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WHERE THE BUFFALO ROAMED—OR DID THEY?

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ABSTRACT—Grazing management on the Great Plains has been criticized for not more closely matching the presumed grazing patterns of bison. The critics assume that bison “flash grazed,” that is, grazed heavily for a short time, then moved on, and did not return for months or even years. This assumption complements the traditional view of an annual north-south migration of the herds. However, evidence from explorers’ and other travelers’ journals contradict both flash grazing and annual north-south migration. In a few cases where prolonged continuous observations were made in the same favorable habitat, bison were seldom absent. In Canada, bison sometimes moved from the plains into the bordering aspen parklands during severe winter weather, but not regularly and not north-south. Throughout the Great Plains, bison numbers were so great and so thoroughly spread over the country that if a herd moved on, they were quickly replaced by another, giving little opportunity for rest or regrowth of the plant communities. Bison appeared to move in response to local conditions of forage availability, as influenced by weather, fire, and previous grazing. In at least one case, bison remained on a depleted watershed until they starved, rather than moving to an adjacent watershed with adequate forage.

KEY WORDS: bison, Canada, Larocque, Lewis and Clark, plains

Introduction

“If one examines the habits of bison, one finds they used ‘flash’ grazing. The herds moved into the land, grazed it, and moved on. Most of the plants were grazed only once per grazing season. Domestic cattle on the Great Plains today graze and regraze each plant” (Brunner 1997). This statement represents one rationale for intensive rotation grazing and even for removing livestock from rangelands entirely. It is a perspective frequently echoed by other authors. For example, an article on the Tallgrass Prairie Preserve commented that “Unlike cattle, bison do not deplete an area

of grass when grazing" (*Wildlife Conservation* 1990). Also, Cushman and Jones (1988) quote Sue Galatowitsch, an ecologist with the Colorado Natural Areas Program, as saying "It's hard to tell what a prairie would have looked like when it was grazed by bison and not by cows."

Unfortunately, Brunner's comparison of grazing by cattle and bison presents two conclusions contradicted by observation. Domestic cattle seldom graze an individual tiller, the functional physiological unit of grass plants, more than once during the growing season (Hart and Balla 1982; Hart et al. 1993). Brunner's (1997) statement that bison used "flash" grazing may not hold true for bison at all times. Behavior of semidomesticated bison in fenced pastures, or of "wild" herds in outdoor zoos such as Yellowstone National Park, provides little information about distribution and movement of bison before European settlement. In parks and pastures, stocking rate and distribution are controlled, and long-distance migration is prevented.

In this paper, I use information from journals of early explorers, travelers, traders, and trappers to examine two hypotheses: (1) the traditional views of bison migration are not supported by observation, and (2) the Great Plains were so fully occupied by bison that migration would have usually taken them to areas already grazed by other bison, resulting in repeated rather than "flash" grazing.

Methods

I evaluated bison distribution by using information in journals ("bison" and "buffalo" were used interchangeably by the journal writers) to reconstruct "strip samples" (Robinette et al. 1974; Figs. 1-3). All the journals cited are from the late 18th century to the late 1870s, when bison were nearly exterminated. Earlier journals were so incomplete, and the locations so poorly described, that the information could not be used.

On the maps presented in Figures 1-3, a solid circle indicates a day on which bison sightings were recorded, and a number next to a solid circle indicates that bison were sighted for that number of days in one place. A dotted line with no number next to it indicates a single day with no bison sighting, whereas a dotted line with a number indicates that number of days of no bison sightings. If bison were seen nearly every day, I assume the area was fully occupied, unless the bison were following the same path, at the same speed, as the diarist. A circled dot indicates the party camped in one place for that number of days but provided no information on bison sightings. Geographical references are to present-day towns.

Results

Did Buffalo Migrate?

Hornaday (1889) was one of the strongest proponents of regular bison migration: "So long as the bison held undisputed possession of the great plains, his migratory habits were . . . regular, general, and on a scale that was truly grand." But Roe (1970) "found nothing . . . indicating that he [Hornaday] had any first-hand acquaintance with buffalo in their native haunts in the West prior to . . . 1886." While Roe (1970) somewhat overstated his case, Hornaday (1889) did often appear insufficiently critical of the anecdotal evidence for regular migration of buffalo. Roe demonstrated that this evidence was not only anecdotal but often contradictory and sometimes downright ridiculous. For example, Dodge (1882) wrote that "most 'old Plainsmen,' and the Indians . . . admit the northern migration . . . but refuse to admit the southern or return migration. . . . [I]t was stoutly maintained that they did not go south at all." Dodge (1882) also concluded that "These migrations were exceedingly erratic, depending somewhat on climate, but principally on the supply of grass."

A few of the journal writers stayed in one place long enough to determine how long bison continued to graze in an area. Alexander Henry operated trading posts on the Red River of the North, near the US-Canadian border (Fig. 1), from 1800 to 1808 (Gough 1992). Henry's journal records plenty of bison in the vicinity of the posts at all times, except for the winter of 1803-04. Extensive prairie fires in the summer of 1803 had destroyed nearly all the grass for miles around the post, so that even the post horses had trouble finding enough to eat. Lewis and Clark camped near the Great Falls of the Missouri (near Great Falls, MT) in June and July of 1805 (Moulton 1983). During their 29-day stay, they reported buffalo in the area for 19 days. Such observations suggest bison grazing was more like a "slow burn" than a "flash."

At a later date, Charles Goodnight told Haley (1936) that the summer of 1867 was very dry in the Texas Panhandle, and bison herds had gathered on the Little Colorado River in such numbers that "They had remained until the grass was gone, and had died from starvation by thousands and thousands. The dead buffaloes, which extended for a hundred miles or more, were so thick they resembled a pumpkin field." Goodnight also stated that although there was still good grass on the Rio Concho, 30 miles across a divide to the southwest, the buffalo had stayed on the Little Colorado.

Distribution of Bison

Canada

Many bison hunters believed that bison formed distinct herds, each with its own range and pattern of migration (Dawson 1859). According to these hunters, the Red River herd spent winter and spring on the Souris, Cheyenne, and Red Rivers (Fig. 1) and summer on the upper Missouri River. The western herd supposedly wintered between the North and South Saskatchewan Rivers and summered on the Missouri and Yellowstone Rivers. According to this tradition, there should have been few buffalo on the North and South Saskatchewan Rivers during the summer. However, Palliser and Hector found many bison there in the summers of 1857, 1858, and 1859 (Spry 1968) (Fig. 1A). Near Manito Lake (south of Lloydminster, AB) in June 1858, they stated, "Buffalos have been seen in large numbers about 15 miles from our stopping place . . . miserable herbage which had been cropped bare by the buffalos." Palliser camped for 14 days in the Hand Hills (east of Red Deer, AB) in June 1859, where he saw bison every day and "killed a good many." Bison were in the Hand Hills in the winter, too: on 18-19 December 1858, Hector "saw great bands of buffalo, and killed six. . . . [T]he plains [are] quite covered with them"(Spry 1968).

Hind (1969), at an unspecified location on the Souris River early in July 1858, reported that "the buffalo were very numerous during the whole of the winter of 1856 and spring of 1857 on the banks of the Souris, but the great fires during the autumn of the last year have driven them south and north-west." Bison were responding to a local phenomenon and not following regular migratory pattern.

Epp (1988) concluded that "Migratory and non-migratory behavior occurred simultaneously in the bison population, each with varying intensity depending upon forage conditions in the various parts of the overall range." In this he concurred with Morgan (1980), who supported the idea of a seasonal migration between grasslands and aspen parklands rather than between regions. Their conclusions seem based on the evidence.

Upper Missouri and Yellowstone Rivers

Thompson traveled from the junction of the Souris and Assiniboine Rivers (Fig. 1A) to the Mandan villages (now under the east end of Lake Sakakawea), from 28 November to 30 December 1798 (Glover 1962).

Despite “a dreadful Storm from the westward . . . 64 degrees below the freezing point,” he recorded bison on 13 of the 33 days. He noted “the smallness of the herds, which rarely exceed twenty; whereas to the westward, and near the Mountains the ground is covered with them.”

Lewis and Clark, moving up the Missouri River from St. Louis in 1804 (Moulton and Dunlay 1983), saw their first bison near the junction of the Missouri and the Big Sioux Rivers (junction of Iowa, South Dakota, and Nebraska; Fig. 1C). From there to the Mandan villages, they moved through herds of bison for several days, separated by one to three weeks during which they saw no bison, usually when near concentrations of Native Americans. On 16 September 1804, just above the mouth of White River, Lewis noted that “vast herds of Buffaloe deer Elk and Antilopes were seen feeding in every direction as far as the eye of the observer could reach.” On 17 September Lewis wrote: “I estimate the number of Buffaloe which could be comprehended at one view to amount to 3000.” But from 24 September to 16 October the Indians followed the expedition’s boats upriver, and they saw no bison.

After wintering at the Mandan villages, Lewis and Clark continued up the Missouri River on 8 April 1805 but saw no bison until 13 April, because “the country from Fort Mandan to this place [about 50 miles upstream] is so constantly hunted by the Minetaries that there is but little game.” From that time until they reached the Great Falls of the Missouri River on 14 June, they were seldom out of sight of bison (Fig. 1B), and they described “immence herds of Buffaloe, Elk, deer, & Antelopes feeding in one common and boundless pasture.” It was during this time that they saw buffalo 19 of the 29 days they spent near Great Falls, until they left on 15 July: “infinitely more buffalo than I had ever before witnessed at a view.” However, they saw buffalo only on the first day after leaving the falls, and saw them no more all the way to the Pacific Ocean.

On the return journey (Fig. 1C), Lewis saw the first bison on the South Fork of Sun River, west of Great Falls, on 8 July 1806. On 11 July he recorded “immence hirds of buffaloe. I sincerely beleif that there were not less than 10 thousand buffaloe within a circle of 2 miles.” He saw “immence herds of buffaloe” nearly every day on the Missouri River until he reached its junction with the Little Missouri River, where he rejoined Clark. Clark, in the meantime, had traveled down the Yellowstone River, where he saw his first bison on 16 July near Livingston, Montana (Fig. 1C). He then saw bison every day but two until he reached the junction of the Yellowstone and Missouri Rivers. On 24 July he wrote: “for me to . . . give an estimate of the

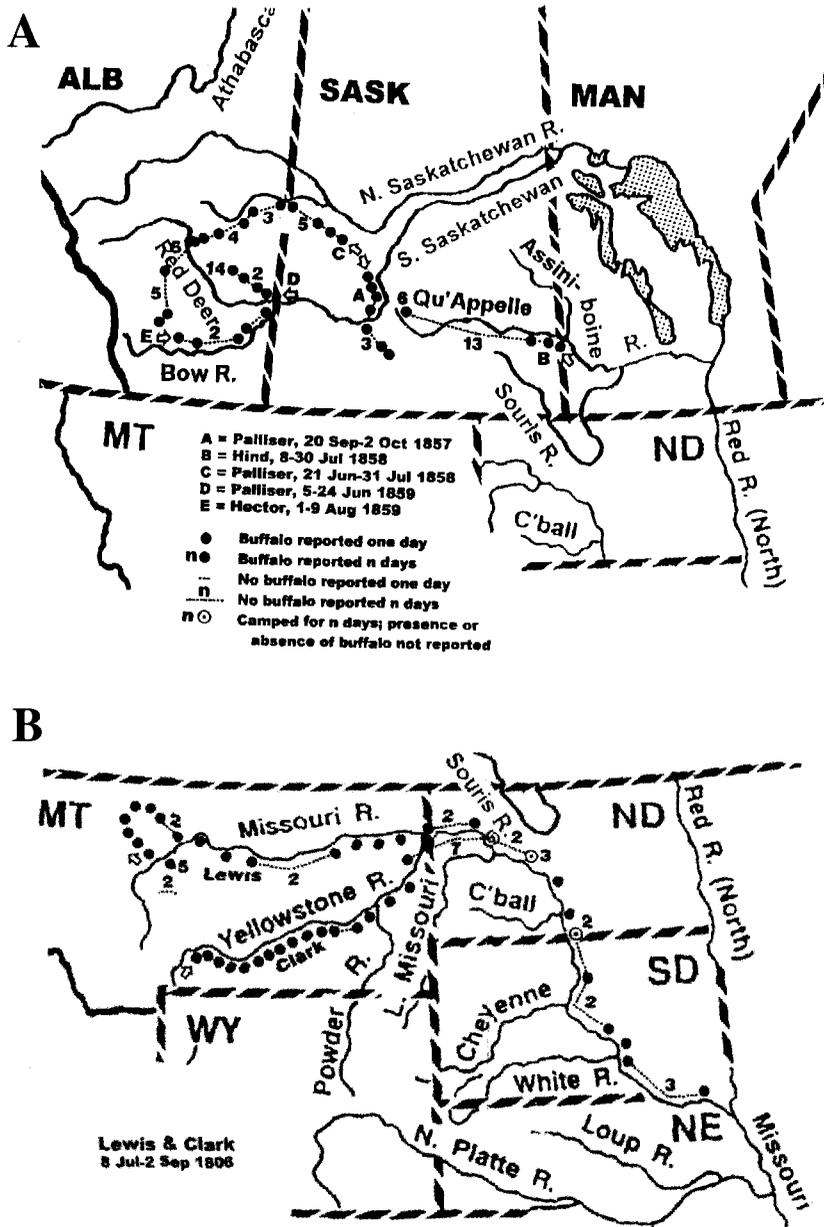
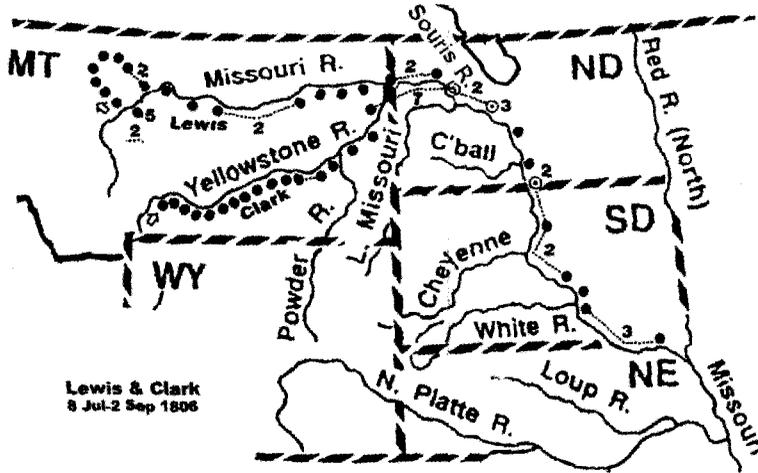


Figure 1. Bison sightings reported by (A) Palliser, Hind, and Hector; (B) Lewis and Clark.

C



D

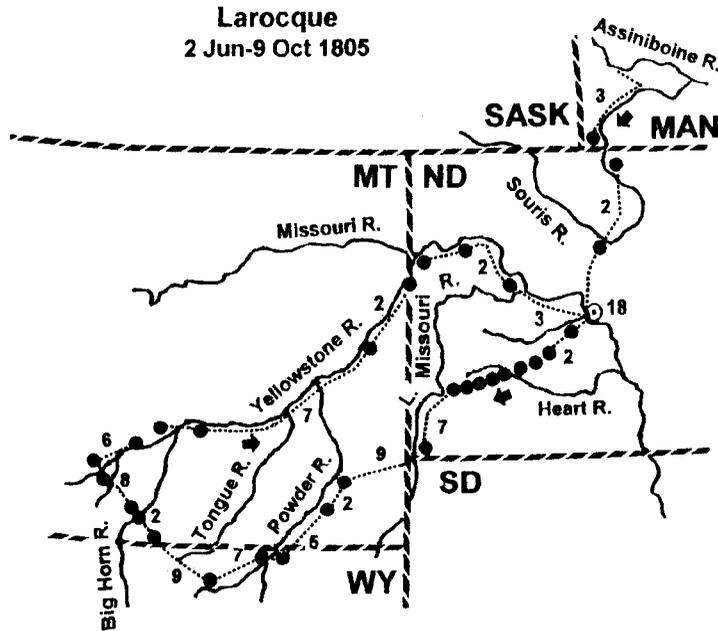


Figure 1 continued. Bison sightings reported by (C) Lewis and Clark; and (D) Larocque.

differant species of wild animals on this river particularly Buffalow, Elk Antelopes & Wolves would be increditable.”

Martin and Szuter (1999) postulated that buffalo were so abundant on the Yellowstone and upper Missouri Rivers because this region had no permanent inhabitants but was a buffer zone only occasionally “probed by various Indian war parties.” However, below the mouth of the Yellowstone River, bison were seen less often but the herds were larger. On 29 August, just past the mouth of White River (Fig. 1C), Clark wrote: “I had a view of a greater number of buffalow than I had ever seen before at one time. I must have seen near 20,000.” It is likely that so many bison would have had little opportunity to move to fresh grazing after grass was heavily grazed.

Larocque (Fig. 1D) apparently found bison much less frequently on the Yellowstone River in 1805 (Wood and Thiessen 1985). He found the greatest concentration on the upper Heart River on 9 July: “[A]s far as the eye could discern Buffaloe were seen in amazing Number.” On 27 July he wrote: “The plains on the western side of the [Powder] River were covered with Buffaloes” and “It is amazing how very barren the ground is between this [Powder River] and the lesser Missouri. Nothing can hardly be seen but those *Cornin de Raquettes* [prickly pears]. Our horses were nearly starved.” This explains why bison were seen on only one day of the 17 required to cross this stretch of country. On 25 August he observed, “Plenty of buffaloes between the Large Horn and the River aux Roches Jaunes [the Big Horn and the Yellowstone Rivers].” His observations of large numbers of bison between the Missouri and Heart Rivers and the Big Horn and the Yellowstone Rivers indicate bison were often present on uplands in mid-summer.

In May and June of 1810, bison were scarce on the middle Missouri River. Brackenridge (1904) and Bradbury (1904) saw their first bison near the mouth of the Platte River but reported bison on only 11 of the 51 days required to travel upstream from the Platte to the Mandan villages (Fig. 2A). This may be an underestimate. Although Bradbury did not record any sightings of bison from 23 May until 4 June, on 8 June he wrote: “Our hunters killed two buffaloe and two elks. Of the former we had *for some days past* seen a great number of herds.” The herds were, as usual, enormous. On 22 June, Bradbury “counted seventeen herds; but the aggregate number of the animals it was difficult even to guess at; some thought upwards of ten thousand.” Coming back downstream required only eight days from the villages to the mouth of the Platte River; buffalo were seen on four of those days.

On the middle Missouri River, bison were even rarer in 1833 and 1834. In 1833 Maximilian, Prinz zu Wied (1843), saw no bison south of the Cannonball River (C'ball in Fig. 2B), and very few from there to six days' travel north of Fort Union, at the junction of the Yellowstone and the Missouri Rivers. Then he saw bison for 12 consecutive days. On 25 July Maximilian's party came to "the part of the country called Mauvaises Terres [the badlands], where we could not expect to find much large game," but on 27 July he "saw the whole prairie covered with herds of buffaloes." Coming back downriver in September, again he saw bison every day along the stretch of river where they had been so plentiful in July, but they required only five days to cover the distance. Maximilian's party wintered at the Mandan villages, and saw bison only once, in April, after they resumed their journey downstream.

From 1804 to 1834, the observations suggest a progressive decrease in buffalo on the middle Missouri River, but they remained plentiful on the upper Missouri River and the Yellowstone River until mid-century. Hayden wrote: "Descending the Yellowstone River in the summer of 1854, I saw, for the distance of 350 miles, the prairies on both sides of the river covered with herds of buffalo," and he also noted, in 1857, that "in the valley of the Yellowstone and along the Upper Missouri thousands may yet be seen" (Warren 1981).

Platte River

By the early 1800s, bison were seldom seen on the Platte River below Grand Island, NE. The Pawnee, who were established on the Loup and the lower Platte Rivers, may have reduced bison populations (Martin and Szuter 1999). In 1820 the Long expedition saw bison almost every day from Grand Island to the vicinity of Fort Morgan, CO (Fig. 2C), often in great numbers (James 1823). On 22 June, just west of the fork of the North and South Platte Rivers, James saw "immense herds of bisons . . . at least ten thousand here burst on our sight in the instant. . . ." On 24 June, these herds were "blackening the whole surface of the country." For 10 days Long's party was out of sight of bison, then saw them on five of the next 12 days. When at Bell's Springs, near Cañon City, CO, James wrote that "the country around them abounds with bisons, deer, &c." The group divided on 24 July, a party under Swift heading down the Arkansas River and Long continuing south into northeastern New Mexico, seeing few bison on the way.

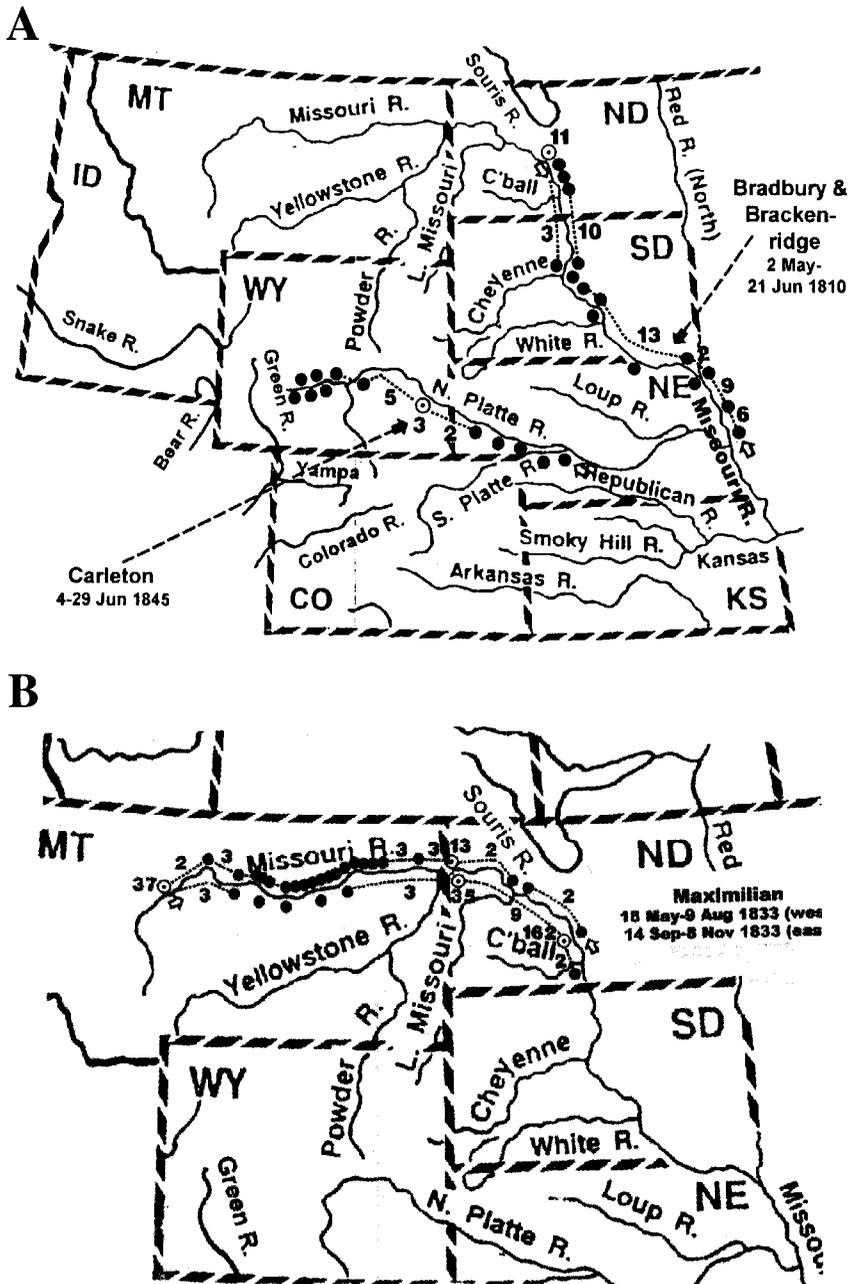


Figure 2. Bison sightings reported by (A) Bradbury and Brackenridge and Carleton, and (B) Maximilian.

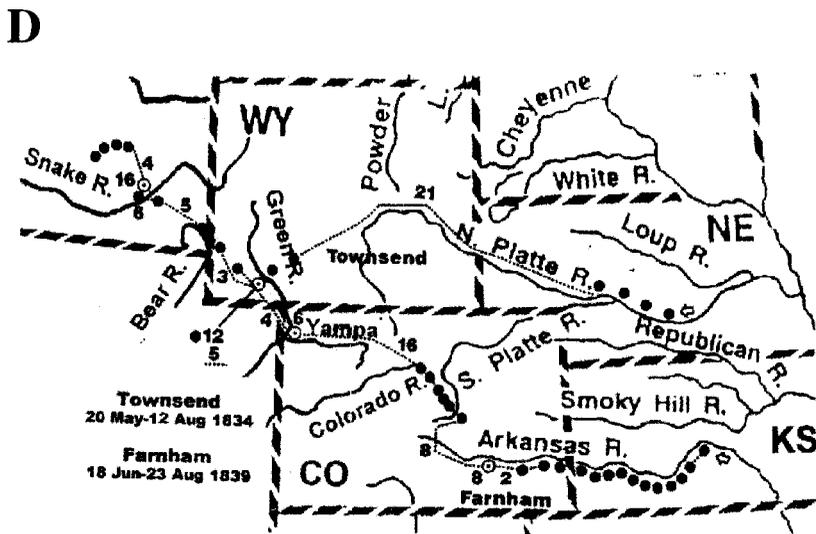
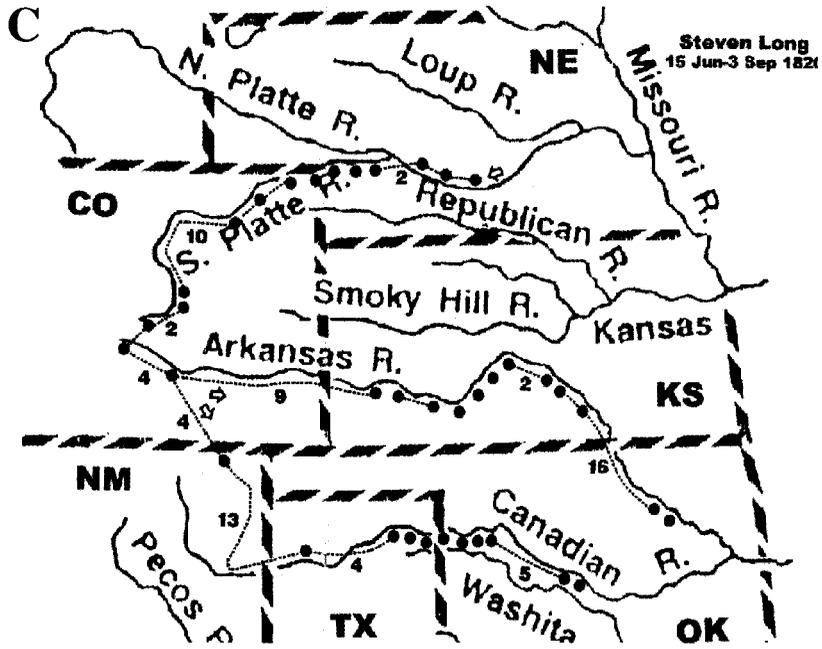


Figure 2 continued. Bison sightings reported by (C) Long expedition, and (D) Townsend and Farnham.

In 1834 Townsend (1978) saw bison for four days between Grand Island and the fork of the North and South Platte Rivers, and for two days near the Green River in western Wyoming (Fig. 2D), but no other bison between there and the mouth of the Columbia River. This was the same year in which Maximilian reported no bison on the middle Missouri River.

Fremont (1845), on his way up the Platte River in 1842, saw bison "swarming in immense numbers over the plains, where they had left scarcely a blade of grass standing," on seven of eight days from just above Grand Island, NE, to near Julesburg, CO. He also saw bison on six of 14 days between Fort Laramie and Jeffrey City, WY.

In 1845 Carleton (1943) and Franklin (1979) saw bison at the fork of the North and South Platte Rivers for the first time since leaving Fort Leavenworth, KS (Fig. 2A). They saw them every day for the next five days, until they were three days out of Fort Laramie. After leaving the fort, they recorded no bison for five days, then no bison for seven of the next eight days, until they were almost to the Green River. Carleton wrote: "[I]t is seldom that the buffaloes ever approach nearer than two or three days' journey of it [Fort Laramie]." Buffalo could still be found on the Platte in 1857. Hayden wrote in 1857 (Warren 1981): "[Bison] are quite abundant on the Platte River and along the valley of the Smoky Hill Fork of the Kansas." Warren (1981) added in a footnote: "These animals occupy very different localities in different years and different seasons."

Bison were found on the Platte River in the winter as well as in the summer. From December 1812 to March 1813, the eastbound Astorians noted the "abundance of buffalo, which seemed absolutely to cover the country on the Platte below the Forks" (Irving 1834). In December 1824 Ashley recorded that "the valleys were literally covered with buffaloe . . . numerous herds of buffaloe moving down the river" (Dale 1918). But Townsend (1978) saw few bison on the Platte River in 1834 and no bison for 21 days between the fork of the North and South Platte Rivers and the Green River in southeastern Wyoming.

Southern Great Plains

It would appear that buffalo were plentiful on the Arkansas River and on other rivers flowing across Kansas and Oklahoma in summer, fall, and winter. On the Arkansas, they were recorded as early as June (James 1823; Farnham 1843) and as late as December (Pike 1966; Fowler 1979).

Long and Swift found bison very scarce in the first week or two after leaving the eastern front of the Rocky Mountains (Fig. 2C) (James 1823).

Long saw a few bison on the Canadian River just after crossing into Texas. Three days west of the Texas-Oklahoma boundary, on 16 August, James wrote: "Bisons became astonishingly numerous . . . countless thousands of them were seen coming in from every quarter to the stagnant pools [in the Canadian River]," and on August 21: "[T]he country we passed was swarming with innumerable herds of bison, wild horses, deer, elk, &c." After five days without seeing bison, Long's party saw a few on two successive days, but saw none on the lower Canadian River. Meanwhile, Swift's party saw "great numbers of bisons" near Dodge City, KS, and almost every day thereafter until just before reaching the southern boundary between Kansas and Oklahoma. On 16 August, Swift thought: "We have now passed the boundary of the summer bison range"; but, he was mistaken. They saw "a herd of bisons" on 1 and 2 September, south of the junction of the Saline and Arkansas Rivers.

In 1839 Thomas Farnham (1843) found plenty of bison from the Great Bend of the Arkansas River (near Great Bend, KS) to three days east of Bent's Fort near Pueblo, CO (Fig. 2D). On 24 June he wrote: "The buffalo during the last three days had covered the whole country so completely, that it appeared oftentimes extremely dangerous . . . to attempt to break . . . through them." He again found bison in South Park (Park County, CO), describing "vast spherical swells covered with buffalo." He saw five bison on the Green River in southeast Wyoming, and small herds of bison between Fort Hall and Sun Valley, ID.

On 19 June 1843 Fremont (1845) saw bison between the Smoky Hill and Republican Rivers: "five or six buffalo bulls, forming a vanguard of immense herds, among which we were traveling a few days afterwards." On 26 June he recorded that on "the Republican fork of the Kansas, . . . herds of the buffalo were scattered all over the country in countless numbers."

Trapper Jacob Fowler (1979), unlike Long, Farnham, and Fremont, was on the Canadian River in Oklahoma in fall and winter but saw plenty of bison from the Great Bend of the Arkansas River (near Great Bend, KS) west into Colorado (Fig. 3A). On 5 October 1821 he wrote: "We seen great numbers of Poor Buffelow Bulls . . . there Was no Cows among So many Buffelow as we Cold [could] see at all most any time." Then on 6 October he complained: "[Buffalo] are not so plenty as the Ware [they were] and We beleve Have been latly drove off by the Indeans as the are now shy." Fowler recorded on 23 October: "Emence Hords of Buffelow all traveling to the north While those we pased a few days ago Ware traveling to the South." These observations call into question any systematic migration. On 8 November, near Lamar, CO, Fowler wrote: "We Crossed the River on act

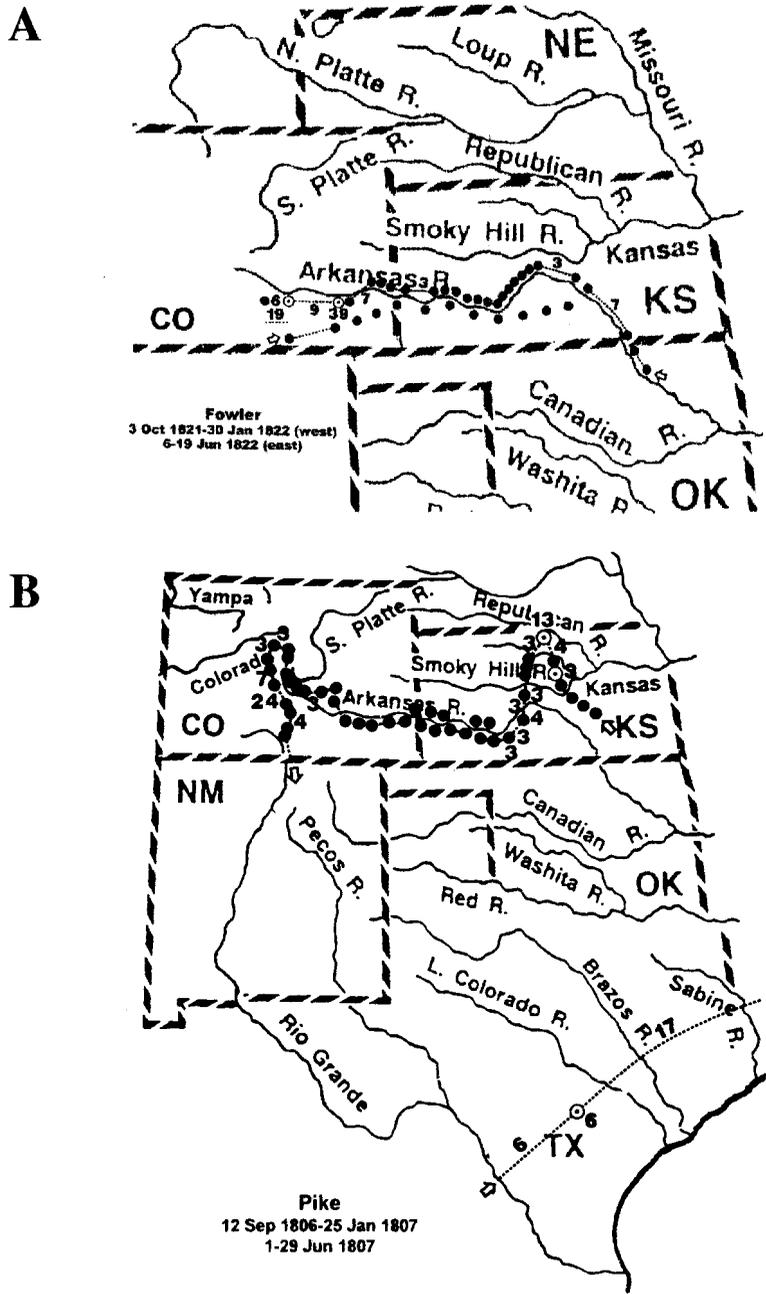


Figure 3. Bison sightings reported by (A) Fowler and (B) the Zebulon Pike expedition.

[account] of a Snow Storm . . . Buffelow Plenty and all traveling fast to the north." Fowler's party found few bison near La Junta and Pueblo, CO, in the winter of 1821-1822, so they headed for Taos, NM, at the end of January. They left Taos on 4 May 1822 and saw their first bison near Raton Pass (between Raton, NM, and Trinidad, CO) on 6 June. They then saw bison every day, except one, until they reached Hutchinson, KS, on 19 June. Fowler wrote: "Heare We Sopose We Cold See at one time ten thousand Buffelow." Thus, Fowler reported great numbers of bison on the uplands in the summer of 1822, between the Colorado-New Mexico border and the Arkansas River, and on the uplands within the Great Bend of the Arkansas River from Dodge City to Wichita, KS.

Pike (1966) was also on the Arkansas River in the fall and winter of 1806 and 1807. He made a detour up to the Republican River in September and October, and he saw plenty of bison except near the Pawnee village, where he camped for 13 days (Fig. 3B). Back on the Arkansas River, he recorded bison nearly every day from the Great Bend, which he reached 18 October, to the headwaters in South Park on 17 December (Fig. 3B). Pike seldom referred to the numbers of bison, but on 6 November he wrote: "I will not attempt to describe the droves of animals we now saw . . . their numbers exceeded imagination." After 17 December Pike reported bison on only five days, and his party lived on mule deer until 25 January 1807. They likely would have starved or frozen to death if the Spanish authorities had not arrested them and taken them to Mexico for the winter.

On 1 June 1807 Pike crossed the Rio Grande River near Guerrero, TX, and headed north, reaching Natchitoches, LA, on 1 July. No bison were seen the entire trip. Marcy (1850, 1937) also found bison remarkably scarce in Texas. From 4 April to 28 June 1849 he traveled from Fort Smith, AR, to Santa Fe, NM, and saw only two bison the entire trip. Marcy explored the valleys of the southern Red River and Washita River in May, June, and July of 1852; in 78 days he saw bison on only five days, and never more than a few at a time. Bollaert (1956) traveling across southern Texas in the spring of 1844, wrote: "I omit to say more than there are immense droves [of buffalo] in Texas"—but this was hearsay; he never saw one.

Bison Distribution and Impact

Roe (1970) cited numerous reports of great herds of bison from Saskatchewan to Texas, but without day-to-day records he could not determine how completely the herds covered the country. He quoted travelers

who found plenty of bison in regions where other travelers in other years found few or none. Thus, in an occasional year bison might be totally absent from a region throughout the grazing season, or they might pass through only once or twice. Then the size of the herd and the speed of movement would determine the intensity of grazing.

But it would seem that in most years, along the upper reaches of the major rivers traversing the Great Plains, the country was densely occupied by bison. If bison were found in such numbers and at so many locations, there must have been little opportunity for "flash grazing" or what we today would call high-intensity short-duration grazing. Rather, reports seem to indicate repeated, exhaustive grazing. Carleton (1943) recorded that there was "not enough forage on a mile square . . . to have furnished even one squadron [about 100-120 horses]" on the Platte River in 1845 near Grand Island, NE. Franklin (1979), also on the Platte River in 1845, reported "scarcely any grass on the hills." Larocque complained: "Our horses were nearly starved" between the Powder and Little Missouri Rivers in 1805 (Wood and Thiessen 1985). Palliser wrote: "The grass in this arid soil, always so scanty, was now actually swept away by the buffalo" on the South Saskatchewan River near Swift Current, SK, in 1857, and "miserable herbage which had been cropped bare by buffalos" near Unity, SK, in 1858 (Spry 1968). Henry recorded in 1800: "They [bison] have ravedged [*sic*] this small Island. . . . Nothing remains but the large Elm and Oak trees. . . . Brush wood and Grass are not to be seen in this little wood" near his post on the Red River of the North (Gough 1992).

The uplands might have received some respite from grazing during the summer, when "[a]ll the small rivers were completely dried up" by mid-July (Maximilian 1843). However, Laroque (Wood and Thiessen 1985) saw plenty of bison on the uplands between the Missouri and Little Missouri Rivers in July 1805 (Fig. 1D), and Fowler (1979) saw great herds of bison on the uplands in the Big Bend of the Arkansas River in late June 1822 (Fig. 3A).

Other Grazers, Drought, and Fire

Bison were not the only grazers on the Great Plains. Reports of the great numbers of pronghorn antelope, elk, and feral horses, all primarily grazers, have already been cited (Shaw and Lee 1997). England and DeVos (1969) cited estimates of antelope numbers equal to or greater than buffalo numbers.

Prairie dogs may have been the most abundant mammals in North America at the time of the first European explorations (Seton 1929). Lewis and Clark crossed a prairie dog town seven miles wide (Moulton and Dunlay 1983), and Messiter (1890) estimated a prairie dog town in Montana to be 30 to 40 miles long. A Texas colony was 250 miles long and 100 miles wide (Davis 1974). To the billions of prairie dogs add innumerable other grazing rodents, rabbits, and jackrabbits.

At times grasshoppers denuded the Great Plains as effectively as mammalian grazers. Harmon (1922) encountered "grass-hoppers in such prodigious numbers . . . [that] devour everything before them, leaving scarcely a leaf on the trees, or a blade of grass on the prairies" in Saskatchewan in 1802. On the Yellowstone River in 1806, Clark reported: "emence Swarms of Grass hoppers have distroyed every sprig of Grass for maney miles on this side of the river" (Moulton and Dunlay 1983). On the North Platte River west of Fort Laramie in 1842, Fremont (1845) wrote: "There had been no rain, and innumerable quantities of grasshoppers had destroyed the grass . . . buffalo were very scarce."

Thus, the Great Plains presented a shifting mosaic of areas grazed mostly heavily but occasionally lightly by animals of all sizes, from buffalo to grasshoppers. The less heavily grazed areas periodically supported fierce prairie fires, which may have reduced buffalo populations. For example, McKenzie (Wood and Thiessen 1985) "observed whole herds of Buffaloes with their hair singed—some were blind; and half roasted carcasses strewed our way" between the Souris and upper Missouri Rivers in 1804. Such reductions, and those caused by drought and severe winters, allowed some recovery of the Plains vegetation. Nevertheless, the general appearance of the Great Plains was of heavily grazed rangeland (England and DeVos 1969, Hart and Hart 1997).

Conclusions

While bison moved, it does not appear they "migrated," if migration is defined as following a regular and predictable seasonal or annual route (Roe 1970). Often bison were found continuously in the same location for weeks or months. At other times they were absent, and neither presence nor absence followed predictable patterns. Thus, the hypothesis that migration of free-ranging wild bison was common is not supported by the recorded observations. Nor is the second hypothesis, that bison "flash grazed," supported by the observations available. Although a herd may have moved on

after a few days of grazing, densities of bison appeared to be so great that another herd probably moved in a few days or weeks later and regrazed the area, provided there was anything left to eat.

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