How Many Bison Originally Populated Western Rangelands?

James H. Shaw

In 1871, Colonel R. I. Dodge traveled along the Arkansas River through an immense herd of American bison (*Bison bison*). Dodge estimated that the herd was at least 25 miles across and after consulting with hunters and other travelers, concluded that it must have been at least 50 miles long. From such descriptions, historians, anthropologists, and zoologists have tried to estimate the original or pre-settlement population size for bison. We will never have an answer that would meet the standards of modern wildlife research, which demand random or systematic sampling and replication. Nor is it realistic to presume that the pre-slaughter population was stable. Indeed, given pressures from subsistence hunting, the robe trade, passing wagon trains, livestock (along with their infectious diseases), altered fire regimes, and the encroaching railroads, it seems reasonable to infer that the population of bison was far from stable.

Rather than trying to arrive at a single magic number, it might be more constructive to review the means through which various estimates were obtained. This review should impress upon readers the need for caution in accepting historical estimates. It also may provide insight into how modern landscape-level simulations might eventually replace the historical estimates with more realistic ranges of possible population sizes. Three approaches have traditionally been used: direct observations, estimates of numbers killed, and estimates based on carrying capacity.

Direct Observations

Colonel Dodge, although obviously impressed with the size of herd he saw in 1871, never published his observation. Instead, he waited 16 years to describe the huge herd in a letter to William T. Hornaday when Hornaday was piecing together his historical account of bison occurrences and subsequent slaughter (Roe 1970). Dodge recalled the herd's dimensions and noted that the density of the moving herd could not have exceeded an average of more than 15–20 bison/acre. The lower number (15/acre) over an area of 25 × 50 miles would result in an estimated herd of 12 million. Hornaday tended to be conservative in his estimates of bison numbers and was "almost certain" that the herd was wedge-shaped rather than rectangular, so he arbitrarily reduced it by two-thirds, to the widely-cited estimate of 4 million (Hornaday 1889). Roe (1970) evaluated Hornaday's estimate with characteristic thoroughness and concluded that the figure of 4 million was more likely an underestimate than an overestimate.

In 1839, Thomas Farnham traveled through a herd of bison along the Santa Fe Trail for 3 days for about 45 miles. Farnham estimated that he could see for 15 miles in both directions, suggesting that the single herd covered at least 1,350 square miles (McHugh 1972).

Luke Vorrhees rode from the South Platte River to Pawnee Buttes in Nebraska in the summer of 1859. His route was more than 200 miles, during which time he passed through one vast herd of bison (Garretson 1938).

The all-time record claim for herd size came form Robert Wright, who claimed that General Phil Sheridan and Major Henry Inman tried to calculate the number of bison they had seen between Fort Supply, Oklahoma to Fort Dodge, Kansas in the late 1860's. The herd was "known" to be more than 100 miles wide and of unknown length. Wright said that their first calculation was 10 *billion* bison, an impossibly high figure. Subsequent revisions scaled the estimates downward, first to 1 billion and then to "considerably" more than 100 million (Garretson 1938). Roe (1970) doubted the validity of Wright's account, pointing out that no other writer, including Sheridan himself, ever mentioned such an enormous herd.

C.J. "Buffalo" Jones estimated that there were 15 million bison in the west in 1865, 14 million in 1870, 1 million in 1875, and 395,000 in 1880 [Table reproduced in Roe (1970)]. Jones never explained how he arrived at his estimates. Strangely, his attrition table presumed that (1) all mortality in bison from 1865–1884 was human-caused, (2) his estimates of that mortality were accurate, and (3) *that no calves were born* during that 19-year period. Roe (1970:489) concluded that "it may be doubted whether a

Author is Professor, Department of Zoology, Oklahoma State University, Stillwater, Okla. 74078

Acknowledgements—Some of this material resulted from a grant for ecological interpretations of historical accounts of bison and fire from The Nature Conservancy and The Nature Conservancy of Oklahoma. I thank Drs. Tracy Carter and Davic M. Leslie, Jr. for constructive comments on an earlier draft and Dr. Fritz Knopf for calling my attention to R.W. Koucky's paper. The Oklahoma Cooperative Fish and Wildlife Research Unit provided administrative and technical assistance.

more worthless table of statistics was ever compiled for public information".

Estimates Based Upon Numbers Killed

Hornaday (1889) attempted to estimate minimum herd sizes based upon the numbers killed during the peak of the hide trade from 1871–74 on the southern plains. He began with records from the Atchison, Topeka and Santa Fe railroad showing that they shipped 165,721 hides in 1872, 251,443 in 1873, and 42,289 in 1874. No such records were obtainable from the Kansas Pacific or Union Pacific railroads, so Hornaday (1889) relied heavily on observations and opinions of Colonel Dodge and assumed that all three railroads carried the same number of hides and thus tripled the figures from the Atchison, Topeka, and Santa Fe railroad. This estimate totaled 1,378,359 hides. Dodge also estimated that hide hunters killed 3 bison for every hide shipped east in 1872, 2 for each one shipped in 1873, and 5 killed for every 4 shipped in 1874, the reduced losses presumably due to improved efficiency. Altogether, Hornaday (1889) calculated that hide hunters on the southern plains killed 3,158,730 bison between 1871 and 1874.

Colonel Dodge also tried to estimate numbers of bison killed by Indians during the same period, based mainly upon accounts of bison robes sent to market. He estimated 130,000 bison killed annually by Indians during each of the three years, 1872–74, for a total of 390,000. Finally, Hornaday (1889) guessed that another 50,000 bison were killed wantonly by white settlers and Indians each year, or 150,000 for the 3-year period.

Adding his estimates of the numbers of bison killed by hide hunters, those killed by Indians for subsistence and robes, and those killed wantonly, Hornaday (1889) came up with a total estimate of 3,698,730 killed by human hunters on the southern plains until the species was commercially and ecologically extinct in 1875. From these estimates he concluded that perhaps 4 million bison inhabited the southern plains in 1870, roughly the same number computed from Colonel Dodge's single immense herd seen along the Arkansas River the next year.

Hornaday's (1889) calculations for the northern herd were less detailed and results more conservative. He cited reports for the *Sioux City* (Iowa) *Journal* that 100,000 bison hides were shipped from the Yellowstone country, representing the harvest of 1880–81. According to the *Journal*, harvest was up sharply from the previous winter's record of 30,000 from the Yellowstone area. From such sources Hornaday (1889) estimated that as of 1870, the northern herd contained only about 1.5 million bison.

Estimates Based Upon Carrying Capacity

More recent estimates of pre-settlement bison numbers were derived from estimated carrying capacities of the native ranges. The first such attempt was based on a 1910 USDA census of livestock on the plains (Seton 1929). The USDA tallied 24 million horses and cattle and 6 million sheep on an area corresponding to what Seton took to be half of the bison range on the plains. Extrapolating for area and allowing for competitors such as elk (*Cervus elaphus*), Seton estimated that the plains could have supported 40 million bison. Tallgrass prairies to the east could, Seton supposed, have supported another 30 million, plus another 5 million for all wooded regions east of the prairies, for a total of 75 million bison (Seton 1929).

Using the same 1910 USDA surveys, but relying upon county reports rather than state ones, Flores (1991) estimated that the carrying capacity for the southern plains would have been 8.2 million and 28–30 million for the entire plains region. Flores (1991) was careful to note that bison numbers and distributions would have varied substantially with climate changes, but concluded that weather patterns in 1910 were roughly at the median for the previous 500 years.

The most widely-cited estimate for the pre-settlement bison population west of the Mississippi, 60 million, came about in a different way. Seton (1929) first accepted Hornaday's (1889) estimate of 4 million for the large herd seen by Colonel Dodge. He then arbitrarily assumed that such a herd would range over an area of no more than 200,000 square miles. The plains and prairies could, on the basis of area, support 15 such herds, or 60 million bison.

McHugh (1972) used methods from "modern" range management to derive an average carrying capacity for western prairies of 26 bison/square mile. At carrying capacity, the area of would have supported roughly 30 million bison (McHugh 1972).

Discussion

All three methods used to estimate pre-settlement bison numbers contained serious shortcomings. Only Colonel Dodge's estimate of not more than 15–20 bison/acre attempted to convert area estimates to actual numbers. For all others, we must contend first with the reliability of area estimates, and then guess the densities of bison within the areas. Paintings by artists George Catlin and John M. Stanley, who actually observed herds of bison before settlement, depicted the animals as running (typically from pursuing hunters) in long lines with what appeared to be 10–100 yards between lines. William J. Hays and Meyer Strauss, who also saw bison before the hide hunts, painted running herds packed virtually shoulder to shoulder (Barsness 1977). Densities within herds could thus have easily varied over an order of magnitude or more, depending upon spacing. Given these limitations, direct observations of herd dimensions offer little insight into original numbers, other than the trite conclusion that the population must have numbered in the millions.

Records of shipments of hides and robes might appear to be more reliable than estimates of the size of bison herds but invariably must be taken as extremely conservative

approximations. The most thorough and detailed estimate, Hornaday's (1889) tally for the southern herd, was based on only one official record: the number of hides shipped by the Atchison, Topeka, and Santa Fe railroad from 1872–1874. Hornaday *assumed* that the other two railroads shipped the same numbers. Relying upon Colonel Dodge, Hornaday added what can only be called educated guesses as to the ratio between numbers of animals killed and hides shipped, numbers of bison killed by Indians, and the numbers killed wantonly. For these latter guesses, Hornaday presumed that the kill rate was constant over the years 1872–74, a likely impossibility given the herd's precipitous decline during those 3 years.

Finally, uncritical acceptance of figures from historical accounts can lead to questionable inferences about bison ecology. For example, Koucky (1983) concluded that the sudden collapse of northern herd in 1881–82 must have been due substantially to the introduction of livestock-borne disease, and suggested that Texas tick fever (*Babesia* spp.) was the likely culprit. Koucky's (1983) evidence was circumstantial and rested largely on his cursory acceptance of 4 million bison in the northern herd by Lt. G.C. Doane, an army officer who traveled extensively through the region the 1870's.

Carrying capacity estimates may seem scientifically more solid than either direct observations of herd sizes or records of hides and robes shipped in trade. They too offer substantial potential for error. The 30 million livestock counted in the 1910 USDA survey were fenced under conditions of continuous grazing and fire exclusion and therefore not comparable to grazing patterns imposed by free-ranging herds of bison. Seton (1929) merely guessed at bison numbers on tallgrass prairies and in woodlands to the east, having already based his guess upon a questionable approximation. While deriving his famous figure of 60 million, Seton (1929) accepted Hornaday's (1889) herd size of 4 million, assumed a consistent area occupied by such a group, and presumed that similar-sized herds were stable and spatially exclusive (group territoriality), traits uncharacteristic of gregarious bovids. McHugh's (1972) estimate was more modern and methodical, but it was simplistic and failed to take into account such vital factors as herd stability, distances moved by herds, regularity of such movements, and pre-settlement fire regimes. Finally, even if carrying capacity could be accurately estimated, the resulting numbers would represent a theoretical maximum rather than the actual numbers at any given time. Other forces, including predation and human hunting, could have held populations below carrying capacity.

Several conclusions can be drawn from all these estimates. Most importantly, none of them were developed through methods that would even remotely meet the standards of modern biological sciences. All contain serious sources of error and most also relied on untested assumption, abitrary guess, or both. When all estimates and their likely sources of error are considered together, one may assume with reasonable certainty that the bison population west of the Mississippi River at the close of the Civil War numbered in the millions, probably in the tens of millions. Any greater accuracy seems unlikely.

Finally, bison populations would have varied between centuries, even between decades, in keeping with climatic shifts, particularly precipitation patterns. This fluctuation would have occurred even without intrusion by white hide hunters. Based on historical and prehistoric evidence of ebbs and flows in bison abundance. Meagher (in press), the leading authority on American bison, suggested that bison numbers in the years immediately following the Civil War would likely have declined, although by far less, even without commercial hide hunting.

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