Recent Changes in Population Distribution: The Pelican Bison and the Domino Effect

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Abstract

Bison apparently have wintered for centuries in the Pelican Valley area of Yellowstone National Park. Compared with the other locations where bison winter in the park, Pelican Valley routinely experiences the most severe conditions. Nevertheless, a population has survived there because of the presence of geothermally influenced sites. Until 1980, these bison were isolated in winter by deep snows. Both winter and summer range use showed broadly consistent and predictable patterns, as did seasonal movements between range use areas. In the early 1980s, gradual but escalating changes in the bison population became apparent. Annual winter use of foraging areas by the Pelican bison expanded west from traditionally used, geothermally influenced places near the shore of Yellowstone Lake to sedge areas near the mouth of Pelican Creek, Lake area, and on to Hayden Valley. Because Hayden Valley (part of the Mary Mountain unit) was occupied already by wintering bison, as more shifted from Pelican Valley, more bison moved into the Firehole. They also moved earlier. The process of winter range expansion was coupled with a population increase, and more bison moved further west to Madison Junction and beyond, to spill over the park's west boundary into Montana. We term this cascading pattern of population increase *the domino effect.* Concomitantly with the winter westward shift, summer distributions also changed dramatically. The Pelican bison no longer crossed the Mirror Plateau to reach subalpine areas in the upper Lamar country in early summer. Instead, increasing numbers of bison concentrated in Hayden Valley during the breeding season. Some then moved back to the Pelican area before winter set in. With an increased bison population park-wide, numbers also spread across the Lamar Valley in midsummer, and appeared in meadows west and north of Madison Junction where summer use was not recorded previously. Over roughly 20 years, an apparent ecosystem change has occurred involving the bison of the interior of Yellowstone National Park. Although complex and interactive factors involving climatic variation and bison social behavior seem likely to have had a role, another element may have been human-generated. In recent decades, recreational use by people of the park's interior road system in winter resulted in compacted snow surfaces that, in certain locations and times, provided ready-made travel linkages between locations where bison preferred to be. This was seen first in 1980 with bison located on the packed road surface west from the Mary Bay site of the traditional Pelican winter range. The observed changes may not have reached their maximum expression, but the future for the Yellowstone bison does not appear reassuring.

Introduction

A bison *(Bison bison)* population has wintered for centuries in and adjacent to Pelican Valley at the northeast corner of Yellowstone Lake (Figure 1). Compared with the other bison wintering locales in Yellowstone National Park, this area routinely experiences the most severe conditions in terms of snow depths and length of season. However, bison apparently have utilized this winter range for at least 800 years, as suggested by bones at a dated archeological site (Cannon et al. 1997). Winters toward the latter part of the 1800s frequently were more severe (Meagher and Houston 1998) than those in recent decades (and surely were during much of the Little Ice Age, roughly 1450–1750 AD), but regardless, wintering bison survived in this locale. The presence of scattered geothermal sites appears to have been key to the ability of a bison population to survive success-

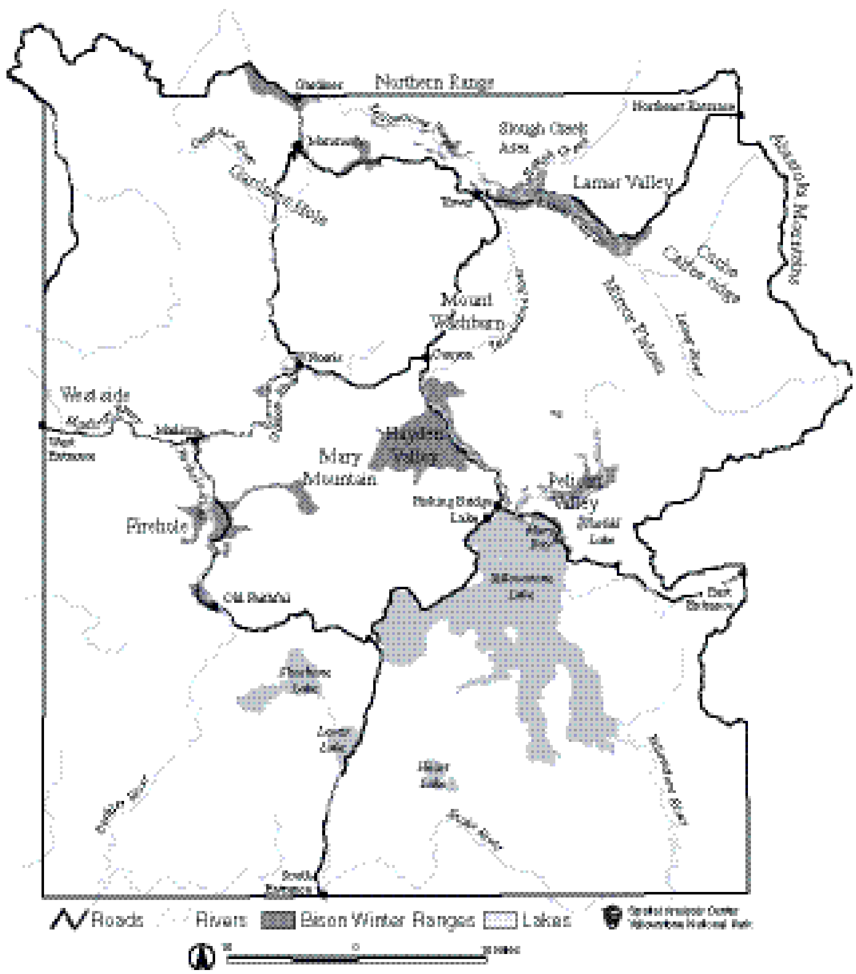

Figure 1. Key bison winter ranges and road system in Yellowstone National Park. (Yellowstone National Park GIS.)

fully through the most severe winters. (The term *geothermal sites* includes a spectrum of geothermal activity that ranges from features such as geysers to geothermally influenced foraging areas where snow depths are less, comparatively, and snow cover lasts a shorter time.) As winter progressed, mixed groups (predominantly females with juveniles and calves) commonly would forage on geothermally influenced sedge areas, and some groups would begin to fragment (stress dispersal) and scatter into small, remote geothermal sites. As conditions moderated, the bison would regroup (Meagher 1971, 1973, 1976). Since park establishment in 1872, limited historical information and subsequent administrative accounts suggest that the seasonal land-use patterns for the early park years were comparable with those described by Meagher (1973), with the Pelican bison wintering apart from other park bison, isolated by deep snows (Figure 2).

In spring (early to mid-June) the Pelican bison traditionally would leave their winter range and move in a generally northeasterly direction, sometimes traversing more than 32 km of snow and melt-water on the Mirror Plateau to cross the Lamar River, and go upward to the greening subalpine vegetation on the westward-facing lower slopes of the Absaroka Mountains. As green-up progressed, the Pelican bison would move higher, usually arriving at the east boundary of the park toward the end of July and early August (Figure 3). By this time, breeding

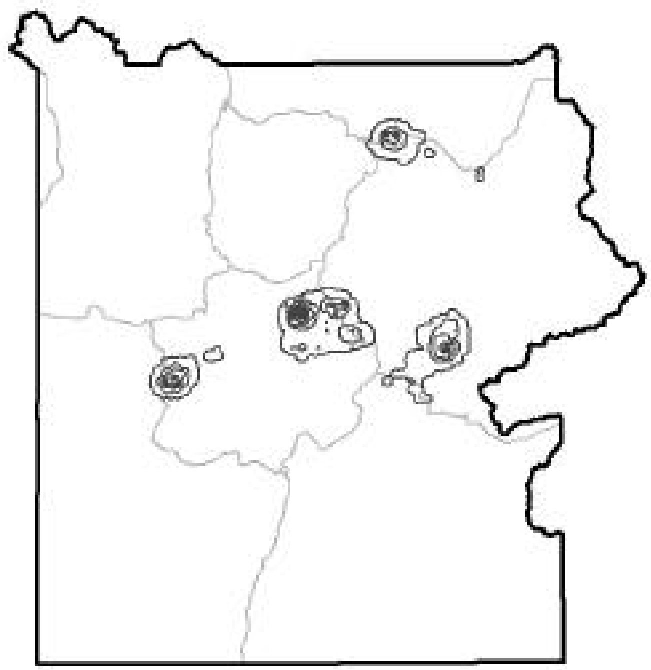

Figure 2. Typical winter distribution in the 1960s and 1970s. The plotted lines indicate contours of proportional use. The outer ring contains 95% of the bison recorded for the flight. Air survey records show only bulls along the lakeshore. Flight 16; date: 14 February 1973; number of bison observed: 702.

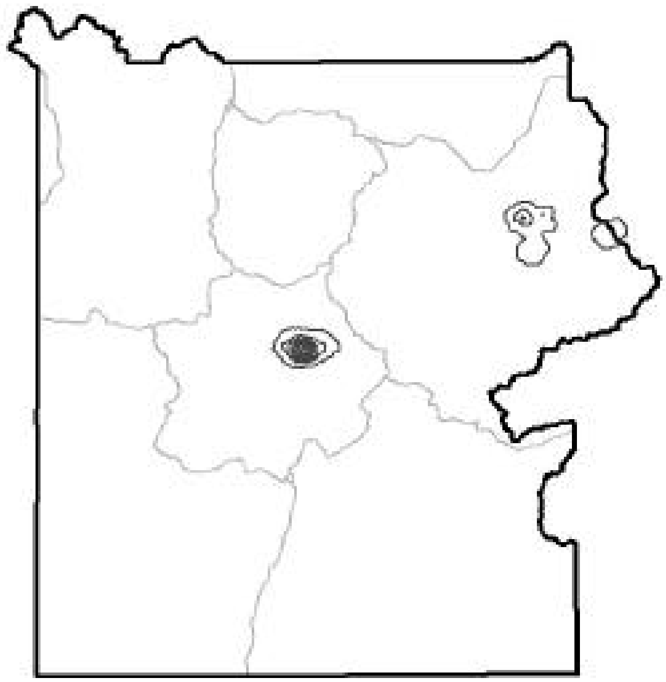

Figure 3. Typical summer distribution in the 1960s and 1970s. The roughly concentric lines indicate proportional use. Note concentration in Hayden Valley and bison presence on the east boundary. Flight 25; date: 29 July 1974; number of bison observed: 832.

season would be underway and the Pelican bison would mix (and interbreed), at least to some extent, with bison from the northern range. Subsequently, groups of bison would recross the Lamar River to the Mirror Plateau. Movements back and forth across the river would continue as the bison utilized various subalpine foraging sites, but they did not stay in the Lamar Valley bottom during spring and summer. Rather they would make large circular movements down and back up, usually spanning 12 to 24 hours. Most of the time they stayed in subalpine areas until storms pushed them down to winter in the lower-elevation valleys of the northern range and Pelican Creek sometime in November. This was the typical land-use pattern that was described for the 1960s (Meagher 1973) and that also prevailed during the 1970s.

In the early 1980s, interior bison land-use patterns began to change. The changes as described here emphasize the bison of the Pelican area, but include the centrally located Mary Mountain (Firehole and Hayden Valley) bison because changes that occurred first on the Pelican winter range appeared to have influenced subsequent changes throughout the interior of the Yellowstone plateau. Generalized descriptive overviews of these bison land-use changes were published earlier (Meagher 1993, 1998; Meagher et al. 1996).

Data Sources

The primary data were derived from 151 aerial surveys of bison numbers and distributions, made from 1970 through July 1997 using a Piper Supercub. The same pilot (Dave Stradley) and observer (Mary Meagher) worked as a team throughout, with rare exceptions for which at least one of those two people was aboard. The data were transferred to a computer, and analyzed as described in Taper et al. (2000). Supplementary ground surveys were made by horseback, foot (skis in winter), and vehicle travel on established park roads. Opportunistic information supplied by park personnel provided additional details. Comparable air and ground methods were used during the 1960s (Meagher 1973).

Bison Land-use Patterns, 1962–1980

In Pelican Valley, bison mixed groups would concentrate initially on sedge foraging areas. As winter progressed, deepening snows eventually closed them out of much of the sedge, and shifts would occur to upland sites, especially the extensive flats above the north side of Pelican Creek, which traverses the length of the valley. Travel trails would develop along south-facing bluff edges and between small hilltops and other accessible forage sites. Usually by the latter part of February, snow depths caused the mixed groups to break into smaller units, sometimes just a few animals, or perhaps a cow with a calf. Commonly, these small groups scattered into widely distributed geothermal sites. Some of these support very limited forage, but there are extensive, interconnected patches of warm, bare ground that allow minimal expenditure of energy (what could be termed a “stand-and-survive” strategy). Warmer parts of major creeks stayed ice- and snow-free and allowed travel and access to creek-bank forage. Some geothermally influenced sites that provided forage also aided travel, including a southward route to the geothermal areas of the lakeshore. Scattered bulls would be found on hilltops, particularly in the western third of the main Pelican Valley, and at various geothermally influenced sites, especially along the shore of Yellowstone Lake east of lower Pelican Creek. Sometimes by late March and early April (while the main valley was still covered with deep snows) mixed groups would move to Mary Bay and nearby geothermal sites. The presence of visible geothermal activity and geothermally influenced foraging sites (with lesser snow depths) appeared to function most years as the survival margin for a bison population in this deep-snow country, especially in late winter (Meagher 1971, 1973, 1976).

As spring developed, forage in geothermal locations in upper Pelican Valley would begin to show new green growth earlier than other places, luring the bison north and east toward the routes used to cross the Mirror Plateau to the subalpine meadows of the upper Lamar area. As the growing season progressed, these bison would move upward to the crest of the Absarokas (Figure 1), usually about the end of July. Thereafter they would make extensive summer range travels that utilized the larger subalpine meadows of both the upper Lamar and the Mirror Plateau.

After the reductions of the 1960s resulted in a park-wide population of approximately 400 bison (Meagher 1973), a moratorium on management actions allowed an increase in numbers. The bison that wintered in the Lamar Valley of the northern range reached ecological carrying capacity for that locale with the unusually compacted snow conditions that prevailed during the winter of 1975–1976, and expanded their range westward (as they did historically) down the topographic and environmental gradient formed by the Yellowstone River (Meagher 1973, 1989). *(Ecological carrying capacity* is the number of animals that a given area can support under current environmental conditions; see Caughley 1976 and MacNab 1985). Ecological carrying capacity will, of course, change yearly as conditions vary. The centrally located herd that utilized the Mary Mountain locale (Firehole and Hayden Valley combined) continued to increase, as did the winter-isolated Pelican bison. For both winter ranges the use patterns remained within traditional locales, as seen in Figure 2.

Changes in Bison Land-use Patterns, 1980–1997

Changes first began with the bison using the Pelican winter range. On 24 February 1980 (a below-average winter for snowfall in the Pelican area as recorded by the Lake snow course), 332 bison were tallied on that winter range. Of these, 157 were scattered among the relatively barren geothermal sites to the northwest of the main Pelican Valley. This number was unprecedented in those locations compared with prior air surveys. The unbroken snow surface and absence of travel trenches in the main valley suggested that they had been there for some time. Most of the remainder were in other geothermally influenced locations, with one striking exception. For the first time, two mixed groups, containing 13 and 29 bison, were seen on and adjacent to the snow-packed road west of Mary Bay (Figure 1). There was no evidence in the snow of bison movement down Pelican Creek to the road (e.g., of snow texture changes, travel indications that would have been apparent even after a new snowfall). The only travel route showing was that which moved southward out of the main valley to the lakeshore geothermal sites.

For comparison, in an air survey of 28 January 1956, 392 bison were counted for the Pelican winter range (after an early-winter reduction of 118). The winter of 1955–1956 was quite severe, and a review of the flight memorandum (D. Condon, unpublished memorandum, 30 January 1956) showed that the majority of the bison were located at geothermally influenced sites, including 64 at the relatively barren locations northwest of the main valley. Interestingly, only 24 were counted just above the mouth of Pelican Creek, with “some” noted as on the road. (At that time the road was seldom used in winter and the snow was not compacted, although a few park employees wintered at the Lake area and might have made an occasional ski trip to the valley). Also, apparently on 25 January 1956, when Hayden Valley was surveyed, perhaps two dozen bison (mixed group) had created a trail through the deep snow along the east side of the Yellowstone River. According to the pilot (J. Stradley, personal communication), these apparently had traveled from the Pelican area. No such movement from the Pelican area to Hayden Valley was known to be repeated before 1984.

On 22 February 1981 (with there being even less snow than during the preceding below-average winter), 482 bison were counted during the survey of the Pelican-area winter range. Of these, 105 were observed near the mouth of Pelican Creek, which included mixed groups of 14, 23, and 38. Again, there was no evidence in the snow of movement from the main valley southwest down Pelican Creek to the road. In 19 winters of air surveys, this was the first time mixed groups were seen in this location. The circumstances indicated that the bison accessed this location by use of the snow-packed road west from Mary Bay.

With the winter of 1981–1982, both interior bison populations (Mary Mountain and Pelican) reached ecological carrying capacity for the conditions of that winter, which was somewhat above average for snowfall. This was evidenced by an estimated 20% population loss (Meagher 1997), reflecting a recorded natural mortality of over 300 bison.

Continued winter air surveys after 1981 showed ever-increasing numbers of bison in mixed groups located on lower Pelican Creek near the mouth and for 1-1.5 km upstream. From there, Pelican bison winter range use expanded to the Fishing Bridge area and upstream for several kilometers on the east side of the Yellowstone River, and westward across the bridge to meadows in the Lake developed area (Figure 1). By the mid-1980s, it was increasingly apparent that Pelican bison were moving all the way to Hayden Valley during the winter. Occasionally they traveled parallel to the east bank of the Yellowstone River, crossing westward at geothermal sites at the south edge of Hayden Valley. More commonly, however, the snow-packed road that follows the Yellowstone River along the west bank served as the travel linkage between the Fishing Bridge–Lake road junction (Figure 1), and Hayden Valley. Repetitive air surveys indicated that movements occurred throughout the winter.

The Domino Effect

With above-average snow conditions for the winter of 1981–1982, small mixed groups, totaling perhaps 45, were seen at Madison Junction during the air survey of 18 February 1982 (Figure 4). Because the snow-covered road was packed between the Firehole and the junction, no travel trails had to be created through unbroken snow. Once before, during the severe winter of 1955–1956 (as shown by snow course records and narrative written comments by park personnel), perhaps 40–50 bison were known to have moved to meadows west of Madison Junction (Meagher 1973). At that time, none of the snow-covered interior park roads were maintained for travel, and use by people was rare.

After the winter of 1981–1982, with the continued absence of human interference with population numbers, the bison of Hayden Valley were at ecological carrying capacity for prevailing winter conditions. Traditionally, even before that winter, as the season progressed and snows deepened, the greater part of the Hayden Valley bison would cross the Mary Mountain divide to the Firehole, where snow depths were consistently lower. This annual shift would increase the numbers wintering on the Firehole, particularly during the latter part of winter. After Pelican area bison moved to Hayden Valley, thereby increasing numbers

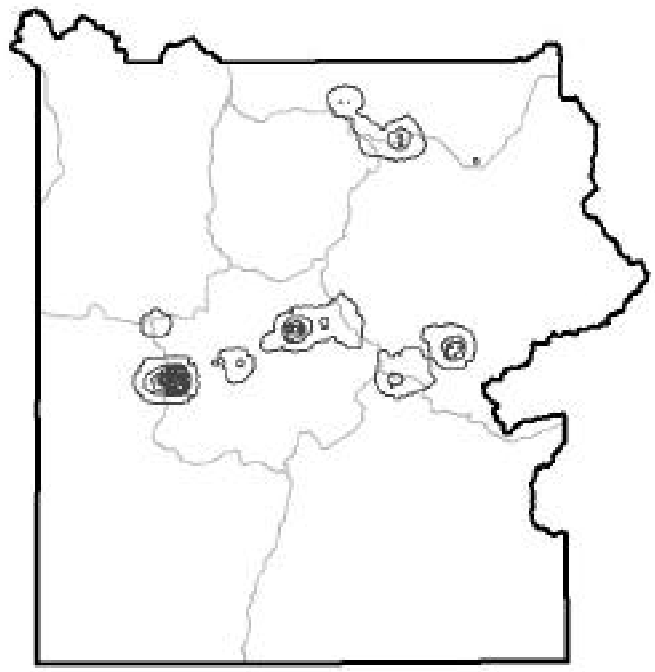

Figure 4. Bison mixed groups at Madison Junction. Note high use on the Firehole. Flight 56; date: 18 February 1982; number of bison observed: 1,907.

there, more bison moved into the Firehole area than would otherwise have been the case. Further, these movements occurred increasingly earlier in the season. Thus, generated by what became an increasing annual winter movement of Pelican bison to Hayden Valley, the distribution and range expansion continued westward (Figure 5). Over time, the interior bison use patterns have shifted westward, with more bison, more of the time, on the Firehole. The movement of Firehole-area mixed groups of bison to Madison Junction that first occurred the winter of 1982 (using the snow-packed road) became an annual occurrence thereafter. And, as more bison moved earlier into the Firehole, more moved earlier, stayed longer, and traveled further west of Madison Junction (Figures 5 and 6). With time, bison mixed groups were commonly seen, even in midsummer, west and north of Madison Junction, and did much shifting between the west side and the Firehole.

Finally, during a few of the winters of the 1990s, bison groups traveled the entire distance from Madison Junction north to Mammoth and the north boundary. During the exceptionally severe winter of 1996–1997, the timing and size of bison removals at boundary areas indicated that between 320 and 350 bison had done this (Taper et al. 2000). Bison have demonstrated a capacity to learn (Meagher 1989), and approximately 30 made this same trip in late October 2000, when the ground was as-yet essentially snow-free along the road corridor. Because the changes that have occurred in interior bison distributions and move-

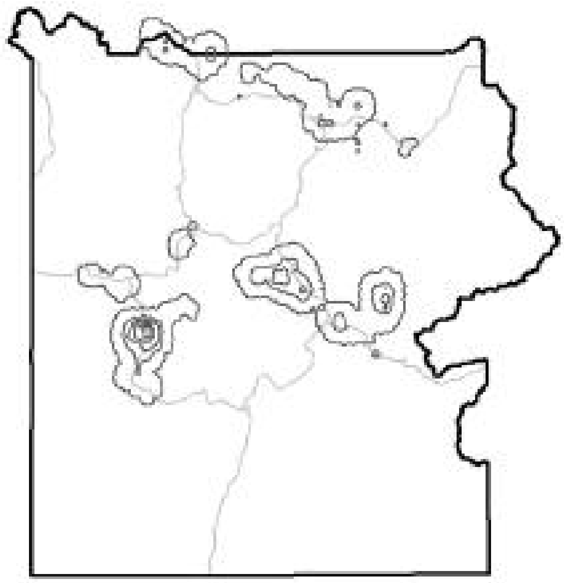

Figure 5. Pelican range expansion merged into Hayden Valley. Note bison west and north of Madison Junction. Flight 71; date: 11 February 1986; number of bison observed: 2,285.

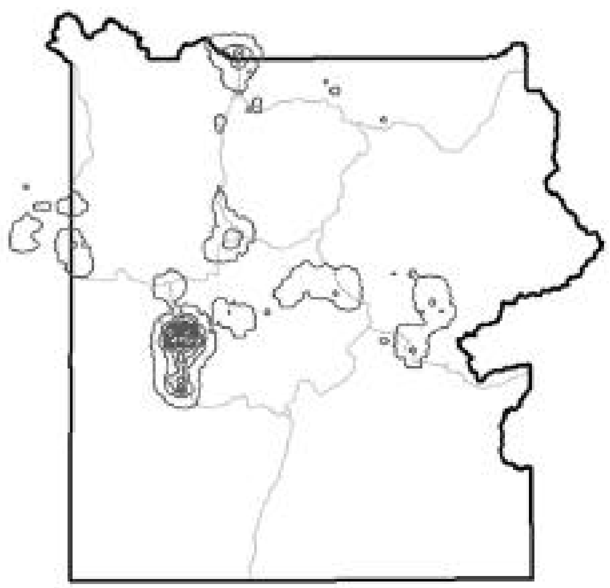

Figure 6. Bison distribution in late February 1996–1997. By this time hundreds had been removed at and outside park boundaries. Flight 145; date: 21 February 1997; number of bison observed: 1,718.

ments apparently began with a west-and-north winter range expansion by Pelican-area bison, and have escalated over the past two decades, we have termed the changes in use patterns *the domino effect.*

Changes in Bison Summer Range Patterns After 1983

The air survey of 21 July 1983 marked the last time bison groups were observed on the crest of the Absarokas south of the head of the Cache-Calfee ridge. Long-term experience indicated that these were probably bison that had come from the Pelican winter range. Some Pelican bison apparently did cross the Mirror Plateau to some of the lower slopes of the Absaroka Mountains during the summer of 1985, but they did not move higher to the crest of the range (D. Stradley, personal communication). Air surveys through the summer of 2001 have not located mixed groups of bison on the east boundary (Taper et al. 2000; J. Mack, personal communication), nor has there been any indication since 1985 that Pelican bison have crossed the Mirror Plateau.

The air survey of 9 August 1984 showed another major change in summer range use. Of 588 bison counted for the northern range unit, 477 were down in the Lamar Valley. These numbers must have included some of the bison that had wintered in the Pelican area, as only 119 bison were located in the subalpine meadows of the Mirror Plateau. This kind of distribution became an annual summer occurrence thereafter.

The seasonal shift of the interior population westward has resulted in enormous summer breeding season congregations of bison in Hayden Valley, sometimes reaching approximately 3,000 animals (Taper et al. 2000). In August, those with affinities for the Pelican winter range would begin to move back to that locale. However, as soon as winter set in, they would start to shift back to Hayden Valley. This seasonal shifting back and forth resulted in larger numbers of bison utilizing interior winter ranges earlier and in greater numbers than had been the pattern prior to the beginnings of winter movement of Pelican bison to Hayden Valley. Preliminary information indicated that this circumstance may be generating habitat degradation in at least some geothermal areas. Four comparative photographs taken from 1912 through 1997 appeared to show directional changes in quantity of vegetative cover that appeared to be supported by the particular characteristics of those soils (Taper et al. 2000).

Pelican-area Winter Use Patterns, 1998–2001

Pelican-area winter use patterns have become very fluid. Prior to the above-observed changes, long-term records suggested that a minimum of approximately 100 bison would remain to survive, regardless of winter severity (Meagher 1971, 1973, 1976). This was evidenced by the winter of 1942–1943 (a recorded 122 bison) and by the comparable winter of 1996–1997, when 94 bison were located in the air survey of 19 May 1997. Because movements from Pelican Valley to Hayden Valley went on throughout the winter, as indicated by decreased numbers with each air survey, the lowest count (minus new calves) in late May and very early June reflected the numbers that spent the entire winter in the Pelican area. Comparable surveys for May 1998 and 1999 (J. Mack, personal communication) showed some increase, with 145 and 152 counted, respectively.

In contrast, the end-of-winter Pelican-area surveys for 2000 and 2001 (J. Mack, personal communication) dropped to 50 and 47, respectively. For 2000, a detailed review of the Pelican-area survey, coupled with attached map coordinates, allowed scattered bulls that winter in certain sites apart from the rest of the bison to be separated from the total. When both scattered bulls and newly born calves were discounted, only 24 bison were recorded as mixed groups. This is nearly the same as the historically recorded low of 22 in 1902 (Meagher 1973), after cessation of poaching.

Major changes have been observed over the past two decades in the wintering numbers, distribution, and seasonal movements of the bison of the interior of Yellowstone National Park, beginning with those that wintered in Pelican Valley. The analyses of the computerized data from the air surveys of 1970–1997 (Taper et al. 2000) showed changes in bison numbers, distribution, timing of seasonal movements, and social behavior such as group size and cohesiveness. Additional analyses of the habitat data (Jerde et al. 2001) also showed changes in use patterns.

The continued decrease by Pelican-area bison to historic lows that were observed during the winters of 1999–2000 and 2000–2001 reinforce an interpretation that indicates a very fluid and perhaps unstable situation, geographically speaking, in the bison that inhabit the interior of the Yellowstone plateau. Key to this is the long-observed determination of bison to maintain group social bonds if at all possible. Although they can survive by breaking social bonds and scattering into geothermal sites, if presented with a choice they will move preferentially to maintain a higher level of aggregation. They will also shift toward less harsh winter conditions, as is usual with ungulates in mountain habitat. Over time, as this has occurred, many more bison have exited the park in an apparent effort to maintain social aggregations that the within-park habitat would not permit. In so doing, they have come into conflict with different land-use objectives outside the park. Although attempts have been made to force them back into the park, this has been a short-term solution at best, and most have been removed from the population under state legal authority. This situation can be expected to continue.

The data do not provide a cause-and-effect relationship for the observed changes. Interacting factors of environmental fluctuations and bison behavior likely are involved, even as those factors influenced the bison historically. But the air surveys and observational information suggest that another (and also interactive) element may have a role. This is the relatively recent addition of snow-packed travel linkages formed by sections of interior park roads between and within some areas of bison use. The use of snow-packed or plowed roads certainly represents some energy savings to the central herd, and even provides access to areas that would otherwise be inaccessible to bison. It is unclear if these energy savings have merely facilitated a population and range expansion that would have occurred anyway, or if an apparently minor change has upset a delicately balanced demography and caused the expansion. This raises the possibility that the changes in the bison population and their relationships with their habitat may have a human-caused influence.

The changes appear to be ongoing, and the fluidity of bison shifts suggests that large movements of interior bison across park boundaries likely will occur in the future. These bison probably will be removed from the population. This, coupled with the fluidity of movements and the possibility of habitat changes inside the park, suggests that overall numbers likely will decrease. The summation of the observed changes suggests an uncertain future for the interior park bison.

Acknowledgments

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References

Cannon, K.P., K.L. Pierce, P. Stormberg, and M.V. MacMillan. 1997. Results of archeological and paleoenvironmental investigations along the north shore of Yellowstone Lake, Yellowstone National Park, Wyoming: 1990–1994. Unpublished report. Lincoln, Neb.: Midwest Archeological Center. (On file, Yellowstone National Park, Wyoming.)

Caughley, G. 1976. Wildlife management and the dynamics of wildlife populations. In *Applied Biology.* Vol. 1. T.H. Coaker, ed. New York: Academic Press, 63–57.

Jerde, C.L., M.L. Taper, and M. Meagher. 2001. Habitat utilization shifts by bison in Yellowstone National Park. Paper presented at the annual meeting of the Ecological Society of America, 8 August, Madison, Wisconsin.

McNab, J. 1985. Carrying capacity and related slippery shibboleths. *Wildlife Society Bulletin* 13, 403–410.

Meagher, M. 1971. Snow as a factor influencing bison distribution and numbers in Pelican Valley, Yellowstone National Park. In *Proceedings of the Snow and Ice Symposium, February 11–12.* Ames: Iowa State University, 53–57.

———. 1973. *The Bison of Yellowstone National Park: Past and Present.* National Park Service Scientific Monograph no. 1. Washington, D.C.: U.S. Government Printing Office.

———. 1976. Winter weather as a population-regulating influence on free-ranging bison in Yellowstone National Park. In *Research in the Parks: Transactions of the National Park Centennial Symposium.* (Symposium at the annual meeting of the American Association for the Advancement of Science, 28–29 December 1971.) National Park Service Symposium Series no. 1. Washington, D.C.: U.S. Government Printing Office, 29–38.

———. 1989. Range expansion by bison of Yellowstone National Park. *Journal of Mammalogy* 70, 670–675.

———. 1993. Bison in the Greater Yellowstone. In *Proceedings of the North American Public Herds Symposium, La Crosse, Wisconsin*. R. Walker, comp. Custer, So. Dak.: Custer State Park, 384–391.

———. 1998. Recent changes in Yellowstone bison numbers and distribution. In

Proceedings of the International Symposium on Bison Ecology and Management in North America, June 4–7, 1997. L. Irby and J. Knight, eds. Bozeman: Montana State University, 107–112.

Meagher, M., S. Cain, T. Toman, J. Kropp, and D. Bosman. 1997. Bison in the Greater Yellowstone Area: Status, distribution, and management. In *Proceedings of the National Brucellosis Symposium, September 1994, Jackson, Wyoming.* E.T. Thorne, M.S. Boyce, P. Nicoletti, and T.J. Kreeger, eds. Laramie: Wyoming Game and Fish Department, 47–55.

Meagher, M., and D.B. Houston. 1998. *Yellowstone and the Biology of Time.* Norman: University of Oklahoma Press.

Taper, M.L., M. Meagher, and C.L. Jerde. 2000. The phenology of space: Spatial aspects of bison density dependence in Yellowstone National Park. Final Report, U.S. Geological Survey Biological Resources Division Contract 1445-CAO9-95-0072 (sub-agreement no. 7). Bozeman: Montana State University.

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