in wood bison during the Hook Lake project (Nishi et al., 2002; Gates et al., 2010). The practice of vaccinating, testing, and slaughter has been successfully used to eliminate brucellosis in the Henry Mountains, Wind Cave National Park, and Elk Island National Park herds (Gates et al., 2010). The quarantine program that has been established for the Greater Yellowstone area is a pilot project, with a goal to produce bison that are free of brucellosis for use in establishing new herds or for the augmentation of existing herds (N. Anderson, personal communication).

As the prevalence and distribution of brucellosis within the United States has been greatly reduced due to effective eradication and testing programs, the U.S. Department of Agriculture's Division of Animal and Plant Health Inspection Service (APHIS) has proposed a new strategy that will allow a more effective and efficient application of limited resources toward minimizing disease risk (APHIS Veterinary Services, 2009). The proposed strategy would shift from state-by-state sampling to a national surveillance strategy that would allow a greater focus on regions of known reservoirs of the disease, such as the Greater Yellowstone Ecosystem (APHIS Veterinary Services, 2009). There would be a shift from

herd depopulation to the development of risk-based affected-herd management plans (APHIS Veterinary Services, 2009).

This strategy would move away from a whole state approach to one using established disease management areas that would be collaboratively managed by the state and federal government, thus minimizing the burden on individual states (APHIS Veterinary Services, 2009). This would also allow for a more effective approach to disease management and would minimize the economic impact on producers (APHIS Veterinary Services, 2009). Under this new strategy the status of the entire state would not be affected based on the infection of individual herds (APHIS Veterinary Services, 2009). There was a series of public meetings throughout the United States to obtain stakeholder input on the new strategy from January to March 2011. The projected time line is to have a published proposed rule by July 2011 and a published final rule by April 2012.

On December 27, 2010, APHIS adopted an interim rule in order to refocus resources to the control and prevention of brucellosis and to protect and maintain the economic viability of the livestock industry (75 FR 81090). The rule was open to public comment until February 25, 2011. This interim rule will reduce the amount of testing required to maintain Class Free status for states that have been Class Free for five years or more and do not have wildlife populations that are known to carry brucellosis (75 FR 81090). The interim rule also removes the provision for automatic reclassification of any Class Free State or area to a lower status if two or more herds have tested positive for brucellosis within a two-year period, or if a single herd that has shown signs of infection is not depopulated within 60 days (75 FR 81090). The interim rule lowers the age at which cattle are included in herd blood tests and requires any regions with brucellosis-infected wildlife to develop and implement a brucellosis management plan in order to maintain Class Free status. The rule also provides alternative testing protocol for dairy cattle herds to allow producers more flexibility for herd certification processes (75 FR 81090).

Bovine Spongiform Encephalopathy

Bovine spongiform encephalopathy (BSE), which is also referred to as "Mad Cow Disease," is one of the transmissible spongiform encephalopathies, which is caused by rogue, misfolded protein agents called prions that are lacking nucleic acids (Prusiner, 1982; Gates et al., 2010). BSE was identified in ten species of Bovidae and Felidae in zoological collections in the British Isles, including bison, though there has not been a case of BSE reported in bison in North America (Kirkwood and Cunningham, 1994; Gates et al., 2010). There have also been no reported wildlife cases of BSE in North America. There has been only one report of an infected cattle herd in Washington, and two cases of infection of atypical BSE in Alabama and Texas (Gates et al., 2010; J. Rankin, personal communication).

Research has shown that an animal becomes infected with BSE through the consumption of feed that is derived from infected animals (MDOL, 2010b). In order to prevent BSE in Montana, the MDOL issued an official order in March 2001, which states that "animal protein derived from mammalian tissues shall be prohibited in ruminant feeds

in Montana" (Official Order No. 02-01-001). "Protein derived from mammalian tissues means any protein portion of mammalian animals, excluding blood and blood products; gelatin; inspected meat products which have been cooked and offered for human food and/or further heat-processed for feed (such as plate waste and used cellulosic food casings); milk products (milk and milk proteins); and any product whose only mammalian protein consists entirely of porcine or equine protein" (Official Order No. 02-01-001).

BSE is a chronic degenerative disease that affects the central nervous system of the infected animal. The signs of BSE include abnormal posture, difficulty rising, a decrease in coordination, progressive weight loss, decreased milk production, low-level tremors, and possibly changes in temperament, such as nervousness or aggression (Gates et al., 2010; MDOL, 2010b). Though there are tests for BSE, there is not a treatment, and death tends to occur within six months of infection (MDOL, 2010b). The human consumption of BSE-contaminated food causes the new variant Creutzfeldt-Jakob disease, which is fatal in humans (Gates et al., 2010).

Bovine Tuberculosis

Bovine tuberculosis (BTB) is a chronic and progressively debilitating contagious disease caused by a bacterium that is part of the Mycobacterium group (MDOL, 2010e). There are three types of bacteria in the Mycobacterium group: *Mycobacterium bovis, Mycobacterium avium,* and *Mycobacterium tuberculosis* (MDOL, 2010e; Gates et al., 2010). BTB is caused by the bacterium *Mycobacterium bovis* and has the largest range of hosts of the Mycobacterium group with the ability to infect all warm-blooded vertebrates (MDOL, 2010e). Cattle and bison are the primary hosts for BTB, making them susceptible to infection and allowing the bacteria to grow and spread within them under natural conditions (Gates et al., 2010). BTB is zoonotic and therefore can be transmitted from livestock and wildlife to humans (MDOL, 2010e). Human infection is rare, and treatment requires six to nine months of antimicrobial drugs, but the treatment success rate is more then 95 percent (Gates et al., 2010). BTB replicates and grows within a host, and can only survive outside a host for a few weeks (MDOL, 2010e). The bacteria cannot tolerate prolonged exposure to heat, direct sunlight, or dry conditions, but under cold, dark, and moist conditions it may survive longer outside a host (MDOL, 2010e).

An animal or human becomes infected with BTB primarily though inhalation or ingestion of unpasteurized milk (J. Rankin, personal communication). Microscopic droplets, or aerosols, containing the BTB bacteria are expelled from the infected animal through exhaling or coughing, and then may be inhaled by a susceptible animal or human (MDOL, 2010e). Enclosed spaces, such as barns, increase the risk of infection from inhalation (MDOL, 2010e). Humans may also be infected if they have cuts or abrasions and come into contact with infected animals or their meat (Clifton-Hadley et al., 2001). Infection of offspring may occur through ingestion of contaminated milk, and humans may become infected through the consumption of unpasteurized milk from infected cows (MDOL, 2010e). Infection may also occur through communal water sources contaminated with saliva or other discharges from infected animals (MDOL, 2010e). Once the bacterium has

entered a new host, it may take many months to develop due to its slow growth rate. It is also possible for the bacteria to remain dormant within a host without causing the disease (MDOL, 2010e).

The signs and symptoms of BTB often do not become apparent until the advanced stages of the disease (MDOL, 2010e). Upon inhalation the bacteria enters the terminal bronchi and from there moves to the blood and lymph system, which allows it to spread throughout the body, causing chronic lesions that may become necrotic, calcified, and caseous (Clifton-Hadley et al., 2001; Gates et al., 2010). The clinical signs of the disease depend on which organs are affected, which can include respiratory, digestive, urinary, nervous, skeletal, and reproductive systems (Clifton-Hadley et al., 2001; Gates et al., 2010). As infection progresses it leads to a generalized stage, which causes weakness, debility, a reduction in fertility, and eventually death (Clifton-Hadley et al., 2001; Gates et al., 2010).

The immune response that results from a BTB infection allows detection of the disease through tuberculin skin tests, though this is not an effective test for wildlife as it requires a three-day waiting period for the results and produces false positives that require further testing (MDOL, 2010e; N. Anderson, personal communication). There is not an effective vaccine for BTB (Gates et al., 2010). There is evidence that individual domestic animals can be treated though the long-term use of antibiotics (Gates et al., 2010). This treatment is not practical for wildlife due to the need for long-term containment and the high cost of therapy (Gates et al., 2010). The MDOL (2010e) recommends controlling BTB within a domestic herd through repeated testing and culling of infected individuals; however, since this method is not guaranteed, they then recommend herd depopulation. Maintaining a closed herd may also reduce infection.

Current endemic infection within bison has only been documented in and around Wood Buffalo National Park in Canada (Clifton-Hadley et al., 2001; Gates et al., 2010). There have not been reported cases of BTB within bison herds in Montana. BTB has previously been detected in a few game farms within Montana. In the mid-1990s a mule deer and a coyote located near a BTB-infected game farm near Hardin tested positive for BTB (N. Anderson, personal communication).

Bovine Viral Diarrhea

Bovine viral diarrhea (BVD) is a disease caused by a virus that is a member of the *Pestivirus* genus (Van Campen et al., 2001). BVD infects a variety of domestic and wild ruminants (Loken, 1995; Van Campen et al., 2001). The virus is very common in cattle in North America, but there are few confirmed cases of pestivirus-caused disease in free-ranging ruminants, and no evidence that these viruses have significant population impact (Van Campen et al., 2001; Gates et al., 2010). BVD poses no known threat to humans (Gates et al., 2010). The virus is mainly transmitted to wildlife through interactions with domestic livestock, as the principal reservoirs of BVD are persistently infected cattle and sheep (Van Campen et al., 2001; Gates et al., 2010). BVD is transmitted from persistently infected animals to susceptible animals through direct contact, aborted fetuses, fetal membranes,

secretions, and shared food and water sources (Van Campen et al., 2001). It is believed that transmission of pestiviruses by acutely infected animals is inefficient (Van Campen et al., 2001). The factors that influence the persistence of BVD in a population are size and density, herd behavior, the timing of reproduction, and the survivorship of offspring (Van Campen et al., 2001). There is evidence of BVD in bison in the Greater Yellowstone area, and positive antibodies were detected in 31 percent of tested bison within Yellowstone National Park (Williams et al., 1993; Taylor et al., 1997). Pastoret et al. (1988) suggest that wildlife do not play a determinant role in the transmission of BVD to domestic livestock.

Infection within wild ruminants and cattle depends upon the immune status of the animal, the route of transmission, and the virulence of the isolate (Van Campen et al., 2001). The infection in cattle and sheep is usually subclinical (Van Campen et al., 2001). In cattle, acute infection typically occurs in younger animals and tends to be associated with diarrhea (World Organization for Animal Health, 2009). In an acute infection cows may suffer from infertility, and bulls may show a temporary decrease in fertility with the ability to shed the virus in their semen (World Organization for Animal Health, 2009). Some infections may cause fetal malformations, weakened offspring, death, or abortion in pregnant animals (Van Campen et al., 2001). Though rare, persistently infected cattle may eventually develop mucosal disease, which results in severe diarrhea, dehydration, fever, and loss of appetite, and often leads to death (Van Campen et al., 2001; World Organization for Animal Health, 2009).

There are tests to determine the presence of the antibodies that occur during exposure to BVD, and domestic livestock can be vaccinated (Van Campen et al., 2001). Animals can develop immunity to the virus, though there does not appear to be a proven treatment (Van Campen et al., 2010). Maintaining a closed herd and quarantining replacement stock is recommended to reduce the chance of infection. Maintaining a clean environment and preventing contact with biological waste and birthing fluids can also reduce the risk of infection (Van Campen et al., 2001).

Johne's Disease

Johne's disease, or paratuberculosis, is caused by the bacterium *Mycobacterium avium,* subspecies *paratuberculosis,* which occurs worldwide in a variety of wild and domestic ruminants including bison, cattle, and sheep (Buergelt et al., 2000; Williams, 2001; Gates et al., 2010). Johne's disease typically enters a herd when a healthy but infected animal is introduced. An animal is most susceptible to the disease during the first year of life. Infection occurs when the newborn swallows a small amount of infected manure from the birthing environment or the udder of an infected mother. Infection may also occur while the animal is in the uterus or through the milk and colostrum (APHIS, 2010b). The bacterium that causes the disease may survive in the soil or water after fecal contamination for over a year, but will not grow and multiply outside the host species (APHIS, 2010b). Humans are not at risk of Johne's disease from either livestock or wildlife (Gates et al., 2010).

The clinical signs of the disease rarely present themselves until two or more years after the initial infection. Johne's disease primarily affects the small intestine of ruminants, and signs of the disease include weight loss and diarrhea with a normal appetite, decreased milk production, and mortality (Gates et al., 2010; APHIS, 2010b). Once an animal has begun to show signs of the disease, it can shed the bacteria within its feces (Gates et al., 2010). There is no known treatment for Johne's disease, and the disease typically leads to mortality. Certain cattle herds are enrolled in the Voluntary Johne's Disease Herd Status Program, which identifies herds of low risk through repeated testing. The best ways to prevent the spread of Johne's disease are the maintenance of a clean birthing environment, the removal of females that test positive from the herd, the removal or culling of offspring born to infected females, implementation of practices to prevent manure contamination of feed, and replacement of stock from low-risk herds (Gates et al., 2010; APHIS, 2010b). Within bison, there have not been reports of Johne's disease within conservation herds, though some commercial herds have had cases (Gates et al., 2010).

Malignant Catarrhal Fever (sheep associated)

Malignant catarrhal fever (sheep associated)(MCF) is a disease caused by a virus of the genus *Rhadinovirus* (Gates et al., 2010). There have been at least ten MCF viruses recognized worldwide, and five have been linked to disease within sheep, goats, cattle, and pigs (Gates et al., 2010). Within bison, MCF is caused by infection of the ovine herpes virus type two. Ovine herpes virus type two's natural host is domestic sheep, and though domestic sheep carry the virus they do not express the disease (Heuschele and Reid, 2001; Gates et al., 2010). Testing has indicated that the virus is common in the United States in domestic goats (61 percent) and sheep (53 percent) (Li et al., 1996; Gates et al., 2010). Non-natural host animals that develop MCF are not considered contagious and may be dead-end hosts (Heuschele and Reid, 2001). MCF infection in bison is highly lethal, with almost 100 percent mortality within an infected herd (Schultheiss et al., 2001). Studies have shown that bison herds that are not associated with domestic sheep do not show evidence of MCF (Gates et al., 2010). There is no evidence that MCF is infectious in humans (Heuschele and Reid, 2001; Gates et al., 2010).

After initial infection, sheep experience periodic reactivation episodes in which they can transmit the virus (Heuschele and Reid, 2001). Inhalation of aerosol droplets and ingestion of food contaminated with the virus through feces, nasal secretions, and tears are the most common modes of transmission (Heuschele and Reid, 2001). Bison mostly become infected through direct contact with domestic sheep, though MCF was reported in bison herds that were located 3 miles from a lamb feedlot (Schultheiss et al., 2001; Gates et al., 2010).

MCF is expressed in two forms in bison, acute and chronic. In acute cases the bison typically dies within seven to ten days of infection, or within 48 hours of showing symptoms. In some cases death may not occur for as long as two months following infection (Schultheiss et al., 2001; Gates et al., 2010). It is also possible for an infected animal to survive, but remain persistently infected (Schultheiss et al., 2001). Clinical signs

of MCF within bison include hemorrhagic cystitis, colitis, conjunctivitis, ocular discharge, nasal discharge, excess salivation, loss of appetite, diarrhea, melaena, haematuria, multifocal ulceration of the oral mucosa, fever, circling, ataxia, blindness, lameness, and difficultly urinating (Liggitt et al., 1980; Schultheiss et al., 1998; Heuschele and Reid, 2001; Gates et al., 2010).

It is possible to test for the presence of infection, though there is currently no vaccine or effective treatment for MCF (Heuschele and Reid, 2001). In order to reduce the spread of MCF from domestic livestock to bison, bison should not be grazed in the same pastures or adjacent to sheep pastures, especially during lambing periods (Heuschele and Reid, 2001; Gates et al., 2010).

Management

Bison/Livestock Interactions

Free-ranging bison and cattle have coexisted within the same regions of the Henry Mountains in Utah since the 1940s. The cattle are managed within a traditional fencing system and the bison are able to move across the landscape. Observations of interactions between the two species have shown that they will sometimes graze within close proximity of one another, with neither species altering its behavior in response to the other until about 13 feet apart (Van Vuren, 2001). When bison and cattle did come within 13 feet of each other, the cattle either altered their direction away from the bison, or moved aside as the bison approached (Van Vuren, 1980; 2001). During a few observations bison were openly aggressive toward cattle. This mainly occurred with yearling bison. Cattle were always submissive and were driven an average of 13 feet away during these interactions (Van Vuren, 1980). Studies have found that dominance hierarchies between different species are complicated by the observation that the social rank of individual animals within their own species influences how they behave toward other species. For example, if an individual is timid and low ranking within its own herd, it will tend to behave this way toward an individual of another species (Mosley, 1999).

Bison and domestic cattle coexist in Henry Mountains. PHOTO CREDIT: A. DOOD

The experience that ranchers have had with bison and cattle interactions have been similar in Saskatchewan with the free-ranging Sturgeon River Plains Bison Herd. Regional ranchers have reported that they occasionally see bison in the presence of cattle, but they have not had incidents of bison harassing the cattle, and note that the two species seem pretty tolerant of each other (G. Vaadeland, personal communication). There have been no observed occurrences of male bison attempting to breed with cattle within the Sturgeon River Plains Bison Herd (G. Vaadeland, personal communication).

Grazing

Montana has a long-standing tradition of allowing private citizens to graze domestic livestock on public lands. This practice is important for the economic viability of individual ranchers and communities within the state. Prior to the ratification of the Taylor Grazing

Act in 1934, ranchers in Montana assumed a "right" to graze livestock on public lands. The language within the Taylor Grazing Act defined the grazing of private livestock on public lands as a privilege and not a vested right.

Though recognized as a privilege and not an inherent right, the continuation of the practice of private grazing on public lands is essential to ensure the survival of domestic livestock ranching in Montana. With the passage of the Taylor Grazing Act and the Multiple-Use Sustained Yield Act, a focus was placed on balancing the need to graze domestic livestock on public land with concerns for range health, watershed protection, and the resource needs of wildlife.

Currently within Montana private grazing occurs on a variety of public lands that are managed by independent agencies. The largest landowners that allow public grazing are the U.S. Forest Service, Bureau of Land Management, and Department of Natural Resources and Conservation.

There are nine national forests under management of the U.S. Forest Service (USFS) in the state. Within its grazing program the USFS permits an overall number of animal unit months (AUMs) that may be issued. Based on evaluations of range health and seasonal condition, the USFS determines how many AUMs will actually be authorized each year and then awards grazing allotments to private citizens. The number of permits allowed and then authorized can differ among the national forests. A combined total of approximately 491,970 AUMs were authorized on the national forests in Montana based on AUMs authorized in 2010 for Flathead, Gallatin, Kootenai, Lewis and Clark, Lolo; 2009 for Bitterroot, Custer, and Helena; and 2008 for Beaverhead-Deer Lodge. The allotments are used primarily for cattle grazing, but there is some limited grazing of horses and sheep.

The Bureau of Land Management (BLM) manages around 7,500,000 acres throughout Montana and maintains an active grazing program. The BLM had approximately 1,270,000 currently active AUMs for 2010. The allotments are primarily for cattle, but there are a limited number of horse, domestic bison, sheep, goats, and burro grazing allotments.

Another type of public land that has an active grazing program within Montana is the state trust lands, which are managed by the Montana Department of Natural Resources and Conservation (DNRC). There were approximately 996,195 active AUMs on DNRC-managed lands in 2010.

Fencing

When examining the effectiveness of fencing, it is important to recognize that the purpose of the fence has a large impact on evaluations of its effectiveness. Most of the information pertaining to the effectiveness of fencing related to bison comes from those who are attempting to contain domestic bison and deter their natural instinct to move to better habitat. Fencing is viewed differently when it is recognized as a way to keep

domestic livestock contained while allowing wildlife to move across the landscape. For example, if a fence is meant to contain a captive bison herd and the animals are able to jump the fence, then it is ineffective; however, if the purpose is to contain other domestic livestock and allow free-ranging bison to move across the landscape by jumping the fence, then it is considered effective.

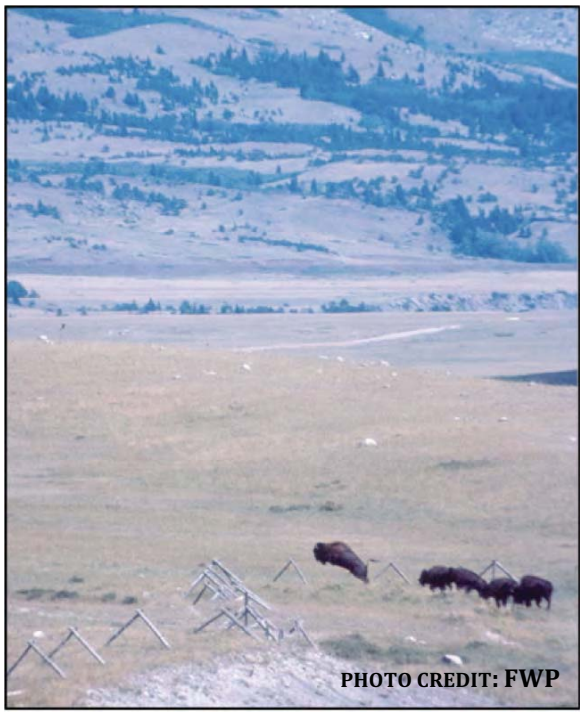


PHOTO CREDIT: FWP

When evaluating a fence's ability to contain captive bison, it is important to consider the following factors, as they may enhance or hinder the effectiveness of fencing. Whether or not a fence is constructed and maintained properly will have a large impact on its ability to contain bison. The ability of the herd to access the proper quality and quantity of food and water is essential to maintaining them within fencing, as bison's motivation to breach the fence will increase if attractive food or other objects are on the other side of the fence (Gates et al., 2010). If bison are to be maintained in captivity on larger sections of public land, fencing needs to be used to rotate bison through established seasonal ranges. The density of bison can impact the effectiveness of fencing, with effectiveness decreasing as density increases (Gates et al., 2010). The age and sex structure of the herd can impact the effectiveness of a fence. For example, to ensure genetic variation it has been recommended that sex ratios be close to 50/50. However, this ratio will increase the competition between bulls, and could lead to containment difficulties as less-dominant males try to roam. Snowpack and drift can also have an impact on the ability of a fence to contain bison (Gates et al, 2010; C. Knowles, Wildlife Biologist and Bison Rancher, personal communication). Another important factor in evaluating the effectiveness of fencing is determining the impact it may have on all other wildlife species in the area.

Properly constructed and maintained electrified high-tensile fencing appears to be highly effective in containing captive bison herds (Lee, 1990; Butterfield Sr., 1990; Karhu, 2004; Quitmeyer et al., 2004; Dixon, Manager Snowcrest Ranch, personal communication). Maintenance of high-tensile electric fencing is minimal, with most of the maintenance issues occurring due to improper construction (Lee, 1990; Quitmeyer et al., 2004). Familiarity with electric fencing deters domestic bison from contact. Typically domestic bison do not rub on high-tensile electric fencing (Lee, 1990). It has been observed that bison are easier to train to respect electric fences than cattle (Dixon, personal communication). While electric fencing does appear to be more effective than other types of fencing in containing bison, bison handlers have reported that when electric fences short out, bison quickly test the fences and move through them (C. Knowles, personal communication).

There is support that properly maintained three-wire, four-wire, and five-wire high-tensile electric fences are all effective for containing domestic bison (Lee, 1990; Butterfield Sr., 1990; Karhu, 2004; Quitmeyer et al., 2004; Paige, 2008; Dixon, personal communication). If three-wire fencing is properly constructed and maintained, it should contain bison and cattle yet be traversable by both adult and juvenile deer, elk, moose, and pronghorn antelope (Karhu, 2004; Quitmeyer et al., 2004; Paige, 2008). Four-wire fencing has not been proven to offer better control of bison or cattle, but it can be difficult for elk and moose to traverse (Karhu, 2004). Dixon recommends a five-wire high-tensile electric fence, which is 48 inches in height with an 18-inch bottom wire (personal communication). However, FWP's *A Landowner's Guide to Wildlife Friendly Fences: How to Build Fence with Wildlife in Mind* (Paige, 2008) strongly cautions against fencing over 42 inches. L. Feight, High County Ag Marketing Inc., notes that three-wire high-tensile electric fencing is effective for 2 to 3 miles from the energizer; however, if a fence has to run farther from the energizer it is better to increase the number of strands. This is because the farther the electricity has to travel, the more strands will be needed to deliver an effective shock (personal communication).

A study of the effectiveness of three-wire high-tensile electric fencing to contain bison by Quitmeyer et al. (2004) examined the following tests. First, two yearling separation tests, which separated cows from their calves in the fall in a corral or in a pasture setting, were conducted, and in each case there was 100 percent containment of the bison. Second, two bull-cow separation tests, which separated bulls from cows that were coming into estrus, were conducted. In the first test there was 100 percent containment. During the second test there was 95 percent containment, as three of the bulls escaped without any damage to the fencing and two cows were pushed through the fence when the herd was crowded into a corner. The Quitmeyer et al. (2004) study also conducted one test to determine the fence's effectiveness in excluding bison from a winter wheat field, which was 100 percent effective.

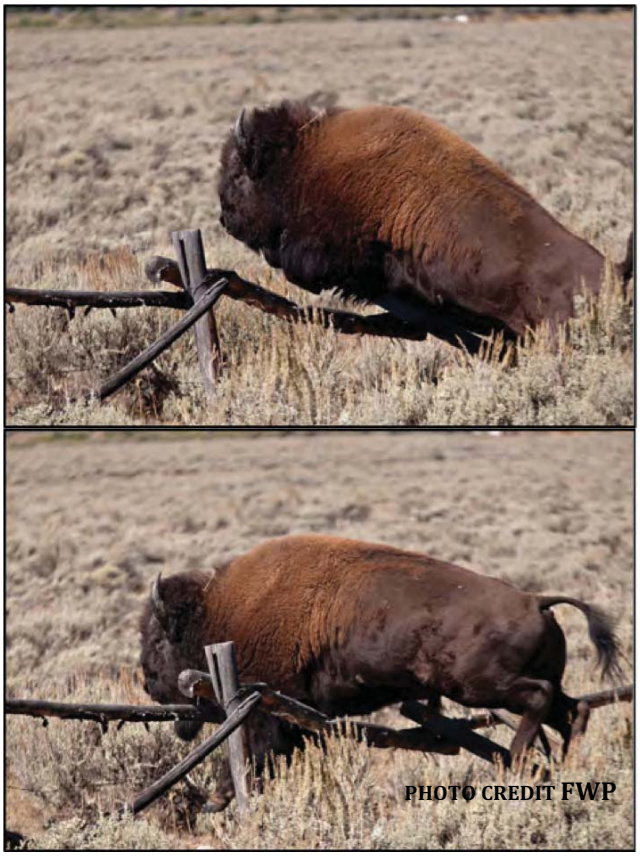


PHOTO CREDIT FWP

Maynard Barrows noted in a letter from 1937 that "in the buffalo show pasture at YNP, several small hills were being overgrazed. An electric fence of three strands of (electric) barbed wire, spaced about 18 inches apart, was set up around one of these hills. So long as supplied with current it kept the buffalos out" (McAtee, 1939).

A wild animal that is unfamiliar with fencing often will investigate the fence with its nose, leading to a severe shock, which deters crossings (Mckillop and Sibly, 1988). Attaching objects such as plastic strips or plastic bottles will increase the likelihood that wildlife will stop and investigate an electric fence and subsequently be shocked (Paige, 2008). Averse conditioning, as well as the increased awareness of fencing, will decrease the likelihood that wildlife will cross the fence (Mckillop and Sibly, 1988), yet reports from private landowners who share their region with free-ranging herds suggest that if bison are being pursued by humans, "there isn't a fence in the world that will stop them" (G. Vaadeland, personal communication).

One of the main concerns with high-tensile wire is that it tends to stretch, and therefore does not readily break when an animal becomes entangled. It is recommended that electric fencing be equipped with energizers, which increase the amperage and voltage, and thus the power of the electric shock, on the fence line for brief periods of time. The periods of increased electric shock deters crossing, but the periods of decreased strength allow humans and animals to free themselves from a fence should they become entangled (Lee, 1990).

Barbed wire fencing has also been used to contain domestic bison herds. Some landowners recommend five wires with a height of about 5 feet 6 inches, though others note that a properly maintained three- or four-wire fence will deter free-ranging bison and/or contain domestic bison (Butterfield Sr., 1990; G. Vaadeland, personal communication). Barbed wire fencing can be highly problematic for wildlife species, however, especially if wires are loose or are spaced too closely (Paige, 2008). Many wildlife species, including native ungulates and birds, become tangled in barbed wire fencing and perish (Paige, 2008).

Woven wire fencing that is 48 inches high with two or three barbed wire strands at the top has also proven successful in containing captive bison (Butterfield Sr., 1990). However, woven wire creates a complete barrier to fawns and calves, which are then separated from the herd and perish. It also creates a barrier for other wildlife species, such as bears or bobcats, that are not able to jump or slip through (Paige, 2008). Woven wire becomes a complete barrier when it is topped with barbed wire, especially for fawns, calves, pronghorn, and other animals that are unable to jump such a fence (Paige, 2008). A study that examined 600 miles of different fence types for two seasons found that woven wire fence topped with a single strand of barbed wire was the most lethal type of fence. This was due to the increased chance that an animal's leg would become tangled between the barbed wire and the rigid woven wire (Paige, 2008).

When containing a captive bison, it is recommended that fence lines be higher than the bison's line of sight (Butterfield Sr., 1990). Knowles notes that he has found that 48 inches is the minimum height needed to deter bison from attempting to cross (personal communication). Regardless of fence type, the impact to wildlife must be considered when deciding upon fence height.

If bison need to be managed in a quarantine program, a significantly taller and stronger fence is required. It is recommended that quarantine fencing be at least 7 feet high to prevent bison from jumping out (Dixon, personal communication). If a quarantined bison were to escape and mix with non-quarantined animals, then all of the non-quarantined animals would have to be placed in quarantine (M. Frisina and S. Knapp, Montana Fish, Wildlife & Parks, personal communication). The purpose of a quarantine fence is to keep non-quarantined bison, livestock, and wildlife from coming into nose-to-nose contact with the quarantined bison. Therefore it is recommended that the fence be constructed of high-tensile woven wire with a strand of high-tensile wire as a top strand (Dixon, personal communication).

Raymond Ranch elk jump that bison learned to jump, but neighboring domestic cattle did not.
PHOTO CREDIT: A. DOOD

The interactions of free-ranging bison with fencing have been studied within the northern boundary of Yellowstone National Park. Observations by Scott (1992) of wildlife crossings of an approximately 6-foot buck and pole fence during the winter showed that bison did not cross the fence if it was intact. A small number of bison crossed the obstacle by breaking rails, or by using the 3-foot 3-inch irrigation ditches that ran under the fence. The majority of bison that came into contact with the fence would walk along the fence downhill until they were able to circumvent it or until they reached an open gate. Meagher (1989) observed that bison went around an 8-foot-2-inch-high fence constructed of cable, woven wire, and wooden snow fence.

Due to the limited number of free-ranging bison herds, there is a general lack of information on the impact that free-ranging bison have on fences. Further observation of the few existing free-ranging herds and their impact on fencing is needed to develop creative management solutions.

Hunting

FWP utilizes hunting as a wildlife management tool and as a means to generate public interest in the conservation of a species. In 2005 FWP began issuing permits for "fair chase" bison hunting within limited regions adjacent to Yellowstone National Park. The Montana bison hunt has been used to cull bison that exit the park, and increase the interest of the sportsman community in the species and its management. The number of bison that exit the park varies from year to year, and therefore hunter success has varied, from 46 bison taken in 2005–06, 57 in 2006–07, 167 in 2007–08, and only one bison in

2008–09. The bison season for 2010–11 was set from November 15, 2010 to February 15, 2011. During the 2010 bison season, it is estimated that 26 were harvested by state hunters and 185 were harvested by tribal treaty hunters.

Year	Applications	Successful Drawing Applicants
2004	8,373	10*
2005	6,178	24
2006	6,210	74
2007	4,402	38
2008	3,079	36
2009	10,363	36
2010	7,754	34
*The hunting season did not begin until 2005. The successful 2004 applicants were given a 2005 license; therefore there were 34 licenses issued in 2005.		

Table 2: Number of Applications and Successful Applicants for Bison Hunting Tags in Montana. Data provided by N. Whitney, FWP

Hunters from the Confederated Salish and Kootenai, the Shoshoni-Bannock, the Nez Perce, and the Umatilla tribes are able to hunt bison in regions of Montana surrounding Yellowstone National Park based on the off-reservation hunting rights within their respective treaties. The four tribes exercise these hunting rights to harvest bison during the 2010–11 season. In addition to the four tribes listed above who are exercising their off-reservation hunting rights, a legislative statute preserves the limited rights to hunt bison of the Assiniboine and Sioux, Blackfeet, Chippewa Cree, Crow, Gros Ventre and Assiniboine, Northern Cheyenne, and Little Shell Band of Chippewa (MCA 87-2-731).

One common misperception is that bison are less wary of humans than other wildlife. This is because most people are exposed to bison that are in domestic herds or in protection, such as in a national park. Yet regions that maintain free-ranging populations of hunted bison report that bison become very wary of humans, resulting in an experience similar to that with other big game species. Game managers in Utah report that hunting has caused bison to become very wary of human presence with a strong tendency to flee at the sound of a stopping vehicle or the smell of approaching hikers (K. R. Hersey, Utah Division of Wildlife Resources, personal communication). Bob Hayes, a biologist for the Kluane region of the Yukon, notes, “hunting pressure is changing the behaviour of these animals. They’re moving away from places where people commonly saw bison the last few years in late winter and they’re clearly avoiding people, going to places that are difficult to go to” (CBC News, 2001).

Hunting is used as a bison management tool in Alaska, Alberta, Arizona, British Columbia, South Dakota, Utah, and Wyoming. The cost of a 2010–11 bison license in the state of Montana was $125 for residents and $750 for nonresidents. Table 3 outlines the cost of a bison license for the 2010–11 season for other states and provinces.

Region	Type of License	Resident	Nonresident
Alaska	General Bison License	General hunting license fee	$450.00 nonresident
			$650.00 alien nonresident
Arizona	Bull	$1,095.00	$5,452.25
	Cow	$659.50	$3,262.75
	Cow or Yearling	$659.50	$3,262.75
	Yearling	$362.75	$1,754.75
Alberta	General Bison License	$50.00	Not offered
British Columbia	General Bison License	$70.00	$700.00
South Dakota	Trophy Bull	$5,000.00	$5,000.00
	Non-Trophy Bull	$1,500.00	$1,500.00
	Cow	$1,000.00	$1,000.00
Utah—Henry Mountains	General Bison License	$408.00	$1,513.00
Utah—Antelope Island	General Bison License	$1,105.00	$2,610.00
Wyoming	General Bison License	$402.00	$2,502.00

Table 3: Prices of Bison Licenses in Other Regions. The prices listed above are for hunting tags only and additional hunting licenses and application fees may apply. (Alaska Department of Fish and Game, Arizona Game and Fish Department, Government of Alberta Sustainable Resource Development, British Columbia Ministry of Environment, South Dakota Game, Fish and Parks, Utah Division of Wildlife Resources, Wyoming Game and Fish Department; personal communications).

The number and types of licenses/permits that are issued, as well as the format of hunts within each region, changes based on the current bison population and management objectives. In Custer State Park, hunters are guided by state agency staff and have three consecutive days to harvest their bison. Ten trophy bull, 25 non-trophy bull, and 10 cow permits were issued for the 2011 season (South Dakota Game, Fish and Parks, personal communication). The Delta bison hunt in Alaska generates 15,000 applications annually for approximately 100 permits. Nonresidents must be accompanied by a guide (Alaska Department of Fish and Game, 2010). In Utah six permits are issued annually for the herd on Antelope Island. The number of permits issued for the Henry Mountains has been approximately 170 in past years. This number was reduced to 39 for 2010 since a number of bison have been transferred to the Book Cliffs (Utah Division of Wildlife Resources, personal communication). In 2010 Wyoming issued 80 “any bison” tags and 200 cow tags (Wyoming Game and Fish Department, personal communication).

Because of their wariness of humans and the resulting difficulty to hunt on both the House Rock Wildlife Management Area and the Raymond Ranch Wildlife Management Area (WMA), the Arizona Game and Fish Department employs three different types of hunts. First is a general season hunt, which occurs in the spring and fall on both wildlife management areas. For 2010, 14 spring hunt permits were issued for the House Rock WMA, but there were no fall hunting permits issued in an attempt to entice bison to move back onto the wildlife management area from neighboring Grand Canyon National Park (B. Wakeling, Arizona Game and Fish Department, personal communication). Four permits were issued for both the spring and the fall hunt for the captive Raymond Ranch bison. A wildlife manager accompanies hunters on the Raymond Ranch, and specific bison are preselected for harvest (B. Wakeling, personal communication). The bison population in Arizona is also managed through a population management hunt. The Arizona Game and Fish Commission sets a maximum number of Population Management Hunt Permits, then the director quickly issues these permits throughout the year if population objectives are not being met through the regular hunt or if bison escape from the Raymond Ranch (B. Wakeling, personal communication). Finally, companion tags are used in Arizona as an additional bison population management tool. Hunters of other big game species on the House Rock WMA have the opportunity to purchase companion bison tags. The companion tags allow for the additional annual harvest of bison should they move back onto the wildlife management area (B. Wakeling, personal communication).

Harvested bison. PHOTO CREDIT: FWP

Native American Off-Reservation Hunting Rights

Many of the tribes who were native to Montana and surrounding regions entered into treaties with the U.S. government that preserved their right to continue to hunt bison outside of their respective reservations. Due to subsequent treaties and treaty disputes, many of these rights are still being contested. The following is an attempt to summarize some of these preserved off-reservation hunting rights. Note that if a Native American tribe is not included in the list below, it does not mean that they do not have off-reservation hunting rights.

Blackfeet Nation

Members of the Blackfeet Nation, which is made up of descendents of the Blackfeet, Kainah or Bloods, and Piegans, preserved their right to hunt outside of their reservation on what is known as the Badger Two Medicine Area, or the "ceded strip" (Juneau, 2009). Following the original designation of the Blackfeet Nation's reservation, an agreement was signed in 1895 and ratified in 1896, which ceded part of the existing reservation to the United States (Kappler, 1904). The ceded region consisted of "a strip of land, along the west side of the Blackfeet Reservation, from the crest of the Continental Divide east to the foothills, using the center high points of Chief Mountain and Heart Butte as key references for the north and south ends" (USFS, 2005). The right of the Blackfeet Nation to hunt on this land was preserved under Article I, which stated "that the said Indians hereby reserve and retain the right to hunt upon said lands and to fish in the streams thereof so long as the same shall remain public lands of the United States under and in accordance with the provisions of the game and fish laws of the State of Montana" (Kappler, 1904, pp. 605).

Confederated Salish and Kootenai Tribes

The Confederated Salish and Kootenai Tribes (CSKT), composed of the Bitterroot Salish, the Pend d'Oreille, and the Kootenai, maintain hunting rights outside of the Flathead Reservation through their respective signatures of the Treaty of Hellgate. The Treaty of Hellgate, which was signed in 1855 between the United States and the confederated tribes of the Flathead, Kootenai, and Upper Pend d'Oreille preserved the rights of these respective tribes to continue to hunt outside of their reservation's land. Under Article III the tribes retain the "privilege of hunting, gathering roots and berries, and pasturing their horses and cattle upon open and unclaimed land" (Kappler, 1904, pp. 723). "The CSKT consider all state and federal land that is "open and unclaimed" (e.g., not some of the designated parks) "within the Tribes' aboriginal territory to be places that tribal members can exercise off-reservation treaty hunting rights, consistent with CSKT member hunting regulations" (J. Harrison, Confederated Salish and Kootenai Tribes, personal communication).

Crow Tribe

The Crow tribe's right to hunt for game including bison off their reservation land was preserved through the ratification of the 1868 Fort Laramie Treaty. Under Article IV of this treaty it is stated that the Crow "shall have the right to hunt on the unoccupied lands of the United States so long as game may be found thereon, and as long as peace subsists among the whites and Indians on the borders of the hunting districts" (Kappler, 1904, pp. 1009).

Shoshone and Shoshone-Bannock Tribes

The 1868 Fort Bridger Treaty preserved the rights of the Eastern Shoshone tribe of

the Wind River Reservation in Wyoming and the Shoshone-Bannock tribes of the Fort Hall Reservation in Idaho to hunt on lands outside of their respective reservations (Kappler, 1904). Article IV of the treaty states that the tribes "shall have the right to hunt on the unoccupied lands of the United States so long as game may be found thereon, and so long as peace subsists among the whites and Indians on the borders of the hunting districts" (Kappler, 1904, pp. 1021).

Nez Perce Tribe

The Nez Perce Treaty of 1855 preserves the right of the Nez Perce to hunt on land outside of their reservation, which is located in Idaho. This preservation of hunting rights is articulated under Article III of the 1855 Treaty. Article III states that the Nez Perce retain "the privilege of hunting, gathering roots and berries, and pasturing their horses and cattle upon open and unclaimed land" (Kappler, 1904, pp. 703).

Confederated Tribes of the Umatilla Reservation

In accordance with the Treaty of 1855 between the United States and the Walla Walla, Cayuse, and Umatilla tribes, members of the Confederated Tribes of the Umatilla Reservation were reserved the right to hunt on land outside of their reservation. Under Article I of the 1855 Treaty Between the Cayuse, Umatilla and Walla Walla Tribes, in Confederation, and the United States, it states "the privilege of hunting, gathering roots and berries and pasturing their stock on unclaimed lands in common with citizens, is also secured to them" (Kappler, 1904, pp. 695). According to the 2010 Treaty Hunting Seasons and Regulations, the 1855 Treaty preserves the right of enrolled tribal members to hunt on state and federal lands where hunting is a permitted use, including all national forest lands, state forest lands, Bureau of Land Management lands, and national wildlife refuges where hunting is permitted (Confederated Tribes of the Umatilla Indian Reservation Department of Natural Resources, 2010).

Public Safety

"As with other species of large herbivores (e.g., moose and elk), bison pose small, but manageable, risks of personal injury" (Gates et al., 2010, pp. 111). The two free-ranging bison programs in Utah have not had any reported incidents of bison threatening or injuring humans, even though the region of the Henry Mountains occupied by bison has seen a large increase in public recreational use (K.R. Hersey, personal communication). Uses include backcountry travel, mountain biking, horseback riding, ATV use, camping, hiking, and hunting. An outdoor educational school also utilizes the region, taking large groups of young men and women into the backcountry to learn survival and leadership skills (Utah Division of Wildlife Resources, 2007b). As a result of hunting, the Henry Mountains bison have become very wary of humans, with most tending to flee at the sound

of a stopping vehicle or the smell of approaching hikers (K.R. Hersey, personal communication).

Those involved in the management of the free-ranging Sturgeon River Plains Bison Herd, which moves between Prince Albert National Park and the surrounding region of Saskatchewan, have not had any reported incidents involving human injury as a result of contact with bison (G. Vaadeland, personal communication). There was one instance of a man being charged by a bull bison that he startled on a trail. The bison pushed him into a bush, but he escaped without reported injury (G. Vaadeland, personal communication). A similar incident occurred on Antelope Island in Utah, and the hiker sustained broken ribs, though the details of the incident were unclear (S. Bates, Utah Division of Wildlife Resources, personal communication). Landowners in Saskatchewan have reported that bison tend to move off when humans enter an area, noting that it is possible to approach them more closely on horseback, but "if you can get as close as 50 yards, you are lucky" (G. Vaadeland, personal communication).

Bison moving through a Yellowstone National Park campground.
PHOTO CREDIT: J. PEACO; COURTESY NPS

Bison that are habituated to humans often exhibit a mild-mannered domestic cow–like appearance. This is particularly true in national parks like Yellowstone, which hosts around three million visitors a year. Yellowstone National Park annually reports bison encounters and related human injuries, which typically result from individuals attempting to approach, feed, pet, or be photographed with bison (Conrad and Balison, 1994; Olliff and Caslick, 2003). This type of interaction has occurred on Antelope Island in Utah, where a person was head-butted after attempting to pet a bison in a campground (S. Bates, personal communication). Yellowstone National Park has taken extensive measures to educate visitors on the importance of maintaining the proper distance from bison. These efforts have led to a reduction in human/bison conflicts from a high in 1983 of 13 conflicts, followed by ten in 1984 and ten in 1985, to just two conflicts in 1997, followed by five in 1998 and only one in 1999 (Olliff and Caslick, 2003). Wind Cave National Park in South Dakota, which reports around 600,000 annual visitors and has a herd of approximately 400 bison, has not reported any bison-related human injuries as of August 2010 (R. Mossman, Wind Cave National Park, personal communication).

A study of the behavioral response of the free-ranging Sturgeon River Plains Bison Herd to human activity found that following the detection of human presence, bison reacted by fleeing the area (51 percent of 384 observations), looking in the direction of the human while remaining in place (46 percent of 384 observations), or approaching the human (3 percent of 384 observations) (Fortin and Andruskiw, 2003). Observations of

free-ranging bison in the Henry Mountains found that bison would often flee from an area after coming into contact with humans (Nelson, 1965).

A study was completed during the summers of 2000 and 2001 that examined the reaction of bison, mule deer, and pronghorn antelope to hikers and mountain bikers who were on designated trails on Antelope Island in Utah. The study took place prior to the implementation of a bison-hunting program on the island. It attempted to determine at what distance from a lone silent hiker or mountain biker an animal would become alert to the presence of humans and begin to flee, and for what distance. The hiker or biker did not approach the wildlife, but continued to steadily move down the trail and past the animal or groups of animals. Of the 98 trial encounters with bison, the study found that 75 of the groups, or 77 percent, fled from the person, compared to 56 percent of pronghorn and 60 percent of mule deer (Taylor and Knight, 2003). There was not a significant difference between the reaction of bison to hikers or mountain bikers. The study found that on average bison became alert to the presence of the human when the person was 531 feet away, began to flee when the individual was 308 feet away, and tended to flee 82 feet from their original position (Taylor and Knight, 2003). For comparison, mule deer became alert to the presence of the human at 620 feet, began to flee when the individual was 449 feet away, and tended to flee 616 feet from their original position (Taylor and Knight, 2003). The study found that a larger group size tended to increase the flight response, as did the presence of calves (Taylor and Knight, 2003).

Bison/Vehicle Collisions

Most experienced drivers in Montana are aware of the potential for wildlife collisions due to the large variety of wildlife and occasionally domestic livestock that may be present on roadways. Most experienced drivers in Montana recognize the need to be very aware of their surroundings as they drive, and the state tries to mark regions of increased potential for wildlife collisions with warning signs. Data on the potential for bison/vehicle collisions and frequency of bison encountered on roadways is limited due to the lack of free-ranging herds in the United States. Many mitigating techniques, such as wildlife underpasses, fencing, and signs are already being implemented through the cooperative work of agencies, nongovernmental organizations, and citizens to reduce conflicts of wildlife on roadways around the state. If free-ranging bison were to return to the state, it will be important for the different government agencies, citizens, and private organizations to work together to develop creative solutions for reducing the potential of bison/vehicle collisions. As with all wildlife there is the potential that bison may on occasion enter roadways.

The British Columbia Conservation Foundation's Wildlife Collision Prevention Program (WCPP) examines bison/vehicle collisions with wood bison. The WCPP identifies some of the reasons why wood bison utilize roadways in northwestern Canada. A few of the reasons the animals are attracted to the roadways that were noted include: (1) plowed roads can provide easier travel routes than forested locations, especially during deep snow; (2) highways and right of ways are often windy, which relieves some irritation from biting

insects; (3) vegetation along the side of the road is accessible throughout the year; and (4) the disturbed sites on roads provide good establishment of palatable vegetation (British Columbia Conservation Foundation, 2010). The WCPP indicates that traffic factors influencing the number of bison/vehicle collisions include increased traffic volume, an increased number of industrial vehicles, and long straight stretches that allow drivers to travel at speeds well over the posted limits (British Columbia Conservation Foundation, 2010).

The wildlife factors that contribute to collisions include the fact that bison are a herd animal; that the lowered position in which bison typically hold their head reduces the reflectivity of their eyes, thereby decreasing visibility at night; that bison may have different reactions based on their perception of a threat; and that seasonal factors such as the rut or the presence of calves may alter the potential of bison/vehicle collisions (British Columbia Conservation Foundation, 2010). The WCPP has found that low and changing light at dawn, dusk, and night can increase the risk of bison/vehicle collisions for a number of reasons including the fact that bison may be more active during periods of low light; that bison have dark coats; and that during periods of snowfall the snow can accumulate on the backs of bison, reducing the contrast between the bison and the ground (British Columbia Conservation Foundation, 2010).

Another important factor in the probability of bison/vehicle collisions is based on whether the roadway transects highly used habitats, as it does outside of West Yellowstone. A report compiled by the Western Transportation Institute noted that "one of the winter grazing grounds used by Yellowstone bison is the West Yellowstone basin. US 191 directly cuts through the bison migratory paths, which creates a high level of bison cross-traffic on the 10-mile stretch of US 191 just north of the town of West Yellowstone" (Dupree and DiMambro, 2010).

Bison Vehicle Collisions in Montana and Yellowstone National Park

The region of Montana where free-roaming bison are found and where there have been reports of bison/vehicle collisions is the area surrounding US 191, which runs north from West Yellowstone to just past the junction of US 287. The report by Western Transportation Institute utilized information from the Montana Department of Transportation (MDOT) crash (1999–2008) and carcass removal data (1999–2009). The report recognizes that the data are not complete, but does give a general overview of the number of collisions that occur as well as the number of bison killed. The number of bison killed is larger than the number of crashes that occur, due to the fact that 31 percent of recorded bison/vehicle collisions on US 191 involve more than one bison (Dupree and DiMambro, 2010).

Based on MDOT's data on crashes involving bison, the average number of bison collisions on US 191 between 1999 and 2009 was approximately 1.7 per year. There were no reported crashes involving bison in 2002 and 2004; there was one reported collision in 2000, 2001, 2003, and 2007; there were two reported collisions in 2006 and 2008; and

there were seven reported collisions in 2005 (data provided by P. A. Jomini, Montana Department of Transportation). In 2009, 15 bison were killed between April 11 and 13 when a single car killed seven bison, and in a separate incident a truck killed seven bison and an SUV following the truck killed an additional bison. None of the drivers were seriously injured in the collisions (Mayrer, 2009). The majority of these crashes occurred in the evening or early morning hours (data provided by P. A. Jomini, Montana Department of Transportation).

With more than three million annual visitors to Yellowstone National Park, most arriving during the concentrated summer vacation season and using limited roadways, there is a large potential for collisions with wildlife. The park compiles data on the number of bison killed on roadways based on reported carcasses. The number of bison killed between 2000 and 2009 from vehicle collisions varied yearly from a high of 28 bison killed in 2002 to 9 bison in both 2000 and 2008 (data provided by K. Gunther, National Park Service). The average number of bison killed yearly from 2000 to 2009 was approximately 16. Between 2000 and 2009 approximately 146 bison were killed in Yellowstone as a result of collisions with vehicles (data provided by K. Gunther). Of the 146 killed approximately 75 were bulls, 45 were females, and the gender of 27 was not recorded (data provided by K. Gunther). The ages of the bison killed varied, with approximately 112 adults and subadults, 10 yearlings, 10 calves under a year old, and no age recorded for 14 (data provided by K. Gunther).

Bison on the roadway in Yellowstone. PHOTO CREDIT: J. PEACO; COURTESY NPS

Personnel within the park feel that excessive vehicle speed is what increases the risk of collisions with bison, as does the time of day (K. Gunther, personal communication). The WCPP program recommends the enforced reduction of speed limits, especially during the evening, as an effective way to reduce bison/vehicle collisions (British Columbia Conservation Foundation, 2010). The YNP Division of Law Enforcement notes that there have been no reported human fatalities from accidents involving bison within the park, based on accident reports from 2008, 2009, and 2010 (Division of Law Enforcement, personal communication).

Bison Vehicle Collision Mitigation

The Buffalo Field Campaign (BFC), a conservation organization in West Yellowstone, has made the reduction of bison/vehicle collisions a priority. Several BFC members were trained by the State of Montana as highway flaggers to help facilitate the safe passage of bison across US 191 and to alert motorists to their presence when they are aware that

bison are near the road (Dupree and DiMambro, 2010; D. Brister, Buffalo Field Campaign, personal communication). The BFC has also worked to have the speed limit reduced from 70 mph to 55 mph on US 191 during the bison migration. The organization notes that although the state has reduced the speed limit and the Montana Highway Patrol provides an officer to enforce the reduced speed, very few motorists abide by the reduced speed limit (D. Brister, personal communication).

BFC volunteers warn motorists of bison on the highway. COURTESY BFC

The WCPP has undertaken various projects to decrease the probability of bison/vehicle collisions, with mixed success. One of the mitigation techniques that has shown success is to leave un-mowed stretches of vegetation parallel to the tree line while continuing to mow the region immediately adjacent to the roadway. The un-mowed sections are then plowed during the winter to provide trails that are parallel to the tree line and contain more forage (British Columbia Conservation Foundation, 2010). There has also been some success with plowing "escape routes" off the highway for bison use (British Columbia Conservation Foundation, 2010). The WCPP notes that the use of wildlife warning signs may also decrease the number of bison/vehicle collisions. To increase the effectiveness of signs, the WCPP recommends using signs that emphasize seasonal risks and that should either be removed during periods of lower risk or enhanced during periods of higher risk; signs that are larger and more variable; signs that are portable so they can be moved as needed; signs that are personalized for each species; signs that emphasize the danger the animal poses to the driver; and signs enhanced with flashing lights or flags (British Columbia Conservation Foundation, 2010).

Seasonal reduction in speed limit on US 191. COURTESY BFC

The WCPP recommends a number of ways that drivers can reduce the risk of bison/vehicle collisions. These practices include paying attention to road signs indicating the potential presence of bison, maintaining the posted speed, reducing speed at night, remaining more vigilant, and practicing defensive driving while traveling through regions where bison have been observed.

Lessons from Other Programs

In an effort to gain better insights into bison management programs in different states and Canadian provinces, FWP staff met with regional agencies, private landowners, and bison working groups. The following are summaries of five free-ranging bison management programs and one captive program. These case scenarios are presented so as to examine the successes and challenges of the respective programs. Though implementation and management differs among programs, and each is faced with conflicts and concerns unique to its specific circumstances, there are some general overarching lessons that can be gleaned from their collective experiences. Community and public involvement appears to directly tie into the acceptance and tolerance of free-ranging bison programs.

Henry Mountains Wildlife Management Area, Utah

Henry Mountains bison habitat.
PHOTO CREDIT: A. DOOD

The area occupied by bison within the Henry Mountains Wildlife Management Area comprises approximately 300,000 acres that range from 4,800 to 11,500 feet in elevation, and includes approximately 4,203 acres of private land (1.4 percent of the total) (Utah Division of Wildlife Resources, 2007b). The region consists of steep mountain slopes, flat mesas, deeply eroded canyons, benches, and foothills, which support salt desert shrub, pinyon-juniper, mountain brush, aspen-conifer, and subalpine vegetative communities (Utah Division of Wildlife Resources, 2007b). Bison have proved very adaptable and have utilized all of the elevations, topography, and plant communities within the area (Utah Division of Wildlife Resources, 2007b).

The free-ranging herd was reintroduced to the region in 1941 with 18 bison from Yellowstone National Park. Five bulls were added in 1942, following dispersal by some of the original bulls. There has not been a need for additional augmentations to the herd since that time (Utah Division of Wildlife Resources, 2007b). Traditionally, the population objective for the Henry Mountains herd was approximately 275 adults after the end of each hunting season. The current management plan aims to reach a new population target of 325 adults post–hunting season. This target is being achieved through an incremental increase to 305 in 2010, 315 in 2011, and 325 by 2012 (J. Shannon, Utah Division of Wildlife Resources, personal communication).

Disease management is an ongoing concern for the Henry Mountains herd. The three primary concerns are brucellosis, tuberculosis, and malignant catarrhal fever (Utah

Division of Wildlife Resources, 2007b). Following the detection of positive titers for brucellosis within the herd in 1962, the herd was corralled, tested, and inoculated for brucellosis. Individual bison suspected of infection were marked and then released for sport hunters to cull. Blood from hunter collection kits is tested annually, and there has been no indication of the presence of the disease since 1963. The herd is now considered brucellosis free (Utah Division of Wildlife Resources, 2007b). Testing for tuberculosis in 2001 indicated that the disease was not present within the Henry Mountains herd (Utah Division of Wildlife Resources, 2007b). Agencies have successfully worked with the region's livestock operators to convert domestic sheep grazing allotments to cattle in order to reduce the chance of infection of the bison with malignant catarrhal fever (Utah Division of Wildlife Resources, 2007b).

Bison and cattle have coexisted within the Henry Mountains since 1941. Cattle are managed within fencing and bison are free to move across the landscape. As the population of bison increased, so did tension with regional landowners. Efforts to mitigate these issues include the creation of the Henry Mountains Bison Committee. Public support and/or tolerance of the free-ranging herd appear to have increased following the creation of this group. Studies in the region have indicated that while bison and cattle often utilize different habitats, with bison grazing at higher elevations than cattle, there is substantial overlap in range use (Van Vuren, 1983; Utah Division of Wildlife Resources, 2007b). Within the arid climate of the Henry Mountains, grazing capacity is often limited for both cattle and bison by environmental factors. The BLM, the Utah Division of Wildlife Resources, conservation organizations, and sportsmen's groups have worked together to ensure that grazing continues to be shared by bison and cattle within the Henry Mountains. This effort has been supported by the creation of a Resource Management Plan, Grazing Allotment Plans, and the purchase of grazing privileges from willing sellers (Utah Division of Wildlife Resources, 2007b). There have also been substantial efforts by agencies and groups to improve the grazing habitat for livestock, bison, and mule deer. These programs have included prescribed burns, mechanical treatments, reseeding, and improvement of water sources (Utah Division of Wildlife Resources, 2007b). The impact of bison on regional agriculture has been limited. Bison have encroached upon irrigated agricultural fields during at least two periods of drought in the past 20 years. In both instances the bison were herded from the fields and the landowner was compensated for damages (Utah Division of Wildlife Resources, 2007b).

Though parts of the region have significant physical barriers to bison movement, it is probable that population management has had the greatest effect on the minimal dispersal observed. Public hunting of the Henry Mountain bison has been an essential part of the management program. Approximately 150 highly sought after permits are awarded annually. As of 2007, overall hunter success has been around 87 percent (Utah Division of Wildlife Resources, 2007b). There has been an increased effort by sportsmen and landowners to work together to reduce bison conflicts. Sportsmen's groups have spent hundreds of thousands of dollars on range enhancement and water resources, and have been active in assisting livestock producers with fence repairs.

Book Cliffs Wildlife Management Unit, Utah

Book Cliff's bison habitat.
PHOTO CREDIT: A. DOOD

The Book Cliffs Wildlife Management Unit (BCWMU) consists of approximately 2.1 million acres within Utah's Uintah and Grand Counties, which are managed as BLM lands, Native American Trust Lands, and State of Utah Trust Lands. The BCWMU is divided into three subunits. The Book Cliffs bison herd is managed on the Bitter Creek and Little Creek subunits, which consist of approximately 1.47 million acres, of which 5 percent is private land, 35 percent is Ute Tribe Trust Land, and the remaining 60 percent is BLM, Utah Division of Wildlife Resources, and State Trust Lands (Utah Division of Wildlife Resources, 2007a). The region of the BCWMU containing the bison herds varies in elevation from 7,500 to 9,000 feet, and is part of the arid Colorado Plateau ecotype. The vegetation consists of oak brush and sage, with some aspen and conifers (D. Mangus, Utah Division of Wildlife Resources, personal communication).

Book Cliffs: Ute Tribal

Though bison were historically present in the region, they were absent from the Book Cliffs until the Ute Indian Tribe reintroduced six bison onto the Uintah and Ouray Reservation in 1986 (Utah Division of Wildlife Resources, 2007a). Through additional introductions and natural growth the herd has increased to approximately 600 to 650, though the stated objective is 450 bison (K. Corts, Ute Tribe, personal communication). The tribe manages the population through the issuance of hunting permits, and has increased the number of permits in an attempt to reduce the size of the herd. They are also exploring the potential to sell some of the bison to other programs or tribes to further control the growing herd (K. Corts, personal communication).

The winter range of the tribal bison consists of a mix of desert scrub, pinyon-juniper, and sagebrush flats. Summer range consists of pine and grass meadows (K. Corts, personal communication). When the population numbers were closer to objective, the Ute Tribe reports that there was not a problem with bison moving off reservation land. As the size of the herd increased, bison began to move from the reservation onto adjacent BLM and private lands. This distribution shift resulted in conflicts with adjacent landowners (K. Corts, personal communication; D. Mangus, personal communication). A large number of the tribal bison are rounded up on an annual basis for disease testing. As of October 2010, there has not been any indication of brucellosis within the herd (K. Corts, personal communication).

Book Cliffs: Wildlife Management Unit Public Herd

The effort to reintroduce a free-ranging public herd to the Book Cliffs region began about 20 years ago. Following the movement of some of the tribal bison across the Book Cliffs, in 2006 the North Book Cliffs Bison Planning Committee (committee) was created to examine the potential of reintroducing a public herd to the region. The committee was made up of a diverse collection of public agencies, private landowners, and interest groups (Utah Division of Wildlife Resources, 2007a). The committee established management goals and reintroduction plans. The post–hunting season population goal of the public herd was set at 450 bison (Utah Division of Wildlife Resources, 2007a).

Reintroduction began in August 2008 when 14 bison that had been donated by the Ute Tribe were introduced to the Book Cliffs (D. Mangus, personal communication). In January 2009, 31 bison were captured from the Henry Mountains and 30 were relocated to the Book Cliffs, (D. Mangus, personal communication). The bison from the Henry Mountains were tested for disease prior to release. Though the original plan was for the release of 45 bison total, a surplus of bison at the Henry Mountains allowed the capture and release of an additional 40 bison in January 2010 (D. Mangus, personal communication). The 40 bison, plus a calf that was born while the bison were being held due to snowstorms, were released in May 2010. There are now approximately 100 bison in the public herd. The herd is divided into two groups, each of which contains approximately 50 bison. One group remains primarily on public land, and the other group moves between public land and reservation land. This latter group has some interaction with the tribal bison herd (D. Mangus, personal communication). As bison move between public and reservation lands, the management of the bison shifts between the Utah Division of Wildlife Resources and the Ute Tribe (D. Mangus, personal communication).

Bison being transported for reintroduction to the Book Cliffs.
PHOTO CREDIT: A. DOOD

The management plan calls for public hunting to be the principal population management tool, though it is believed that drought will have an impact on reproduction rates (Utah Division of Wildlife Resources, 2007a). The management plan states that if bison move beyond the BCWMU, they may be considered nuisance wildlife (Utah Division of Wildlife Resources, 2007a). When the population reaches the appropriate level to allow the implementation of the hunting program, hunter test kits will be used to monitor the

herd for disease, but until that time the Utah Division of Wildlife Resources will continue annual disease testing. The herd is currently free of reportable disease (Utah Division of Wildlife Resources, 2007a; D. Mangus, personal communication).

As within the Henry Mountains, there is overlap between the range use of bison and cattle, as well as with other wild ungulates. The Utah Division of Wildlife Resources, with the help of the committee and sportsmen's groups, completed cooperative range and habitat improvement projects on approximately 114,555 acres between 2002 and 2007, and plans to continue to implement range improvement projects (Utah Division of Wildlife Resources, 2007a). The Utah Division of Wildlife Resources and sportsmen's groups have also purchased lands and made those grazing allotments available to wildlife, including bison (D. Mangus, personal communication). This has reduced the contact between bison and livestock. Private grazing allotments are still maintained on the BCWMU.

House Rock Wildlife Management Area, Arizona

Bison utilize all elevations of habitat at House Rock. PHOTO CREDIT: A. DOOD

Though bison were historically present in small numbers throughout Arizona, unregulated hunting led to their extermination from the state (Bison Management Team, 2002). Charles J. "Buffalo" Jones established a herd on the North Kaibab Plateau in 1905, and the U.S. Congress listed bison as one of the wildlife species that should be maintained on the Kaibab Plateau during the establishment of the Grand Canyon Game Preserve (Bison Management Team, 2002). In 1926 Jimmy Owens sold 98 bison to the State of Arizona, which then moved them to the House Rock Valley (Bison Management Team, 2002). The USFS, BLM, Arizona Game and Fish Commission, and local livestock grazing permittees established an agreement, which created the House Rock Wildlife Management Area (House Rock) and determined it would be used for wildlife only (Bison Management Team, 2002).

House Rock is located along the southeastern edge of the North Kaibab Plateau in Coconino County, Arizona. It consists of 30 acres owned by the Arizona Game and Fish Department and over 60,000 acres managed by the USFS. The elevation varies from 5,200 feet in House Rock to over 8,000 feet on top of the North Kaibab Plateau. The terrain consists of arid, rolling plains with some canyons and the steep slopes of the North Kaibab Plateau and Saddle Mountain Wilderness. The vegetation varies from desert scrub and grasslands with some sagebrush at the lower elevations, to pinyon-juniper woodlands and ponderosa pine at the mid-elevation, to dense forests of spruce-fir, aspen, and some mixed conifers of ponderosa pine and white fir interspersed with subalpine meadows at the upper elevations (Bison Management Team, 2002).

The House Rock bison herd reached a population of around 300 during the late 1950s and early 1960s. The herd was then reduced to 100, and a population objective was set to maintain 100 bison (Bison Management Team, 2002; C. King, Arizona Game and Fish Department, personal communication). The bison hunting program was established in 1927, and was considered a herd culling operation, which entailed rounding up the bison using corral traps, and then having hunters selectively harvest them in a larger corral (Bison Management Team, 2002). Pressure from the public led to the transition to "fair chase" hunts in 1972 (Bison Management Team, 2002). The current population is estimated to have grown to over 300 bison as a result of the bison's ability to take refuge in Grand Canyon National Park during the hunts (C. King, personal communication).

Traditionally, the bison freely used the lower-elevation plains and woodlands of House Rock during early spring and summer and then moved toward the higher, more densely forested areas of the North Kaibab Plateau, outside of House Rock, in the fall and winter (Bison Management Team, 2002). Hunting pressure to reduce herd size has resulted in the bison moving off of, and remaining outside of, House Rock and the surrounding national forest land. The herd now seeks refuge from hunting pressure in the adjacent Grand Canyon National Park (C. King, personal communication). Older females, who traditionally led the bison back to House Rock to calve, tend to be the individuals selected by hunters during adult cow and yearling bull/cow hunts. Removal of these individuals has led to concern for retention of this migratory behavior. In 2010 the herd did not migrate down to House Rock to calve, and instead produced their young inside Grand Canyon National Park for the first time. The herd moves out of Grand Canyon National Park and onto national forest land after the hunt ceases. The boundary between the park and the national forest is permeable, and several sections of fence that used to separate the two jurisdictions have been destroyed in wildfires (C. King, personal communication).

Grand Canyon National Park considers the herd an invasive nonnative species because they possess cattle genes (C. King, personal communication; Gates et al., 2010). There is potential for Grand Canyon National Park to support a small population of genetically pure bison that could be kept in House Rock, but they do not want the herd within the park boundaries because it is believed the herd may be damaging natural and archeological resources. To successfully manage the herd, there will need to be a cooperative management program between the Arizona Game and Fish Department and the NPS to reduce conflicts and create a program that will allow for the coordinated management of the herd (C. King, personal communication).

The Grand Canyon Trust, a private nonprofit organization that owns the adjacent Kane Ranch, is also concerned with the status of the existing herd. The Trust's concern is not competition between bison and livestock for forage or the potential for disease transmission. They, like the national park, are concerned about resource damage to springs and other water sources; the persistence of rare, endemic plants found only in the subalpine meadows of the Kaibab Plateau; and protection of archeological sites (C. King, personal communication).

The House Rock herd is actively monitored for brucellosis from hunter-collected blood samples. The herd has not shown any evidence of brucellosis or other diseases of concern to date (Bison Management Team, 2002). In addition to hunting and wildlife viewing, House Rock continues to gain in popularity as a location for a variety of other recreational activities including hiking, bird watching, jeep and ATV tours, and firewood cutting (Bison Management Team, 2002).

Raymond Ranch Wildlife Area, Arizona

Raymond Ranch habitat.
PHOTO CREDIT: A. DOOD

The Arizona Game and Fish Department also manages a bison herd on the Raymond Ranch Wildlife Area (Raymond Ranch). This herd is actively managed within a fenced area. The area manager notes, however, that there is no such thing as "completely contained" bison. The Raymond Ranch, which is located near Flagstaff, consists of 9,438 acres owned by Arizona Game and Fish and an additional 5,199 acres that are leased from the Arizona State Land Department (Bison Management Team, 2002). The highest elevation on the Raymond Ranch is approximately 6,000 feet. The topography consists primarily of gently rolling plains intermixed with some shallow canyons and drainages. The vegetation progresses from primarily plains grassland with desert scrub in the washes and breaks at the lower elevations, to pinyon-juniper woodlands sparsely covering the higher elevations and ridges (Bison Management Team, 2002). The bison move freely within the Raymond Ranch and naturally rotate through the different sections of the ranch based on available forage (Bison Management Team, 2002).

Raymond Ranch was established in 1942 to preserve habitat for pronghorn antelope (Bison Management Team, 2002). Bison were introduced from House Rock in 1945, and their numbers increased to 275 in the 1970s (Bison Management Team, 2002). Similar to House Rock, a public culling operation involving the harvest of corralled bison was utilized to manage the herd down to 40 to 60 bison (Bison Management Team, 2002). Due to public outcry these hunting practices were modified in 1972. The wildlife area manager now guides approximately six to eight hunters annually, though this number is flexible depending on the current demographics of the herd and the population objective. The manager accompanies the hunters to minimize disturbance to the herd, and to help identify the correct age and sex class (Bison Management Team, 2002; A. Zufelt, Arizona Game and Fish Department, personal communication). The bison are monitored for brucellosis through hunter sample kits, and thus far the herd has not shown any evidence of infection (Bison Management Team, 2002).

The primary challenge associated with managing the Raymond Ranch herd is containing them within the wildlife management area. Perimeter fencing has progressed through modifications that include "electric fencing, extension of the fence to nearly nine feet, and use of welded wire panels. These measures have resulted in little improvement in the ability to confine the bison to the wildlife area" (Bison Management Team, 2002, pp. 6). There is concern that the increased height of fencing negatively impacts other wildlife; therefore most of the ineffective fence height extensions have been removed to allow the crossing of elk and mule deer (Bison Management Team, 2002). The perimeter fence currently consists primarily of barbed wire and high-tensile smooth wire. The high-tensile smooth wire fencing can be problematic for other species as the wire does not readily break, resulting in the entanglement of elk and mule deer (A. Zufelt, personal communication). Though the fencing is adequate to confine the bison during most of the year, escape is common during hunting seasons and somewhat common during drought periods when bison seek forage and water on neighboring rangeland. Dominance contests between breeding bulls sometimes results in roaming and escaped younger males (Bison Management Team, 2002, pp. 6). Concerns from neighbors of the Raymond Ranch consist mostly of interference with livestock operations, consumption of forage, and damage to fencing and corrals from escaped bison (Bison Management Team, 2002).

Section of Raymond Ranch perimeter fencing.
PHOTO CREDIT: A. DOOD

Grand Teton National Park and National Elk Refuge, Wyoming

The free-ranging bison herd that resides within Teton County, Wyoming, and the surrounding national park and national forest is managed cooperatively by the USFWS, Wyoming Game and Fish Department, NPS, and USFS (USDI, 2007). The National Elk Refuge consists of 24,700 acres that is part of the National Wildlife Refuge System managed by the USFWS (USDI, 2007). The 309,995-acre Grand Teton National Park and the 23,777-acre John

Bison with elk on the National Elk Refuge.
PHOTO CREDIT: S. ADAMS

D. Rockefeller Jr. Parkway are managed by the NPS (USDI, 2007). The bison herd ranges largely within the national park system and the National Elk Refuge, though some of the bison cross into the Bridger-Teton National Forest and onto state and private lands in the Jackson Hole area (USDI, 2007). The valley's elevation begins around 6,200 feet on the sagebrush-dominated valley floor that is intermixed with grassy meadows, marshes, and forests of pine, fir, spruce, cottonwood, and aspen (Craighead, 2006). Meadows cover much of the southern end of the National Elk Refuge and are an essential food source for the elk and bison that winter on the refuge (Clark, 1999). The valley is known for short, mild summers and long, cold winters, with annual precipitation averaging 16 inches (E. Cole, United States Fish and Wildlife Service, personal communication).

Bison were historically present in the region, but were extirpated by the 1880s (USDI, 2007). In 1948 a small herd of approximately 20 bison from Yellowstone National Park were reintroduced to the 1,500-acre Jackson Hole Wildlife Park, located near Moran, Wyoming. A population of approximately 15 to 30 bison were maintained in a large enclosure within the wildlife park until 1963 (E. Cole, personal communication). In 1963 brucellosis was discovered within the captive herd, and all of the adult bison were destroyed. Four of the vaccinated yearlings and five of the vaccinated calves were retained within the enclosure, and 12 certified brucellosis-free bison were added from Theodore Roosevelt National Park (E. Cole, personal communication).

In 1968 the herd, which was down to 11 bison and a few calves, escaped from their enclosure, and the decision was made to allow them to remain as a free-ranging herd (E. Cole, personal communication; USDI, 2007). The small herd began to winter on the National Elk Refuge in 1975, and began to utilize the supplemental winter-feeding program that the refuge provides for elk in 1980 (USDI, 2007). The refuge began to liberally feed the bison herd in an attempt to keep them separated from the elk population and to reduce human/bison conflict. The increase in quality and quantity of their winter diet due to supplemental feed allowed the herd's growth rate to reach about 13 percent annually, with approximately 1,100 bison observed in 2007 (USDI, 2007). The rapidly growing bison population raised concerns over increasing damage to habitat, competition with elk, the risk of brucellosis, human safety, private property damage, and the additional cost of providing supplemental feed (USDI, 2007).

A plan developed in 1998 would have utilized public hunting to reduce the number of bison on the National Elk Refuge. A lawsuit was subsequently filed and the court ruled that the USFWS had not complied with the necessary National Environmental Policy Act requirements for the establishment of a bison hunt on the refuge (Hatch, 2007). The Wyoming Game and Fish Department was able to move forward in 1998 with a hunt outside of the refuge and the park, but it resulted in little success as most bison tend to stay within the park and refuge lands during hunting season (USFWS, 2006).

The Final Bison and Elk Management Plan and Environmental Impact Statement was released in 2007 with the goal of managing the Jackson bison and elk herds and their habitat to improve environmental health and biotic integrity over the long term. It focuses on the improvement and restoration of native and cultivated forage within the National Elk

Refuge and the park; working with private and agency partners to reduce the conflict between bison and private landowners by providing resources to manage commingling with livestock and reduce depredation of private hay supplies; establishing a public education effort to increase the understanding of natural bison behavior, distribution, disease implications, and effects on other species; and developing a framework of management actions that could progressively transition from intensive supplemental feeding to a greater reliance on natural forage (USDI, 2007).

The plan established a bison population objective of 500, and allows for the public hunting of bison on the refuge (USDI, 2007). The plan also allows for the annual ceremonial taking of approximately five bison by Native American tribes associated with the region (USDI, 2007). The current attempt to reduce the number of bison through hunting has been hindered by the fact that the bison tend to stay in Grand Teton National Park, where they are safe from hunting pressure during the hunting season. Doug Brimeyer, a biologist with the Wyoming Game and Fish Department, notes that "the bison are extremely sensitive to hunter pressure" (Bozeman Daily Chronicle, 2010). In an attempt to encourage the bison to move back onto the National Elk Refuge where they can be harvested, the refuge has adopted a rotational strategy where hunting is permitted for two weeks, then closed for a week, and then reopened for two weeks (Bozeman Daily Chronicle, 2010). For the 2010 season, 80 "any bison" tags and 200 cow tags were issued (Bozeman Daily Chronicle, 2010), and during the season 69 bulls and 115 cows were harvested (E. Cole, personal communication).

Bison grazing in Grand Teton National Park.
COURTESY NPS

The bison that were part of the original herd that escaped from the captive wildlife park in 1968 had all tested negative for brucellosis (USFWS, 2006; USDI, 2007). Brucellosis was observed within the herd in the late 1980s, and as of 2007 between 57 and 84 percent of the herd has tested positive for brucellosis exposure based on small, non-random samples. These percentages indicate that antibodies are present from previous exposure, but do not necessarily indicate active infection. Research has indicated that a much smaller percentage of bison have active infections (USFWS, 2006). The 2007 plan allows the Wyoming Game and Fish Department to vaccinate bison for brucellosis on the refuge, as long as it is logistically feasible and the vaccines are determined to be safe for bison (USDI, 2007).

Sturgeon River Plains Bison Herd, Saskatchewan

Bison within Prince Albert National Park.
PHOTO CREDIT: A. DOOD

Though historically present within the region, plains bison were almost hunted to extinction during the 1880s. In 1906 the Canadian government purchased one of the last remaining plains bison herds from the United States (Parks Canada, 2009). This herd was used to establish the herd in Elk Island National Park, Alberta (Parks Canada, 2009). In 1969, 50 bison from the Elk Island National Park herd were transferred to the Thunder Hills, which lies to the north of Prince Albert National Park, as an additional meat source for First Nations People (Parks Canada, 2009). Upon release the bison began to move south out of the Thunder Hills. Most of these bison were relocated to other regions. Between 10 and 22 of the Thunder Hills bison were permitted to remain in Prince Albert National Park and formed what is now the Sturgeon River Plains Bison Herd (Parks Canada, 2009). The population continued to grow within the park and reached 400 in 2006 (Parks Canada, 2009). The population was reduced to approximately 200 following an anthrax outbreak. The current population has since recovered to close to its 2006 numbers (G. Vaadeland, personal communication). First Nations People have the reserved right to harvest bison from the Sturgeon River Plains Bison Herd outside of park boundaries with landowner permission through treaty rights (G. Vaadeland, personal communication).

The Sturgeon River Plains Bison Herd now utilizes an area of over 500 square miles, which consists of the southwestern corner of Prince Albert National Park and surrounding public and private lands (Parks Canada, 2008; G. Vaadeland, personal communication). The habitat within the region consists of aspen forests, native wet sedge, and dry fescue grasslands (Parks Canada, 2008). Parks Canada (2008) notes that this is the only disease-free, unfenced plains bison population that exists within its historic range in Canada, and the bison are allowed to freely move between the park and surrounding land.

The management of the Sturgeon River Plains Bison Herd is a cooperative effort between government agencies and regional landowners. Bison movement onto private land surrounding the park has led to some conflict with neighboring landowners over crop depredation. The Sturgeon River Plains Bison Stewards (SRPBS) is a nonprofit organization of concerned landowners, ranchers, farmers, and bison producers who work collectively with Prince Albert National Park and the Saskatchewan Ministry of Environment. The SRPBS seeks to conserve Canada's only free-ranging herd of plains bison still within their historic range and to create an environment where they can coexist with local landowners in a mutually beneficial way (SRPBS, 2010). The organization works to fund management of the bison on private land and to develop programs to mitigate the effects of bison on

private land (Parks Canada, 2009). The SRPBS hires wranglers to "gently move bison away from sensitive areas on private farm and ranch land" in the fall; completes vegetation monitoring and sampling on private land to gain a better understanding of bison forage behavior; and provides regional landowners with fencing material to keep bison out of sensitive areas (SRPBS, 2010). The organization also works to identify economic opportunities related to bison and create educational outreach within the region (Parks Canada, 2009).

In 2004 a three-year proposal was submitted to Parks Canada to obtain funding to create and implement a management strategy for the Sturgeon River Plains Bison Herd, to carry out research on techniques to influence the movement of bison, and to create and implement a communication strategy. The proposal was approved in 2005 (Parks Canada, 2008). The management strategy was created by a committee of 14 members representing all jurisdictions, some public interest groups, and individuals from various groups within the local community (Parks Canada, 2008). The recommendations that came out of the committee "include activities that can be undertaken on private lands to reduce the impacts of bison, reducing the cost to landowners associated with the presence of bison, as well as research-based adaptive management options that could be implemented outside and within the Park to influence the movements of bison" (Parks Canada, 2008). The research has led to the continuing development of programs to encourage bison to remain within the park, such as salt stations and the use of drift fencing to direct the movement of bison toward meadows within the park.

SRPBS hosted the Bison on the Edge Conference attended by over 150 individuals. PHOTO CREDIT: A. DOOD

The 2008 Prince Albert National Park Management Plan proposed creating a trail system to move human activity away from core bison habitat (Parks Canada, 2008). The park has since decided to work with regional stakeholders to design and construct new trails that are designed "to withstand both human and bison traffic and to allow visitors the best opportunity to safely view bison in the Park, as opposed to trying to move human activity away" (G. Vaadeland, personal communication).

Beginning in 2010 and moving forward into 2012, the SRPBS, Parks Canada, and the Saskatchewan Ministry of Environment have begun the process to develop a long-term, adaptive management plan for the Sturgeon River Plains Bison Herd (G. Vaadeland, personal communication). This planning process is unique in that the federal and provincial governments have agreed to allow SRPBS, which represents private landowners,

to “sit at the table in full partnership with the government agencies in the development of this plan” (G. Vaadeland, personal communication).

Potential Sources of Bison

There are numerous bison management programs, including public conservation herds, Native American herds, and private conservation herds. In the past, animals provided by Wind Cave National Park, Elk Island National Park, Yellowstone National Park, Custer State Park, and Theodore Roosevelt National Park were primarily used to reestablish conservation herds. Historically many conservation herds were started or supplemented with bison from the Bronx Zoo by the American Bison Society (K. Aune, Wildlife Conservation Society, personal communication).

Bison from the Pablo-Allard herd being transported to waiting trains to take them to Canada. PHOTOGRAPHY BY N. A. FORSYTH; COURTESY MONTANA HISTORICAL SOCIETY

Management considerations that must be evaluated for source herds include the disease status of the herd, the origin of the herd’s founding animals, the level of cattle introgression that is present, and the management regime the herds are habituated to.

Legal Classifications of Bison

Legal Classification of Bison in Montana

The State of Montana's legal classification of bison changes based on whether they are found on commercial farms or in private conservation herds or whether they are found in the wild. In addition, bison classification depends upon the perceived risk of damage to public or private property or transfer of disease. As situations change, so change classifications in law and the Montana state agency with management authority. The two main classifications given to bison within the state are "domestic livestock" or "game animal," which is also considered wildlife.

Bison that are free roaming and held in the public trust are classified as a game species in Montana. "Game animal means deer, elk, moose, antelope, caribou, mountain sheep, mountain goat, mountain lion, bear, and wild buffalo" (Mont. Code Ann. §87-2-101(6)). "'Wild buffalo' means buffalo or bison that have not been reduced to captivity" (Mont. Code Ann §87-2-101(16)). FWP is charged with supervising "all the wildlife, fish, game, game and non-game birds, waterfowl, and the game and fur-bearing animals of the state . . ." (Mont. Code Ann §87-1-201). In addition, FWP "shall enforce all the laws of the state regarding the protection, preservation, management, and propagation of fish, game, fur-bearing animals, and game and non-game birds within the state" (Mont. Code Ann §87-1-201(2)).

In 1995 concern over the potential for the spread of disease from wild bison to domestic cattle led to the enactment of a statute that further classified wild bison as a species in need of management under the authority of FWP, and as a species in need of disease management under the authority of the MDOL (see Mont. Code Ann §87-1-216). The statute states specifically that "the legislature finds that significant potential exists for the spread of contagious disease to persons or livestock in Montana and for damage to persons and property by wild buffalo or bison." The statute designates "publicly owned wild buffalo or bison originating from Yellowstone National Park as a species requiring disease control" and "designated other wild buffalo or bison as a species in need of management." Currently all wild bison within Montana originate from Yellowstone National Park; therefore management authority for wild bison is shared between FWP and the MDOL.

The above statute gives FWP responsibility for the management, "including but not limited to public hunting, of wild buffalo or bison in this state that have not been exposed to or infected with a dangerous or contagious disease but may threaten persons or property" (Mont. Code Ann §87-1-216). The section further requires FWP to consult and coordinate with the MDOL in implementing these management programs "to the extent necessary to ensure that wild buffalo or bison remain disease-free" (Mont. Code Ann §87-1-216). It also gives FWP the authority to "adopt rules with regard to wild buffalo or bison that have not been exposed to or infected with a contagious disease but are in need of

management because of potential damage to persons or property" (Mont. Code Ann §87-1-216).

The act was amended in 2011 to require that FWP develop a management plan "before wild buffalo or bison may be released or transplanted onto private or public land" (MCA 87-1-216).

Bison being hazed on private property in West Yellowstone. COURTESY BFC

The management of wild bison for disease control gives the MDOL the authority to take any of the following actions "whenever a publicly owned wild buffalo or bison from a herd that is infected with a dangerous disease enters the state of Montana on public or private land and the disease may spread to persons or livestock or whenever the presence of wild buffalo or bison may jeopardize Montana's compliance with other state-administered or federally administered livestock disease control programs" (Mont. Code Ann § 81-2-120(1)). The department may physically remove the live bison by the "safest and most expeditious means from within the state boundaries, including but not limited to hazing and aversion tactics or capture, transportation, quarantine, or delivery to a department-approved slaughterhouse"; the live bison may be "destroyed by the use of firearms"; the live bison "may be taken through limited public hunts when authorized by the state veterinarian and the department"; or the live bison "may be captured, tested, quarantined, and vaccinated" (Mont. Code Ann §81-2-120 (1)(a)–(1)(d)). If the MDOL implements the capture, test, quarantine, and vaccinate method, it may certify the wild bison as brucellosis free and then sell or transfer the bison to qualified tribal entities in a "manner that does not jeopardize compliance with a state-administered or federally administered livestock disease control program" (Mont. Code Ann §81-2-120(1)(d)(ii)). "The department (Department of Livestock) may adopt rules consistent with this section governing tribal participation in the program or enter into cooperative agreements with tribal organizations for the purpose of carrying out the disease control program" (Mont. Code Ann §81-2-120(1)(d)(ii)).

Domestic livestock may include bison that have been reduced to captivity and are privately owned under the authority of the MDOL under the laws at Title 81.

Additional Montana Statutes that Pertain to Bison

Public hunting is used as a species management tool by FWP to manage the population size of game species. Public hunting is just one of the tools allowed in the management of bison as a species in need of disease control once bison enter the state from

Yellowstone National Park (Mont. Code Ann §87-2-730). While traditionally FWP has been the agency that regulates hunting, a statute was issued in 2003 creating a special wild buffalo license whereby "the public hunting of wild buffalo or bison that have been designated as a species in need of disease control is permitted only when authorized by the department of livestock" (Mont. Code Ann §87-2-730(1)). This statute required that FWP adopt rules in cooperation with the MDOL and the state veterinarian for the implementation of bison hunts. The hunt must be a "fair chase" hunt, which requires that "hunting be conducted on foot and away from public roads and that there be no designation of specific wild buffalo or bison to be hunted" (Mont. Code Ann §87-2-730(3)(d)).

In addition, a special license to hunt wild bison was temporarily authorized to be provided to each of Montana's designated tribes free of charge (Mont. Code Ann §87-2-731(1)). Members of the tribes are allowed to hunt bison in accordance with the traditional ceremonies of each tribe (Mont. Code Ann §87-2-731(2)). The statute expires on July 1, 2015.

Decorated bison hide. PHOTO CREDIT: FWP

A person convicted of illegally "taking, killing, possessing, or transporting" wild buffalo "or any part of these animals shall be fined an amount of not less than $500 or more than $2,000, be imprisoned in the county detention center for not more than six months, or both" (Mont. Code Ann §87-1-102(2)(a)). Additionally that individual "shall forfeit any current hunting, fishing, recreational use, or trapping license issued by this state and the privilege to hunt, fish, or trap in this state for 30 months from the date of conviction or forfeiture unless the court imposes a longer forfeiture period" (Mont. Code Ann §87-1-102(2)(a)). The penalties increase if the individual is convicted of repeated offenses.

At the same time as the 1995 reclassification of wild bison as a species in need of management and a species in need of disease control, a statute was adopted that allows a private property owner to kill a wild bison that is "suspected of carrying disease and that is present on the landowner's private property and is potentially associating with or otherwise threatening the landowner's livestock" (Mont. Code Ann §81-2-121(1)(a)). The landowner must first notify or attempt to notify the MDOL "in order to allow as much time as reasonable for the department to first take or remove the publicly owned wild buffalo or bison that is on the landowner's property" (Mont. Code Ann §81-2-121). The landowner must also "make a good faith effort to notify the department that a taking has occurred and to retain all parts for disposal by the department" (Mont. Code Ann §81-2-121). The landowner must not "intentionally provide supplemental feed to game animals in a manner

that results in artificial concentration of game animals that may potentially contribute to the transmission of disease" (Mont. Code Ann §81-2-121). If a person is found guilty of providing supplemental feed to game animals as outlined above, they are "guilty of a misdemeanor" and are subject to additional penalties (Mont. Code Ann §81-2-121).

An act was passed in 2011 that granted MDOL the authority to establish a permit and inspection system for the transportation of domestic bison into and out of counties and into and out of the state for the purposes of tracking animal movements and collecting per capita assessments (Mont. Code Ann §81-1-101).

Legal and Conservation Status of Bison in Surrounding Regions

Idaho

The State of Idaho classifies bison as "unprotected" wildlife and domestic livestock (Gates et al., 2010). "Having no other designated status, bison are classified by default as unprotected wildlife in Idaho under the Idaho Fish and Game rules (Idaho Administrative Procedures Act (IDAPA) 13.01.06.200.01.a) and as livestock (Idaho Code §25-3301) and domestic animals under Idaho Department of Agriculture rules (IDAPA 02.04.20.101.12) (J. Rachael, Idaho Department of Fish and Game, personal communication). Bison are listed as an S1 Species in the wildlife commission status report. An S1 rank means that the species is a "critically imperiled species at high risk because of extreme rarity, however Idaho does not currently have any long-term conservation goals for bison within the state, or any proposals for restoration (Gates et al., 2010; J. Rachael, personal communication). There is no language pertaining to bison under Idaho Code Title 36, which pertains to fish and game.

"Under Idaho Code §25-618, bison are considered a significant risk for 'spreading contagious disease to persons, livestock, and other animals' and provides for the management or eradication of bison which have not been reduced to captivity" (J. Rachael, personal communication). Idaho code §25-618 places management of wild bison that pose a threat of disease under the direction of the Department of Agriculture: "it is the purpose of the provisions of this section to provide for the management or eradication of bison which have not been reduced to captivity and which pose a threat to persons, livestock or other animals through the transmission of contagious disease, and to prescribe the duties of the department of agriculture" (Idaho code §25-618). Gates et al. (2010) suggest the major legislative and/or policy obstacles for the restoration of bison within Idaho are the disease status of bison originating in Yellowstone National Park, conflicts within the agricultural and forestry sectors, and regulatory status.

North Dakota

The State of North Dakota classifies bison as a domestic animal under the nontraditional livestock regulations, and the state does not manage any bison as wildlife. North Dakota Administrative Code 48-12-01.0 states that "'Domestic animal' means . . . bison" (NDAC 48-12-01.1-01). North Dakota does not manage a public bison herd. There is a federal herd managed by the USFWS in Sully's Hill National Game Preserve, and a herd managed by the NPS in Theodore Roosevelt National Park (Gates et al., 2010). North Dakota does not have any proposals for further bison restoration within the state. Gates et al. (2010) suggest the major legislative and/or policy obstacles for restoration within North Dakota are conflicts within the agricultural and forestry sectors and regulatory status.

South Dakota

Within the state of South Dakota bison are classified as both wildlife and domestic livestock dependent on their location (Gates et al., 2010). South Dakota statute §39-5-6 defines bison as livestock (South Dakota Code §39-5-6, 2010). Bison are viewed and managed as wildlife only within the confines of the National Park System in Badlands and Wind Cave National Parks under the management of the NPS, and within Custer State Park under the management of South Dakota Game, Fish and Parks (Gates et al., 2010). A bison herd is also managed by South Dakota Game, Fish and Parks on Bear Butte State Park. South Dakota statute Title 41, the regulations for Game, Fish, Parks, and Forestry, does not include bison in its definitions of wildlife, though South Dakota statute §41-17-1.1 includes bison in its discussion of fees for harvest within Custer State Park (South Dakota Code §41-17-1.1, 2010).

South Dakota does have long-term conservation goals for the bison within the state parks, but there are no plans for additional restoration (Gates et al., 2010). Gates et al. (2010) suggest the major legislative and/or policy obstacles for restoration are conflicts within the agricultural and forestry sectors, the classification of bison as livestock outside of the state and national parks, their management under captivity, and regulatory status.

Wyoming

The State of Wyoming classifies bison as both wildlife and domestic animals based on their location. Wyoming Code § 11-6-302 states that "bison are considered livestock unless otherwise designated by the Wyoming livestock board and the Wyoming game and fish commission" (Wyoming Code § 11-6-302). Wyoming Code §23-1-302 gives the Wyoming Game and Fish Commission the authority "to designate individual bison or identifiable herds of bison as wildlife when the action is subsequently approved by the Wyoming livestock board" (Wyoming Code §23-1-302, 2010). Bison are classified as wildlife only within the national forests and national parks of Teton and Park Counties; throughout the remainder of the state bison are classified as livestock (Gates et al., 2010).

Bison within Grand Teton National Park.
COURTESY NPS

The Wyoming Fish and Game Department, NPS, and USFWS manage the bison herd that utilizes Grand Teton National Park and the National Elk Refuge with long-term conservation goals (Gates et al., 2010). Wyoming State Parks and Historic Sites manage the herds at Hot Springs State Park and Bear River State Park (Gates et al., 2010). Wyoming is exploring the potential for further reintroductions, including the reintroduction of a herd

on the Wind River Reservation of the Northern Arapaho (Gates et al., 2010). Gates et al. (2010) suggest the major legislative and/or policy obstacles of reintroduction in Wyoming are the disease status of YNP and Jackson-Grand Teton bison, conflicts within the agricultural and forestry sectors, and the regulatory status of bison outside of designated areas in statute (Park and Teton Counties).

Alberta

Within the province of Alberta, plains bison are classified as a domestic species (Gates et al., 2010). The province considers wild plains bison to be extirpated, and does not recognize them under the Alberta Wildlife Act (Gates et al., 2010). There are no long-term conservation goals or plans for reintroductions of plains bison by the Province of Alberta, although there have been proposals to include plains bison in native species management plans in Banff and Waterton Lakes National Parks (Gates et al., 2010). The herds in Elk Island and Waterton Lakes National Parks are managed by Parks Canada Agency. There are two plains bison herds that range on military reserves. The Department of National Defense manages the Canadian Forces Base Wainwright herd; and the Department of National Defense, Saskatchewan Environment, and Fish and Wildlife Branch manage the free-ranging Primrose Lake Air Weapons Range herd, as it straddles Alberta and Saskatchewan (Gates et al., 2010; L. Saigeon, Saskatchewan Ministry of Environment, personal communication). Gates et al. (2010) suggest the major legislative and/or policy obstacles, which hinder further conservation and reintroduction efforts, are conflicts within the agricultural and forestry sectors, the legal status of bison as livestock, and the conservation status of hybrid bison in Wood Bison National Park.

British Columbia

In the province of British Columbia, plains bison are classified both as wildlife and as domestic animals. The British Columbia Wildlife Act classifies bison as a big game species (R.S.B.C c. 488, 1996). Bison may be produced commercially and held as a domestic animal with a game farm license. The British Columbia Game Farm Act defines bison as a "game" species that may be domestically raised (R.S.B.C. c.168, 1996). British Columbia does not have any long-term conservation goals or proposals for restoration of plains bison (Gates et al., 2010). There is one conservation herd of plains bison in Pink Mountain Provincial Park, which is managed by the British Columbia Ministry of Environment (Gates et al., 2010). Gates et al. (2010) suggest the major legislative and/or policy obstacles of conservation and restoration are conflicts within the agricultural and forestry sectors, and also that plains bison in BC are considered to be outside of their original range.

Saskatchewan

In Saskatchewan plains bison are classified both as a wildlife species and as domestic animals. The Wildlife Regulations list "bison, other than domestically raised

bison" as a big game species (R.R.S. c. W-13.1 Reg. 1, 1981). The Livestock Dealers Regulations include bison in the definition of livestock (R.R.S. c. A-20.2 Reg. 9, 1995). The Captive Wildlife Regulations state that a person may hold in captivity, without a license, "bison that have been reared in captivity" (R.R.S. c. W-13.1 Reg. 13, n.d.). Parks Canada manages a captive herd in Grasslands National Park and a free-ranging herd within and around Prince Albert National Park, and maintains long-term conservation goals (Gates et al., 2010; L. Saigeon, personal communication). The Saskatchewan Environment and Parks Branch has management authority over Buffalo Pound Provincial Park (Gates et al., 2010). Gates et al. (2010) suggest the major legislative and/or policy obstacles in efforts to expand bison conservation are conflicts within the agricultural and forestry sectors and limited availability of suitable habitat.

Current Litigation Pertaining to Bison in Montana as of Spring 2011

Petition for the Listing of Plains Bison under the Endangered Species Act

Male during the rut. PHOTO CREDIT: J. BAILEY

On June 22, 2009, a petition was submitted to the Department of the Interior requesting the consideration of listing wild plains bison as a threatened species under the Endangered Species Act of 1973 (ESA). The petition requests that if bison are not listed as threatened under the ESA, that each of the four "major ecotypes of wild plains bison be listed as threatened, as significant distinct population segments, under the ESA in order to conserve the ecotypes and the ecosystem upon which these animals depend" (Bailey, 2009).

The petition requests the consideration of listing not due to threat of numerical extinction, but threat from "hybridization with cattle, loss of allelic diversity, domestication, loss of wildness due to anthropogenic selection overwhelming a limited range of natural selection, resulting in genetic extinction of wild plains bison, and also ecological extinction" (Bailey, 2009). The petition contends that bison are threatened over a significant portion of their range (Sanderson et al., 2008) and recognizes that the opportunities for bison restoration are limited (Bailey, 2009).

On February 24, 2011, following a 90-day review of the above petition, the USFWS announced that "the petition does not present substantial information indicating that listing may be warranted. Therefore, we are not initiating a status review in response to this petition" (76 FR 10299).

On April 14, 2011, the Center for Biological Diversity and Western Watersheds Project issued a press release announcing that a notice of intent to sue the USFWS over the decision not to list plains bison under the Endangered Species Act had been filed (Greenwald and Marvel, 2011). The organizations noted that "in order to claim bison do not deserve protection, the Fish and Wildlife Service ignored the fact that bison are gone from nearly all of their historic range and instead argued it must only consider the species' current range. Scientists refer to the practice of ignoring historic loss of wildlife populations as a 'shifting baseline,' whereby successive loss and degradation of the environment is accepted by only looking at a narrow window of time" (Greenwald and Marvel, 2011).

Western Watersheds Project et al. v. Ken Salazar et al.

In November 2009, the Western Watersheds Project, Buffalo Field Campaign, Tatanka Oyate, Gallatin Wildlife Association, Native Ecosystems Council, Yellowstone Buffalo Foundation, Meghan Gill, Charles Irestone, and Daniel Brister filed complaint for injunctive and declaratory relief against Ken Salazar, Secretary of Interior; Suzanne Lewis, YNP Superintendent; Leslie Weldon, Regional Forester, USFS Northern Region; and Mary Erickson, Gallatin National Forest Supervisor in the U.S. District Court for the District of Montana, Missoula Division.

The basis of the complaint filed by Western Watersheds Project et al. was that the USFS's decisions and actions under the Gallatin National Forest Plan, which are pursuant to the IBMP, prevents native bison from occupying and using national forest land around Yellowstone National Park. They claimed that the USFS is violating the National Forest Management Act by "not providing for diversity of plant and animal species on the Gallatin National Forest" (WWP et al., 2009, pp. 2).

The cooperative Western Watersheds Project group was also asking for review of the NPS actions and decisions. It contended that the NPS's actions and decisions will likely cause "impairment to native bison populations and other resources by allowing the wanton destruction of bison and not conserving bison and other resources" (WWP et al., 2009, pp. 2). Western Watersheds et al. was also asking the court for review "of both agencies' refusal to analyze and disclose new information and changed circumstances relating to bison management and brucellosis" (WWP et al., 2009, pp. 2).

On February 14, 2011, Judge Charles C. Lovell released his decision on the above lawsuit and request for injunctive relief. The court concluded that the defendants, Salazar et al. had not violated the National Environmental Policy Act, the National Forest Management Act, the National Park Service Organic Act, the National Forest Management Act, or the Yellowstone Enabling Act, and that the requisites for injunctive relief had not been proven (WWP et al., 2011b). Therefore the plaintiffs, Western Watersheds Project et al. were denied all relief (WWP et al., 2011b). Western Watersheds et al. has since filed an appeal to the 9th District Court of Appeals.

Sitz Angus Ranch et al. v. Montana Board of Livestock et al. and Edith Ford et al.

The Greater Yellowstone Coalition, Natural Resource Defense Council, and eight Horse Butte landowners, represented by Earthjustice, intervened on behalf of the Montana Board of Livestock, Montana Department of Livestock (MDOL), State of Montana, and Montana State Veterinarian, after the Sitz Angus Ranch, Bill Myers, and the Montana Stockgrowers Association filed suit against the state agencies in May 2008.

Sitz Angus Ranch et al. filed two Amended Complaints. The First Amended Complaint, filed in June 2008, raised two claims and requested that the court issue an order that would require the MDOL to "remove the wild bison, through hazing and slaughter,

from private and public lands in the area known as Zone 2, which consists of Horse Butte and surrounding lands adjacent to the western boundary of Yellowstone National Park" (Sitz Angus Ranch v. Montana Board of Livestock DV-09-388C). Sitz Angus Ranch et al. argued that that the IBMP is a legally enforceable document, and therefore the MDOL had a legal obligation to remove bison from Zone 2 by the 15th of May.

The Second Amended Complaint filed by Sitz Angus Ranch et al. repeated the original claims, but supplemented these claims with two new claims "attacking the IBMP Adaptive Adjustments and requesting that Respondents (MDOL) be ordered to follow and implement the existing IBMP until they comply with their legal duties to analyze the existing environmental impacts of modifying the IBMP" (Sitz Angus Ranch v. Montana Board of Livestock DV-09-388C). Sitz Angus Ranch et al. claimed that the adoption of the IBMP Adaptive Adjustments without preparing an adequate environmental analysis was in violation of the Montana Environmental Policy Ace (MEPA).

On May 27, 2010, the Honorable John C. Brown, District Judge in Montana's 18th Judicial District ruled that neither the IBMP nor Montana law created a mandatory obligation for the MDOL to remove the bison by the 15th of May, and dismissed Counts 1 and 2 of the Second Amended Complaint. The remaining claims in the litigation relating to compliance with MEPA are still pending.

Western Watersheds Project et al., v. State of Montana and Montana Department of Fish, Wildlife &Parks

In March 2010, the Western Watersheds Project, Gallatin Wildlife Association, Buffalo Field Campaign, and Yellowstone Buffalo Foundation filed a complaint against the State of Montana and FWP with Montana's 18th Judicial District Court, Gallatin County. Western Watersheds Project et al. filed the complaint following the decision of FWP to transfer temporary management of bison that are part of the Quarantine Feasibility Study to the Green Ranch, which is a private ranch owned and managed by Turner Enterprises Inc., and also over the transfer of 75 percent of the offspring that are born during the bison's tenure on Green Ranch to Turner Enterprises Inc.

Bison in the APHIS quarantine facility.
PHOTO CREDIT: S. ADAMS

In May 2010 the State of Montana and FWP filed an answer to the complaint. FWP states that "the public trust responsibility was to the species not individual animals," and that "the evolving long-term commitment was the best solution under the circumstances would be found" (State of Montana and FWP, 2010, pp. 1). The agency notes that the

agreement with Turner Enterprises Inc. “is a non-commercial agreement that will meet costs without taxpayer funding since the other alternatives fell through, and at the end of the five-year period the bison will be returned to FWP, which will have a permanent solution at that time” (State of Montana and FWP, 2010, pp. 2).

As of December 2010 the lawsuit has not yet been heard in front of the court.

Perspectives and Initiatives Pertaining to Bison within Montana by Nongovernmental Organizations

Bison and their management draw varied and often opposing perspectives from the organizations that represent diverse stakeholder groups. FWP feels that it is important for the citizens of Montana to know the varied position statements of these organizations. The following is a brief overview of the goals, programs, perspectives, and resolutions of some of these organizations. It is important to recognize that the following information may change and is representative of the various organizations as it stands during the publication of this background document in spring 2011.

The views and perspectives within this section are not those of FWP. Questions and concerns pertaining to the following opinions and initiatives should be directed to the respective organizations. Each organization was invited to provide information for this background document; therefore the summaries vary in length based on the extent of information that was provided. Every effort was made to contact organizations that are either involved with or potentially affected by bison, though it is important to recognize that if a group is not listed below it does not mean that they do not have a perspective to offer. The following organizations were contacted, but either did not have a bison-specific resolution or perspective, or had not offered a response prior to publication: Alliance for the Wild Rockies, American Wildlands, Buffalo Allies of Bozeman, Montana Outfitters and Guides Association, Montana Bison Association, Montana Cattleman's Association, Montana Stock Growers Association, National Bison Association, Safari Club International, Sierra Club, Sonoran Institute, Yukon to Yellowstone Conservation Initiative.

A number of regional organizations are opposed to or have passed resolutions opposing free-ranging bison and/or the movement of bison within Montana. Many of these organizations offer the perspective that free-ranging bison could be a threat to the agricultural industry due to concerns over disease, competition for forage, and threats to infrastructure such as fencing. Many of the organizations have also cited concern over public safety and potential damage to private property as reasons for opposition. Other organizations have recommended that within Montana the management of bison should fall under the direction of the Montana Department of Livestock (MDOL).

A number of national, international, and regional nongovernment conservation organizations have made the preservation of bison and restoration of wild bison a priority. These organizations are working within Montana and neighboring regions of the West on a number of initiatives. These efforts range from the restoration of bison as native grazers to increasing the available habitat for bison. There is an initiative from a number of the organizations to work toward allowing a year-round presence of bison in the regions around Yellowstone National Park. There are ongoing initiatives by organizations to increase the scientific knowledge used to manage bison and to reduce the occurrence of reportable disease within private herds through testing and culling.

A number of organizations note that is important to recognize the contributions that the private sector makes to the conservation of bison. Gates et al. (2010) distinguishes the conservation efforts of the private sector into two nonexclusive groups: 1) "private citizens interested primarily in commercial production and secondarily in bison conservation; and 2) private conservation groups interested in conserving bison as wildlife" (pp. 64).

The American Prairie Foundation

The American Prairie Reserve is a project led by the American Prairie Foundation (APF). The APF's mission is to create and manage a prairie-based wildlife reserve that, when combined with public lands already devoted to wildlife, will protect a unique natural habitat, provide lasting economic benefits, and improve public access to and enjoyment of the prairie landscape. APF has an international board of directors, and has staff located throughout Montana.

Bison on the American Prairie Reserve.
PHOTO CREDIT: S. GERRITY; COURTESY APF

The APF currently owns approximately 38,000 private acres and leases an additional 83,000 acres of public land within northeastern Montana. APF has a goal to eventually assemble 3.5 million acres using approximately 500,000 purchased, deeded acres to connect three million acres of various public lands managed by the BLM, USFWS and State of Montana. APF states that it strongly promotes public access on its private lands. The organization works closely with land and resource management agencies to ensure compliance with all regulations pertaining to the lands owned and leased by APF.

The APF also works closely with other groups to augment the science behind bison restoration, and reintroduced a captive herd of 16 bison to their lands in 2005. The herd has continued to grow through reintroduction of more bison and through natural reproduction, and as of spring 2010 comprised 215 bison.

The Buffalo Field Campaign

The Buffalo Field Campaign (BFC) is a nonprofit conservation organization based in West Yellowstone, Montana. BFC states that it works to stop the slaughter and harassment of wild bison that migrate out of Yellowstone National Park, protect the natural habitat of native wildlife, and work with First Nations to honor the sacredness of wild bison. BFC's primary goal is to create year-round protection for bison and their habitats and to foster respect for the

BFC members protesting in Helena.
COURTESY BFC

migration of this species.

BFC organizes daily field patrols within bison migration corridors and core habitat areas along the Yellowstone National Park boundary. Patrols document every interaction with the bison and encourage a wide range of activities designed to protect the YNP herd.

The organization notes that it employs planned strategies to protect wild bison through grassroots action, policy work, and litigation. BFC is working toward having bison classified as native wildlife under the management of FWP. BFC emphasizes that the focus should be on creating better brucellosis management plans and practices for cattle, and not on eradicating the disease within wildlife. The organization states that it seeks a scientifically based, ecological, and humane approach to bison management that respects and permanently protects wild bison and their migration between Yellowstone National Park and habitat outside the park.

BFC volunteer records hazing operations. COURTESY BFC

Defenders of Wildlife

Defenders of Wildlife (Defenders) is a national conservation organization with a Rocky Mountain Region Office in Bozeman and a regional field office in Missoula. Defenders' bison conservation priorities in Montana are to promote the restoration of wild bison to suitable regions of the state, create a greater tolerance for YNP bison to migrate beyond the boundaries of the park, and help Native American tribes expand their bison programs.

R. Magnan surveying the Fort Peck bison pasture. COURTESY DEFENDERS OF WILDLIFE

Defenders is assisting the Assiniboine and Sioux tribes of the Fort Peck Reservation and the Assiniboine and Gros Ventre tribes of the Fort Belknap Reservation with their respective bison restoration programs. Defenders has raised more than $70,000 in recent years to assist the two reservations with their efforts to acquire tribal grazing allotments in order to expand their bison pastures, build bison fencing, and inform tribal

members about the bison programs. Defenders supported the transfer of quarantined bison to Turner Enterprises Inc.'s Green Ranch, and recommends allocating the remaining quarantined bison and the bison returned from Turner Enterprises between the Fort Peck and Fort Belknap Reservations and at least one public herd.

Defenders supports changing the bison management plan in Montana on the edge of Yellowstone National Park in order to increase tolerance of free-roaming bison on a larger landscape that includes regional public lands, such as a larger portion of the Gallatin National Forest. Defenders notes that additional land must be made available to maintain a significant YNP bison population and to allow bison to be managed in a manner compatible with other wildlife species. While Defenders recognizes the use of "fair chase" hunting as a management tool, they recognize that the current limited ability for bison to utilize land outside of the park does not allow for these goals. Defenders has helped other conservation organizations to retire grazing allotments in key areas of the Greater Yellowstone Ecosystem by providing limited funding. Defenders is hoping to implement a new coexistence program to help fund projects to reduce conflicts between bison and landowners in the Greater Yellowstone area.

Defenders is calling for the end of slaughter as a management tool. They advocate having the limited livestock that are managed within the region surrounding the park either enclosed in fencing or converted to a bison-friendly alternative, such as steers only, rather than prevent bison from entering the state. In an effort to bring attention to the ongoing bison slaughter, Defenders is actively seeking public support for its programs. The organization recently generated over 100,000 comments to Secretary of Interior Ken Salazar to stop the slaughter and create a formal stakeholder group that represents all interests in order to work toward identifying solutions and advising public agencies on the management of YNP bison.

In addition, Defenders strongly supports efforts to restore bison as a wildlife species to other suitable locations in Montana. The organization is submitting comments on the Charles M. Russell National Wildlife Refuge Comprehensive Conservation Plan, requesting that the USFWS work to reintroduce bison as wildlife, and are encouraging their membership to do the same.

The Gallatin Wildlife Association

The Gallatin Wildlife Association (GWA) is a regional conservation organization that represents hunters and anglers in southwest Montana. GWA promotes the sustainable management of fish and wildlife populations through "fair chase" hunting and fishing opportunities in order to ensure that these resources will be preserved for the future. The GWA's goal is to establish viable year-round populations of free-ranging bison in Montana that would be conserved and managed through public hunting. To achieve this goal, the GWA is working to identify potential regions of both public and private land where landowner tolerance would allow for free-ranging bison populations.

The GWA is opposed to the current Interagency Bison Management Plan, which they claim focuses on hazing, capture, confinement and slaughter of bison attempting to enter Montana from Yellowstone National Park. GWA instead promotes restoration and management of wild bison populations similar to elk. In the interim, GWA continues to suggest improvements to the IBMP that would better protect private property rights and livestock, and manage a year-round bison population as valued and viable native wildlife on suitable habitat in southwestern Montana.

Bison in the Upper Gallatin. PHOTO CREDIT: J. WISMAN; COURTESY GWA

The GWA has drafted and introduced legislation in three previous legislative sessions to have bison recognized as a "valued, native wildlife in the state of Montana." GWA also introduced legislation in the 2011 session. The Montana Wild Buffalo Recovery and Conservation Act of 2011 would restore FWP as the primary agency responsible for wild bison; would ensure that property rights and livestock are protected by creating an advisory role for the MDOL; and would protect private property rights by preventing the government from entering private property without permission.

The Greater Yellowstone Coalition

The Greater Yellowstone Coalition (GYC) is a regional conservation group headquartered in Bozeman. The organization states that since 1983 it has advocated science-based protection for the lands, waters, and wildlife of the 20-million-acre Greater Yellowstone Ecosystem. The GYC's goals for bison are twofold: (1) to create opportunities for them to roam freely on appropriate public and private lands within the Greater Yellowstone Ecosystem, and (2) to advocate for appropriate outlets for restoring YNP bison to other suitable habitats in North America as population levels permit. GYC notes that the tools it has applied to achieve these goals include the purchase of federal grazing allotments from willing sellers, negotiations with landowners, and participation in policy discussions with state and federal agencies.

Bison on private land in West Yellowstone. PHOTO CREDIT: GYC

The organization sees the compensation of willing stock growers, through the buyout of their public land grazing allotments, as a means to

mitigate conflict between livestock and wildlife. GYC has participated in a number of buyouts within the Greater Yellowstone Ecosystem. In 2008 the GYC and partner conservation groups worked with FWP, Yellowstone National Park, and the Royal Teton Ranch to support an agreement allowing YNP bison the freedom to roam 9 miles north of the park along the Yellowstone River to suitable public lands. GYC has also partnered with the National Wildlife Federation to purchase grazing allotments on the Gallatin National Forest. GYC notes that it advocates expanding available habitat for bison within the Greater Yellowstone Ecosystem through policy decisions of relevant managing agencies, and seeks opportunities for making YNP bison available for bison restoration outside of the Greater Yellowstone Ecosystem, including state and federal wildlife refuges and tribal lands. The GYC feels that moving bison to suitable habitat elsewhere around the West will mitigate the need to slaughter YNP bison.

Montana Association of Conservation Districts

The Montana Association of Conservation Districts (MACD) is an association made up of conservation districts, which are units of local government designed to help citizens conserve their soil, water, and other renewable natural resources. The conservation districts are political subdivisions of the state, and are governed by a board of five supervisors elected by local voters in a general election.

In 2009, MACD passed the following resolution pertaining to bison: Resolution 09-07 Opposing Efforts To Create A Multi-Million Acre Wildlife Reserve With Bison In North Central Montana. WHEREAS, the planned conversion of millions of acres by the American Prairie Foundation from cattle ranching to a prairie wildlife reserve featuring bison will have a significant effect on the customs, culture, environment and economy of local communities in north central Montana; and WHEREAS, brucellosis affects a substantial number of bison and elk in the state of Montana and poses a health threat to area cattle; and WHEREAS, the conversion of State and Federal grazing permits from cattle to bison that are managed as part of a wildlife reserve and not a traditional livestock operation will threaten the sustainability of local ranches and the local economy; and WHEREAS, the natural migration of bison may create containment issues and threaten public safety; and

WHEREAS, an assessment of the cumulative impact that a multi-million acre wildlife reserve would have on the natural resources, economy, and communities of north central Montana has not been conducted. THEREFORE BE IT RESOLVED, that the Montana Association of Conservation Districts pursues and supports a temporary moratorium on the conversion of State and Federal grazing leases from cattle to bison. BE IT FURTHER RESOLVED, that based on a study and assessment, a uniform guidance be developed on how to proceed with bison restoration efforts and grazing conversions in Montana. NOW THEREFORE BE IT RESOLVED, that the Montana Association of Conservation Districts stands opposed to the conversion of millions of acres in north central Montana to a wildlife reserve with bison until a study of the social acceptability and an assessment that studies the cumulative impacts of a multi-million acre wildlife reserve on the natural resources, economy, and communities are completed.

Some of the individual conservation districts, such as Cascade County, Garfield County, Hill County, Phillips, McCone, Meagher County, Lower Musselshell, and Yellowstone have also indicated opposition to free-ranging bison out of concern over the threat of private property damage and disease, and the potential impact to the agricultural industry.

The Montana Association of Counties

The Montana Association of Counties (MACo) is an organization for counties of Montana that seeks to further good government and the protection of county interests. MACo is made up of representatives that have been designated by each member county's Board of County Commissioners. The organization seeks to foster cooperation and promote resource sharing among counties, provide services and resources to counties, and study problems and methods for improving the efficiency of county government. The organization also interacts with other government entities of the state and seeks to limit the activities of those entities by, for, or on behalf of government entities of the state of Montana.

MACo has issued the following policy statement pertaining to public lands: "if bison are introduced into areas of the state not currently populated with domestic livestock MACo supports that they be managed by the MDOL."

The MACo Resolution & Legislative Committee drafts legislation based on resolutions, and then works to secure sponsorship for the legislation. MACo adopted two 2011–2013 resolutions pertaining to bison. The first is Resolution 2010-01, amending the Interagency Bison Management Plan (IBMP). The intent of this resolution is "to seek amendments to the Inter-Agency Bison Management Plan that would allow the Counties adjacent to Yellowstone National Park to be a signatory to any agreement involving bison management in the state of Montana" (MACo, n.d., pp. 19). MACo states that IBMP partner agencies "wish to allow wild bison to migrate outside the recognized boundaries of Yellowstone National Park" (MACo, n.d., pp. 19). MACo also states that the IBMP was signed "prior to the current testing protocol for cattle operations in counties adjacent to Yellowstone National Park" and that "wild bison are known to carry the disease Brucellosis, which can be transmitted to other species" (MACo, n.d., pp. 19). MACo notes that local governments were not signatories to the IBMP, and that "local governments are charged with protecting the health and safety of their citizens," and that "counties adjacent to Yellowstone National Park have the legal jurisdiction and management responsibility for all county roads within their counties" (MACo, n.d., pp. 19). Therefore, MACo feels that local governments should be allowed to comment on management plans, and that the management decisions consider the health, safety, and economic well-being of citizens in counties adjacent to the park.

The second resolution that pertains to bison is Resolution 2010-14, Movement of Bison Across County Lines. The intent of this resolution is "to support requiring movement

of bison before crossing county lines to be regulated by the Department of Livestock" (MACo, n.d., pp. 22). MACo notes that bison may currently be moved across county lines without inspection of owner identification. MACo feels that the MDOL is the best agency to manage identification, and therefore should be responsible for regulating bison movement across county lines.

Montana CattleWomen

The mission of the Montana CattleWomen is to "support the livestock industry and its environment though communication, education, and legislative activities" (Montana CattleWomen, 2011). The organization notes that it is opposed to free-ranging bison, and states that its reasoning for opposition is based on concerns over disease and the fact that it feels that bison cannot be controlled. The organization states that "we fence our fields and streams and hay stacks for a reason and feel we would lose a lot if they were free roaming and that is a taking of our property rights" (V. Olson, Montana CattleWomen, personal communication).

Montana Farm Bureau Federation

The Montana Farm Bureau Federation (MFBF) is a regional organization that represents over 16,000 member families, including farmers and ranchers throughout Montana. The MFBF is "adamantly opposed to the establishment of wild or free roaming bison in Montana" (J. Cummins, Montana Farm Bureau Federation, personal communication). The organization cites two main reasons for opposition. The first is that its "members are property owners, they are very concerned that the bison would not be contained to a specific area and when they escape, the bison would be very likely to cause property damage (i.e., tearing down fences, ruining water tanks and reservoirs, disrupting crops, eating grass and hay needed to feed the landowner's livestock, etc.)" (J. Cummins, personal communication).

The second reason for opposition is the concern over the risk of brucellosis transmission. The organization states that "our members believe that all bison outside Yellowstone National Park and the National Bison Range in Moiese should be classified as livestock and subject to regulation by the Montana Department of Livestock since they are a species that is known to carry the disease brucellosis at a very high rate" (J. Cummins, personal communication). The organization notes that if cattle were to become infected with brucellosis, it would be devastating to the industry.

Montana Sportsmen for Fish and Wildlife

The Montana Sportsmen for Fish and Wildlife's (SFW) mission is to "preserve, protect, and enhance Montana's fish and wildlife resources and outdoor opportunities, and to ensure our American heritage of hunting and trapping through hands-on conservation

efforts and responsible predator management by Montana sportsmen" (SFW, 2011). SFW notes that it does not oppose "bison hunting in Montana for the areas we may already hunt, but we are opposed to introduction of free-roaming bison, relocation, translocation, or expansion of FWP's management of bison" (B. Merrill, SFW, personal communication). The organization cites concern over cost/risk with regard to private property issues, conflicts with the cattle/wool industry, and management problems posed to FWP as the basis for opposition (B. Merrill, personal communication).

Montana Wildlife Federation

The Montana Wildlife Federation (MWF) is a regional conservation organization headquartered in Helena. With more than 7,000 members and 23 affiliate clubs, MWF is the oldest and largest hunter and angler conservation organization in Montana. MWF notes that it is an "organization of conservation minded people who share a mission to protect and enhance Montana's public wildlife, lands, waters, and fair chase hunting and fishing heritage." MWF states that it has made the restoration of huntable populations of free-ranging bison managed by FWP a priority.

MWF has passed two resolutions pertaining to bison management in recent years. Part of MWF's current position on bison management is expressed in a resolution titled Wild Bison Restoration in Montana, which was passed in 2004. This resolution documents MWF's position "for the restoration and expansion of native, wild bison herds in Montana beyond the current limited zone 2 within the Greater Yellowstone Area as identified in the IBMP." The resolution also notes that MWF "insists that recovery and conservation of wild bison follow the successful North American model for wildlife management under the complete and sole supervision and authority of the FWP." MWF's board of directors renewed its commitment to bison restoration through the unanimous passing of a resolution in December 2010 stating that "Montana Wildlife Federation supports the development of the statewide bison management program by FWP . . ." and ". . . that MWF supports the establishment of free-ranging wild populations of bison in Montana."

MWF states that all wild bison in Montana should continue to be classified as "game animals," and the organization opposes any efforts to give other state agencies the authority to manage wildlife species and/or remove this authority from FWP. MWF states that it advocates for the management of free-ranging populations of bison in accordance with the North American Wildlife Conservation Model, and thus should be managed by FWP through recreational "fair chase" hunting.

MWF advocates that agencies and groups that are involved with brucellosis management in bison and livestock focus on the treatment of brucellosis in livestock rather than on brucellosis control in wild bison. MWF states that it supports the management of bison as a public trust resource, and therefore opposes the privatization of public bison. MWF believes that Montana's bison quarantine program has produced genetically pure bison that are free of reportable diseases of concern, and so represent a significant investment to sportsmen and the general public. The organization emphasizes that

quarantine bison and their offspring should be retained in public ownership and could be used to establish new herds to eventually be hunted by Montana sportsmen.

Montana Women Involved in Farm Economics

The Montana Women Involved in Farm Economics is (MTWIFE) "dedicated to improving profitability in production agriculture through educational, legislative, communicative, and cooperative efforts" (WIFE, 2011). The organization has an interim policy in opposition to free-ranging bison within Montana (D. Gillespie, Montana Women Involved in Farm Economics, personal communication)

National Park Conservation Alliance

Winter bison in Yellowstone National Park.
PHOTO CREDIT: D. BLANK

The National Park Conservation Alliance (NPCA) is a national conservation organization with a Northern Rockies Regional/Yellowstone Office in Bozeman and a Glacier Field Office in Whitefish. The NPCA states that it supports the migration of YNP bison into suitable habitat within Montana. The organization is making the identification of suitable habitat and facilitation of the acceptance of bison a priority. NPCA contributed funding and was a member of the working group that facilitated the Royal Teton Ranch allotment buyout. NPCA is working with the Gallatin National Forest to identify and prioritize allotments for potential future buyout or retirement. The organization states that it would support a reevaluation of the IBMP and transfer of the management of YNP bison in Montana from the MDOL to FWP.

NPCA states that it supports the restoration of populations of free-ranging bison elsewhere within Montana. The organization advocates the establishment of a bison management plan for the state of Montana, and opposes legislation that would limit the movement of bison within the state. NPCA would like to see the management of bison in Montana returned to FWP, and supports using "fair chase" hunting as a tool to manage restored herds. NPCA also supports the movement of quarantine bison to a suitable location within Montana, and is working to procure funding to facilitate the transfer of quarantine bison to one of the Native American reservations or another suitable location.

The National Wildlife Federation

Male bison during the rut. PHOTO CREDIT: R. POOLE; COURTESY NWF

The National Wildlife Federation (NWF) is a national conservation organization whose Northern Rockies and Prairies Regional Center has been based in Missoula since 1981. The NWF is the nation's largest conservation organization with over four million members and supporters. NWF states that its mission for bison in Montana is to restore a wild, huntable population to the Charles M. Russell National Wildlife Refuge (CMR) and surrounding public lands, and to secure wintering habitat for YNP bison outside of the park. Its work toward that mission includes cooperative partnerships with the American Prairie Foundation and private landowners. NWF notes that it has implemented programs to complement these efforts, and so far has retired three key grazing allotments within the region, totaling over 50,000 acres. NWF has also worked to secure key habitat outside of Yellowstone National Park for wintering bison through its Wildlife Conflict Resolution Program by retiring grazing allotments. As of 2010, NWF has worked with partners to retire 32 allotments totaling more than 566,120 acres of habitat in the Greater Yellowstone Ecosystem. Some of the key retirements have included Horse Butte, two allotments in the Taylor Fork, and an agreement with the Royal Teton Ranch to develop a corridor for bison and transfer livestock from the region. In addition, NWF's Tribal Lands Program is working to secure transfer of YNP quarantine bison to tribal reservations in Montana. MWF states that it recognizes that sportsmen played a lead role in saving bison from extinction, and feels that this interest group can now be a leader in the effort to restore bison. NWF is working to organize state and national sportsmen's organizations to influence key bison planning efforts.

Bull Bison. PHOTO CREDIT: R. POOLE; COURTESY NWF

The Natural Resources Defense Council

The Natural Resources Defense Council (NRDC) is a national conservation organization with a regional office in Livingston. The NRDC states that it is focused on the protection and preservation of YNP bison, as well as the restoration of wild free-roaming bison populations elsewhere in the West. NRDC supports the restoration of bison as a native wildlife species that is not fenced, aggressively managed, or culled. NRDC states that it would like to see the restoration of a wild, free-ranging population of bison in Montana, one that is managed by FWP like other wildlife species such as elk, deer, and pronghorn. To protect bison as a wildlife species, NRDC advocates for a major revision of the IBMP. The

organization also supports a greater acceptance of bison outside Yellowstone National Park in regions of Montana with private landowner tolerance, including maintaining a year-round bison presence in the Horse Butte area. NRDC is working with conservation partners, hunting groups, government agencies, congressional offices, and Native Americans on this effort. NRDC notes that it believes that the restoration of wild herds and the increase of tribal herds will maintain and increase the ecological, economic, cultural, spiritual, and historical values of wild bison.

Herd in Yellowstone National Park. PHOTO CREDIT: DANA LEONARD; COURTESY NRDC

The Nature Conservancy

The Nature Conservancy (Conservancy) is a national conservation organization that works to preserve the diversity of species through the conservation of land and water. While the Conservancy does not have stated goals for bison in Montana, the organization notes that it has worked to conserve more then 800,000 acres of wildlife habitat within the state. The Conservancy is currently working to preserve land on the northern Montana prairies, the Yellowstone River, a vast region of southwest Montana around Yellowstone, and the "Crown of the Continent," which consists of over 18 million acres in northwest Montana and Canada. None of these project call for the reintroduction of bison at this time.

The Conservancy does manage conservation bison herds on eight of their preserves that are located in other states. As of 2010 the combined herds totaled approximately 4,845 head of bison. Bison are used as a grasslands management tool on these preserves. The Conservancy is working to increase the genetic purity of its herds through the testing and removal of bison that show introgression of cattle genes.

Turner Enterprises Inc.

With the development of production herds that consist of over 50,000 head of bison on 14 large ranches, Turner Enterprises Inc. is the largest bison producer in the United States (Gates et al., 2010; Turner Enterprises Inc., 2010). The mission statement of Turner Enterprises Inc. is "to manage Turner Lands in an economically sustainable and ecologically sensitive manner while promoting the conservation of native species" (Turner Enterprises Inc., 2010). Turner Enterprises Inc. manages their bison with "low management inputs similar to many public conservation herds" (Gates et al., 2010, pp. 64).

Turner Enterprises Inc. owns four ranches in Montana: the 22,129-acre Bar None Ranch on the southern end of the Big Belt Mountains, the 13,343-acre Snowcrest Ranch

along the Ruby River in Madison County, the 4,878-acre Red Rock Ranch along the Red Rock River in Beaverhead County, and the 113,613-acre Flying D Ranch near Bozeman (Turner Enterprises Inc., 2010)

In 2009, 87 bison from the FWP and APHIS quarantine facility were transferred to Turner Enterprises Inc. to complete five years of post-quarantine monitoring (B. Frey, personal communication). Turner Enterprises Inc. has assumed management responsibility for the quarantined bison and will "return the original (quarantine) bison and 25 percent of their offspring to FWP. Turner Enterprises Inc. will retain the remaining offspring" (FWP, 2010b).

The bison were transferred to Turner Enterprises Inc.'s Flying D Ranch, which consists of 113,613 acres in southwest Montana, near Bozeman (Turner Enterprises Inc., 2010). The herd is separated from other animals on the ranch and rotated through 14 parcels, which range from 300 to 3,000 acres each (FWP, 2010b). The ranch has the capacity to manage the original bison and their offspring (an estimated 340 bison) for the five-year period, and therefore hunting will not be needed as a population management tool (FWP, 2010b).

The Wildlife Conservation Society

The Wildlife Conservation Society (WCS) is an international conservation group based in New York City. Its North American Program office is located in Bozeman, but the WCS conducts conservation projects and programs across the United States and Canada. WCS states that it emphasizes site-based conservation that is focused on landscapes and species. The organization identifies bison as a keystone species and necessary for sustaining prairie ecosystems. Due to bison's significant effect on their habitat and important functional relationship to other prairie species, the WCS states that it advocates for restoration of wild free-roaming bison on a large scale in representative habitats across North America. WCS notes that it encourages ecological restoration programs that support human livelihoods, sustain human cultures, and connect people to nature. The organization states that it recognizes the importance of the preservation of genetics, diversity, and integrity within wood and plains bison populations throughout North America.

The WCS relaunched the American Bison Society (ABS) in 2005 at its 100th anniversary, and with this initiative came a renewed focus on preserving ecologically functional bison populations. The ABS initiative is working to build a network of bison experts including ranchers; local, national, and international governments; Native American nations; scientists; and nongovernmental organizations from western states, Mexico, and Canada with the purpose of securing an ecological future for bison in North America. The WCS states that it works on researching and promoting scientific resolutions to obstacles that hinder the ecological restoration of bison. The ABS initiative supports federal agencies' efforts to better coordinate the management of bison across federal lands (USDI, 2008), and is working with Canada and Mexico to develop cross-border management.

The World Wildlife Fund

Bison on the American Prairie Reserve. PHOTO CREDIT: S. GERRITY; COURTESY APF

The World Wildlife Fund (WWF) is an international conservation organization whose Northern Great Plains Program is based in Bozeman. The WWF notes that it has made the restoration of bison within Montana and throughout the Northern Great Plains (North Dakota, South Dakota, Wyoming, Nebraska, Alberta, and Saskatchewan) one of its highest priorities. In pursuing its conservation initiatives, WWF states that it engages the wisdom and perspective of tribes, sportsmen, recreationists, scientists, conservationists, landowners, and industry.

The long-term goal of WWF is the recovery of endangered and keystone species and natural processes within the Northern Great Plains. As part of this effort, WWF is focused on the large-scale restoration of wild bison, with the aim of establishing three to four herds that each consist of 5,000 or more animals. To achieve this goal, WWF is working with the American Prairie Foundation (APF) to establish and maintain a herd of bison on the American Prairie Reserve (APR). WWF has provided the scientific underpinnings of bison genetics, disease control, wildlife-friendly fencing, and management on the APR.

The WWF states that it supports the efforts of others aiming to rebuild populations of bison. WWF also supports the work of the North American Bison Specialist group of the International Union for Conservation of Nature, which is a collection of experts from government, private business, academia, and tribal and nonprofit communities in North America who have called for major efforts to conserve bison throughout North America. WWF states that it believes that national parks, national wildlife refuges, and other federal lands are an appropriate place to form the core of bison habitat, and supports the efforts being led by government agencies to better manage and conserve bison. The organization supports the work being done by private bison producers to develop best management practices and genetic management guidelines that provide potential opportunities for private bison herds to contribute to the ecological restoration of bison.

WWF states that it supports the evaluation that is currently being conducted by FWP to examine the potential for populations of wild, huntable bison. WWF believes that the greatest challenge to the recovery of bison is not biological, but rather overcoming the common perception that bison, which have had a profound influence on human history and grasslands ecosystems for over 10,000 years, no longer belong on the landscape. WWF believes that the key to the ecological recovery of bison is the recognition that it is a wildlife species and should be conserved and managed as wildlife.

Conservation Actions of Government Agencies

PHOTO CREDIT: S. ADAMS

As of 2010 there were no specific federal efforts proposed to protect or reintroduce plains bison beyond the boundaries of existing national parks, monuments, or wildlife refuges within the United States (Gates et al., 2010). In 2008 the U.S. Department of the Interior (USDI) published its Bison Conservation Initiative, which is a framework for managing the USDI bison herds. The framework "establishes steps to address the health and genetic composition of DOI bison herds, and acknowledges the ecological and cultural role of bison on the American landscape. It proposes specific actions to better manage and integrate bison populations on select Interior lands in 2008 and future years" (USDI, 2008, pp. 3). The initiative states that while it is not feasible to reintroduce widespread herds, "it may be possible to develop partnership arrangements that will permit bison herds to re-create their natural role in areas where biologically suitable and socially acceptable" (USDI, 2008, pp. 3). The initiative also recognizes that the presence of bison in adequate numbers may help support the "restoration or maintenance of other native species and habitats" (USDI, 2008, pp. 3). The strategy will "consider treating the various populations as a larger metapopulation, looking at ways to create and maintain gene flow, as well as protecting private alleles among these small populations by improving genetic management strategies. This framework also committed USDI agencies to expanding herd size if possible, and building cooperation with partners for the conservation of bison. In addition, comprehensive refuge plans are being reviewed to consider the feasibility of attempting bison restoration on large refuge landscapes, such as the Charles M. Russell National Wildlife Refuge" (Gates et al., 2010, pp. 81).

The USDI chartered the DOI Bison Conservation and Management Working Group, which is charged with working to guide management of the USDI herds, one of which is the National Bison Range herd in Moiese, in northwestern Montana. The working group met in early 2009 and again at the end of 2010 (D. Powell and P. Dratch, United States Department of the Interior, personal communication). In 2011 the NPS and USFWS are planning to host a meeting with wildlife health and management experts to address bison health (H. Frost, NPS, personal communication).

The group held the Bison Conservation Genetics Workshop in September 2008. The result of the workshop was an agreement on the basic tenets of genetic management for the USDI herds and discussion of different approaches to achieve these goals (Dratch and Gogan, 2010). The workshop participants established the criteria for a wild bison herd "as one with a large enough population size to prevent loss of genetic variation and with low

levels of cattle or subspecies introgression, and subject to some of the forces of natural selection, including competition for breeding opportunities" (Dratch and Gogan, 2010, pp. 2). Participants agreed that the desired minimum size of a population should be 1,000 individuals, which could be achieved through the establishment of a single population or the management of several smaller populations as a metapopulation (Dratch and Gogan, 2010). The participants evaluated the current status of the USDI herds and noted that while the herds meet the basic threshold for genetic integrity, most are managed well below 1,000 bison, and there are no management plans in place to manage these smaller herds as metapopulations (Dratch and Gogan, 2010).

There was consensus that herds with no evidence of cattle hybridization must be safeguarded from potential introgression of livestock genes, and must be recognized as very important resources (Dratch and Gogan, 2010). The participants noted that while none of the USDI herds are "subject to the full range of historic natural selective forces that influence genetic variation, management actions should maximize population size, minimize selection for docility and other traits related to domestication, strive for an even sex ratio considering differential survival, and minimally interfere with social behavior" (Dratch and Gogan, 2010, pp. 2). Participants further recognized that USDI herds have "a crucially important role in long-term bison conservation" (Dratch and Gogan, 2010, pp. 2). They noted that almost all USDI herds must be increased in size to avoid negative genetic effects, and since most of the herds "are generally at or near capacity within federal boundaries, establishing satellite herds that can contribute to metapopulations is an important first step. Further, managing bison herds across current jurisdictional boundaries is an important step to long-term bison conservation" (Dratch and Gogan, 2010, pp. 2).

The USFS Region I is a full participant in the IBMP. The Gallatin National Forest has had the lead in the USFS Northern Region, and conservation efforts have included the closure of certain areas of the forest to cattle grazing where the grazing permit was waived back to the USFS with no preferred applicant (L. Weldon, USFS, personal communication). The closure of these regions provides a buffer for disease management, which reduces conflicts regarding disease transmission (Weldon, personal communication).

PHOTO CREDIT: S. ADAMS

The USFS conducted an assessment in 2001 of its management of national grasslands in North Dakota, Nebraska, South Dakota, and Wyoming through the Northern Great Plains Management Plans Revision. An alternative that was proposed in early scoping and in comments to the Draft Environmental Impact Statement was the removal of domestic cattle and the restoration of free-ranging wild bison to the National Grasslands. This alternative

would have required the individual states to assume management responsibility for the bison as wildlife. The Final Impact Statement for the Northern Great Plains Management Plans Revision notes that discussions indicated that those states were not interested in accepting the responsibility for management of bison (USFS, 2001). The USFS notes that the need for bison grazing over cattle grazing was not identified in the Purpose and Need section of the management plan (USFS, 2001).

The Final Impact Statement also notes that "bison are not listed by the USFWS as a threatened or endangered species; therefore, there is no requirement under the Endangered Species Act for formal bison restoration" (USFS, 2001, pp. 2–14). The last Threatened, Endangered, and Sensitive Species List, which guides the USFS wildlife programs, was published in 2004.

The USFS evaluated plains bison for Sensitive Species status in Region I in 2010, but plains bison were not recommended to be included on the Regional Forester's Sensitive Species List (Weldon, personal communication). There are bison present in a limited number of other USFS regions, but there do not appear to be conservation programs or initiatives outside of the Northern Region (Weldon, personal communication).

The USFS does not have an official position on the reintroduction of bison on forest service land in Montana, and Weldon notes that "the reintroduction of bison has not gone through a public process and the Forest Service may need to do a NEPA analysis if USFS lands are included in a bison reintroduction proposal" (personal communication). However, the USFS has stated that it is "prepared to work with the State of Montana to evaluate specific proposals as they are developed" (Weldon, personal communication).

Charles M. Russell National Wildlife Refuge

The Charles M. Russell National Wildlife Refuge (CMR) encompasses approximately 1.1 million acres in north-central Montana including portions of Fergus, Petroleum, Garfield, McCone, Valley, and Phillips Counties. The USFWS and its partners manage the CMR under the National Wildlife Refuge System Administration Act of 1966, which states that "the mission of the National Wildlife Refuge System is to administer a national network of lands and waters for the conservation, management, and where appropriate, restorations of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans" (USFWS, 2010).

Each refuge is then managed to fulfill the specific purpose for which it was established. The CMR was established in 1936 under Executive Order 7509 so "that the natural forage resources therein shall be first utilized for the purpose of sustaining in a healthy condition a maximum of 400,000 sharp-tailed grouse, and 1,500 antelope, the primary species, and such nonpredatory secondary species in such numbers as may be necessary to maintain a balanced wildlife population, but in no case shall the consumption of the forage by the combined populations of the wildlife species be allowed to increase the burden of the range dedicated to the primary species. Provided further, that all the forage

resources within this range or preserve shall be available, except as herein otherwise provided with respect to wildlife, for domestic livestock . . . And provided further, that land within the exterior limits of the area herein described . . . may be utilized for public grazing purposes only to the extent as may be determined by the said Secretary to be compatible with the utilization of said lands for the purposes for which they were acquired" (USFWS, 2010, pp. xvi–xvii).

The USFWS is in the process of developing a Comprehensive Conservation Plan (CCP), which will guide the management of the refuge for 15 years. The USFWS released a Draft Comprehensive Conservation Plan and Environmental Impact Statement in September 2010 for 84 days of public review and comment. The goal is to release the Final Comprehensive Conservation Plan and Environmental Impact Statement in the spring of 2012, and to have a Record of Decision, which will outline the chosen management plan, by the summer of 2012.

As part of the development of the CCP, the USFWS developed a vision for the refuge, which describes the focus of management of the refuge and "portrays a picture of the refuge in 15 years" (USFWS, 2010, pp. xix). Part of the vision emphasizes the importance of the refuge as "an outstanding example of a functioning, intact landscape in an ever-changing West. Working together with our neighbors and partners, the Service employs adaptive management rooted in science to protect and improve the biological integrity, biological diversity, and environmental health of the refuge's wildlife and habitat resources" (USFWS, 2010, pp. xix).

The USFWS developed eight goals to direct the work of achieving the vision and purpose of the refuge. One of these goals is to "conserve, restore, and improve the biological integrity, environmental health, and ecological diversity of the refuge's plant and animal communities of the Missouri River breaks and surrounding prairies to support healthy populations of native plants and wildlife" (USFWS, 2010, pp. xix). A second goal is to "contribute to the identification, preservation, and recovery of threatened and endangered species and species of concern that occur or have historically occurred in the northern Great Plains" (USFWS, 2010, pp. xix). One of the significant issues to be addressed within the Draft Comprehensive Conservation Plan and Environmental Impact Statement is "species reintroductions or management of species that could move onto the refuge: American bison . . ." (USFWS, 2010, pp. 11).

Cottonwood bottoms of the Missouri River within the CMR.
PHOTO CREDIT: M. OAKS/THE WILDERNESS SOCIETY; COURTESY USFWS

The USFWS "has taken the position that it will not consider reintroducing bison on the refuge unless FWP initiates an effort to restore bison as a wildlife species on a larger landscape. The Service recognizes the State's role in managing native wildlife and would work cooperatively with FWP in the development of a bison restoration plan. FWP does not have any plans at this time to consider reintroducing a free-ranging herd of bison in the area. The Service has no desire to manage another high fence captive bison herd on Service lands" (USFWS, 2010, pp. 93).

The Draft CCP presents four alternatives for public review. Alternative A, No Action, does not set any objectives for the restoration of bison (USFWS, 2010, pp. 93). Under Alternative C, Public Use and Economic Use Emphasis, the USFWS would not actively work to restore bison to the refuge, but "if bison are restored to areas outside the refuge, and animals migrate into the refuge as State-managed wildlife species, the refuge would adopt the FWP management plan (USFWS, 2010, pp. 93). The rationale for this objective "attempts to balance economic uses, such as livestock grazing, with bison restoration by not intending to actively restore bison on the refuge, but passively accepting bison as wildlife to be managed in accordance with FWP management guidelines" (USFWS, 2010, pp. 93–94).

Objective B, Wildlife and Habitat Emphasis, and Objective D, Ecological Processes Emphasis (Proposed Action), would "over 15 years, continue to work with FWP, conservation organizations and neighbors to evaluate the economic, social and biological feasibility of restoring bison as a natural component on the surrounding landscape" (USFWS, 2010, pp. 93). If FWP proposed a reintroduction plan that includes the CMR, the USFWS would work to develop a "step-down framework defining under what conditions the refuge would participate" (USFWS, 2010, pp. 93). Within one year of the development of the framework, the USFWS would work in cooperation with FWP and other partners to develop a bison management plan that "specifies and ranks areas of suitable habitat, establishes appropriate abundance, composition and distribution targets based on habitat conditions and appropriate for management of wildlife and recreation on a national wildlife refuge, and details cooperative management responses to be applied to anticipated conflict situations" (USFWS, 2010, pp. 93).

Habitat in the CMR. PHOTO CREDIT: S. ADAMS

The rationale for bison restoration under Alternatives B and D are that while the USFWS recognizes the ecological significance of bison, it also recognizes the complexity and

controversy associated with a restoration effort. The USFWS would therefore want to "work cooperatively and collaboratively with others as a full partner in any proposal with full engagement of the public" (USFWS, 2010, pp. 93). The USFWS would implement the following strategies concurrently with any proposal by FWP for bison restoration. The USFWS would "work with FWP, major universities, World Wildlife Fund, The Nature Conservancy, American Prairie Foundation, and others to develop and carry out research proposals to evaluate the biological, social, and economic feasibility of restoring free-ranging bison in and round the refuge"; would "work with a variety of economists to determine the potential economic effects/impacts of a free-ranging herd in the area"; and prior to reintroduction would "finalize a cooperative bison management plan, developed and agreed to by all involved management parties, that addresses population objectives and management, movement of animals outside restoration areas, genetic conservation and management, disease management and conflict resolution procedures" (USFWS, 2010, pp. 93).

Previous and Preliminary Evaluation of Potential Introduction Sites by Organizations Other than Montana Fish, Wildlife & Parks

Private interests and nongovernmental organizations continue to explore possible sites for bison reintroductions in Montana and the surrounding region. In 2005 and 2006, the Wildlife Conservation Society hosted three meetings with a variety of stakeholders to begin to establish a vision for bison conservation (Sanderson et al., 2008). The outcome of one meeting was the creation of the "Vermejo Statement," which was created by an array of stakeholders, including indigenous groups, bison producers, conservation organizations, and government and private land managers from throughout North America (Sanderson et al., 2008). The statement envisions that "over the next century, the ecological recovery of the North American bison will occur when multiple large herds move freely across extensive landscapes within all major habitats of their historic range, interacting in ecologically significant ways with the fullest possible set of other native species, and inspiring, sustaining, and connecting human culture" (Sanderson et al., 2008).

As part of this project, Sanderson et al. (2008) created a map that outlined a set of 22 habitat types that were historically used by bison west of the Mississippi River. The mapped areas, which encompass parts of Montana, are further suggested as places "where ecological recovery might be possible over three time frames and considered future trends in land use, economic development, demography, and climate" (Sanderson et al., 2008, pp. 256).

In 2001, FaunaWest Wildlife Consultants (FaunaWest) prepared its own site evaluation of possible bison reintroduction sites in Montana. FaunaWest's criteria includes (1) at least 200,000 acres of federal lands, or (2) at least 100,000 areas of federal/state lands, or (3) rangelands to support 50 adult bison without causing an impact on forage "available to other wild and domestic ungulates" (Knowles, 2001, pp. 5). Based on this criteria, FaunaWest identified eight sites: Glacier National Park/Blackfeet Indian Reservation; Bob Marshall Wilderness/Sun River Game Range; Bitter Creek area, northwest of Glasgow; southern Valley County; southern Phillips and Blaine Counties; Terry Badlands, northwest of Terry; Lone Tree Creek, south of Ekalaka; Pryor Mountains and Pryor Mountains Wild Horse Range (Knowles, 2001, pp. 5). The potential of any region as a possible restoration site would be dependent on the parameters of the bison program that is developed.

In February 2011 the National Wildlife Federation funded a survey that was conducted by Moore Information, Inc, a national public opinion research company. Telephone interviews were conducted among a representative sample of 400 registered voters statewide. The response rates to certain questions are listed below, and the full survey results are available on the National Wildlife Federation website (www.nwf.org).

In response to the question, "In your opinion, is it possible for Montana to manage wild bison in the same way that other wildlife species are managed in the state, such as elk and deer, or not?" response rates were 63 percent yes, 27 percent no, and 10 percent did not know.

In response to the question, “Would you favor or oppose the Montana Department of Fish, Wildlife & Parks investigating possible locations in Montana where wild bison populations could be restored?” response rates were 70 percent in favor, 24 percent opposed, and 6 percent did not know.

In response to the question, “Would you favor or oppose allowing hunters to hunt wild bison populations in Montana the same way they hunt other species like deer and elk?” response rates were 70 percent in favor, 23 percent opposed, and 7 percent did not know.

Preliminary Perspectives

The evaluation of any potential bison program is an ongoing process, as new information and science pertaining to bison and their management continues to emerge. Because our understanding of how bison will use different landscapes in Montana is limited, any program that could be developed would need to be adaptable as our knowledge base increases.

In summary:

- Wildlife programs that are cooperative and involve citizens early in the development process are the most successful.

- Bison conservation programs are being developed and implemented by nongovernmental organizations, Native American tribes, and others within Montana and the surrounding region.

- National management agencies, such as the USDI, are facing pressure to examine the status of bison and explore options for conservation.

- Free-ranging bison that are managed through hunting programs in other regions have posed minimal risk to human safety.

- Based on the experiences of free-ranging programs within other regions, bison and cattle can coexist on the landscape.

- Bison do not breed with cattle in a natural environment, and there is little evidence of bison preventing cattle from utilizing vegetation and water sources.

- There is the potential to obtain bison from source herds that are known to be free of reportable disease.

- The experiences of other programs have shown that hunting can be an effective management tool to control the number of bison and their distribution.

- Bison can be a source of conflict on private agricultural lands where landowner tolerance may be lower.

- The management of the YNP bison and the bison in the quarantine program continues to be controversial.

- The management authority and legal statutes within Montana continue to be controversial.

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