

# A Comparison of Sheep- and Wildlife-Grazed Willow Communities in the Greater Yellowstone Ecosystem

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## Summary

The effects of grazing by sheep and wildlife on willow communities in the Greater Yellowstone Ecosystem (GYE) were compared in this study. Willow communities grazed by wildlife (elk and bison) were on the northern range of Yellowstone National Park (YNP). Sheep-grazed areas were in the Centennial Mountains on the U.S. Sheep Experiment Station (USSES) summer range about 100 km west of the YNP. Both locations are in the GYE, an area surrounding YNP that encompasses over six million hectares. Willow height and canopy cover were measured inside and outside four exclosures (established 26 to 31 years prior to sampling) on the northern range of YNP and compared to ten grazed willow communities on the USSES summer range. Repeat photographs were taken at both locations to estimate long-term changes in extent of willow communities. Willow canopy cover at the USSES summer range (93%) was similar ( $P > 0.05$ ) to cover inside exclosures at YNP (95%), but both were greater ( $P < 0.05$ ) than willow canopy cover outside exclosures at YNP (14%). Willow heights averaged 189, 285 and 36 cm at the USSES summer range, inside the exclosures at YNP and outside the exclosures at YNP, respectively, and all means differed ( $P < 0.05$ ). Willows

have disappeared in 95% of the repeat photographs from the northern range of YNP but are still present in all repeat photographs of the USSES. Beaver are also ecologically extinct on the northern range of YNP but are present in all drainages with an appropriate habitat on the USSES summer range. The loss or near loss of two major biotic components (beaver and tall willows) indicates that the northern range of YNP is not in healthy ecological condition.

**Key words:** elk, repeat photography, rangeland health.

## Introduction

Western range sheep operations typically depend upon public lands for over 40% of their forage needs (Taylor et al., 1982). Furthermore, there are essentially no alternatives to public land forage. Dependence on public land grazing by the western sheep industry is demonstrated by the willingness of producers to pay an average of over \$5 per AUM more for federal forage than comparable private land forage as determined by a total cost approach to forage valuation (Torell et al., 1993). Access to forage on public lands is becoming increasingly tenuous because of public concern over the effect of livestock grazing on the health of rangelands. However, concern for the health of rangelands

often appears to be more a function of values and philosophies than concern for rangelands. In an article highly critical of livestock grazing on western rangelands, Fleischner (1994) pointed out the importance of values when he wrote: "Is there an ecologically sustainable future for livestock grazing in western North America? This ultimately is a question of human values, not of science."

This study compared indicators of ecosystem health in wildlife- and sheep-grazed willow communities of the Greater Yellowstone Ecosystem. The GYE is an area extending approximately 100 to 200 km beyond the borders of YNP and encompassing six to eight million hectares. Much of the land in the GYE is public land and it is considered by many to be critical for insuring a properly functioning ecosystem in this area (Noss and Copperrider, 1994). The GYE is considered a bellwether for policy on public land and wilderness ecosystem management and as such provides a useful case study for demonstrating

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how standards for ecosystem health differ depending upon whether defoliation is by wildlife or domestic livestock. Keiter and Boyce (1991) described many problems that must be dealt with in the GYE. "In significant respects, fire, elk and wolves epitomize the transition to ecosystem management that is now occurring in Greater Yellowstone; how they are handled on the public domain will set the stage for how other human-nature conflicts are addressed. Transcending the bureaucratic domain of any single agency, these resources can be managed effectively only on an ecosystem scale. And ecosystem management policies can be devised only by reaching consensus on how to integrate humans and nature on America's remaining wildlands ... . What we are witnessing in greater Yellowstone is the emergence of a new era in public land management. Predicated on a fundamental realign-

ment of the human relationship with nature." The fundamental realignment discussed by Keiter and Boyce (1991) is that man should no longer try to manage nature, but at least in the GYE, he should minimize the impact of his presence.

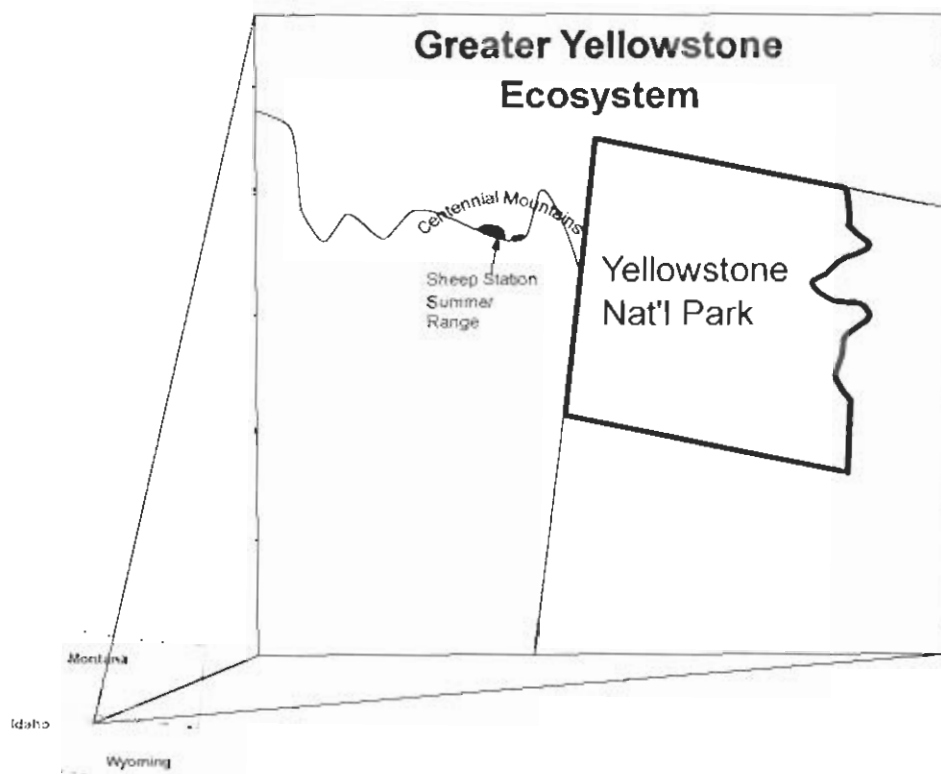
While philosophies and values may ultimately decide how ecosystems are managed, one of the purposes of science is to provide empirical evidence about the effect of different management options. The objective of this study was to compare managed sheep grazing to "naturally regulated" wildlife grazing on flora and fauna of willow communities in the GYE.

## Materials and Methods

We studied willow (*Salix* spp.) communities on the northern range of YNP and on the USSES summer range located in the Centennial

Mountains about 100 km west of the park (Figure 1). The USSES summer range lies between 2,100 and 2,900 meters elevation and the northern range of YNP lies between 1,500 and 2,400 meters elevation. The USSES summer range consists of 6,700 hectares in the Centennial Mountains that were withdrawn from the public domain in 1922 for sheep breeding and grazing research. The USSES summer range is divided into three allotments and these seasonal ranges are grazed during July and August. Prior to 1988, each allotment was grazed annually by a band of sheep at a moderate stocking rate (equal to or less than Natural Resources Conservation Service recommended rate). Restoration grazing has been used since 1988 with each allotment rested every third year. Sheep bands consist of about 1,000 ewes and 1,400 lambs under the care of a herder.

Figure 1. Map showing the location of the U.S. Sheep Experiment Station and Centennial Mountains in relation to Yellowstone National Park.



Yellowstone National Park (890,000 hectares) was set aside in 1872 as our nation's and the world's first national park. Park administrators originally thought there were not enough game animals so they controlled predators and fed wintering elk (*Cervus elaphus*), bison (*Bison bison*) and other wild ungulates. By the late 1920s, concerns grew that the unnaturally large elk population was severely overgrazing the park, and in particular YNP's northern winter range. From 1949 to 1968, rangers shot more than 13,500 elk to reduce the northern herd. Under mounting political opposition, the National Park Service abandoned its elk-reduction program in 1969 and by the early 1970s had switched to "natural regulation" management (Kay, 1990; Boyce, 1991). Under natural regulation, predation is an assisting but non-essential adjunct to the regulation of ungulates through density-dependent homeostatic mechanisms. Elk and other wild ungulates are limited by food; death from starvation is considered a natural phenomenon.

Ten willow communities at the USSES were sampled during the summer of 1993 and compared with measurements of four willow communities on the northern range of YNP taken in 1988. Communities sampled at YNP were located inside and outside of elk-proof exclosures located at Mammoth (established in 1957), Lamar-East (established in 1957), Lamar-West and Junction Butte (established in 1962). Houston (1982) and Barmore (1981) provide background information on these exclosures. At all locations, line-intercept transects were used to determine willow canopy cover by species and height was measured at regularly spaced points on each transect. For complete information on the YNP data, see Chadde and Kay (1988; 1991), Kay (1990; 1994b) and Kay and Chadde (1992). The effect of the three treatments (YNP inside, YNP outside, USSES) on total willow cover and height of Geyer willow (*Salix geyeriana*) were compared using a one-way analysis of variance with each exclosure or community as an experimental unit.

Beaver (*Castor canadensis*) is a keystone species in the GYE and beaver activity was recorded at both locations as an indicator of ecosystem health (Kay, 1994b). Repeat photographs were also used to determine long-term changes at both locations. Forty-four historical photographs that contained scenes of willow communities in YNP were relocated and photographed from 1986 to 1989. Because few pictures of willow communities on the USSES's summer range could be located, the study area was expanded to include the entire Centennial Mountains. While exact management for the entire range is not known, all large ungulates are managed to some degree either through grazing systems or hunting regulations. In the Centennial Mountains study area, 28 historical photographs originally taken between 1871 and 1939 that contained scenes with willows were relocated in the field and photographed during 1994 and 1995.

## Results and Discussion

### *Willow Communities*

The willow canopy cover on the USSES summer range was similar ( $P > 0.05$ ) to willow canopy cover inside exclosures in YNP. Furthermore, willow canopy cover at the USSES and inside the YNP exclosures was greater ( $P < 0.001$ ) than the cover outside exclosures in YNP. The height of Geyer willow differed ( $P < 0.001$ ) among all three locations. Willows were tallest inside and shortest outside the exclosures in YNP; whereas on the USSES summer range, willow height was intermediate to the two locations in YNP, but more similar to willows inside exclosures than outside (Figure 2). The shorter height of willows on the USSES summer range compared with willows inside exclosures in YNP may be the result of repeated browsing by wild ungulates, primarily wintering moose (*Alces americana*). We attribute the browsing to moose rather than domestic sheep because the plants were browsed well above what domestic sheep can normally reach.

Of the 44 repeat sets of photographs of willow communities on YNP's

northern range, dating to the 1870's, tall willows have totally disappeared in 41 sets of photographs (Figure 3), while in the other three, only 5 to 10% of the original tall willows remain. When discussing repeat photographs, tall willows are differentiated from shorter, browsed willows because only the former can be seen in the photographs. In 1871, Captains Barlow and Heap (1872) toured YNP and on the northern range they reported "thickets of willows along the river bank." P.W. Norris (1880), YNP's second superintendent, noted that the Park was "well supplied with rivulets invariably bordered with willows." Since that time, though, the area occupied by tall willow communities on the northern range has declined by 95% or more (Kay, 1990). In contrast to the repeat sets of photographs in YNP, tall willows are still present in all of the sets of photographs from the Centennial Mountains and may have increased in stature at some locations (Figure 4). A recent study reported 100 times more bank erosion on streams in YNP compared with higher reaches of the same streams outside the park where willows are still abundant (Rosgen, 1993).

### *Beaver*

Beaver were common on YNP's northern range during the 1800s, but are now ecologically extinct (although occasional beaver may be found they no longer affect ecosystem function) due to repeated ungulate browsing of the willows and aspen (*Populus tremuloides*) beaver need for food and dam-building materials. In the 1920s, a detailed survey of one small portion of the YNP's northern range reported extensive active dams and 232 beaver. During the 1950s and again in 1986 to 1988, no beaver or any recent activity were recorded (Kay, 1990; Chadde and Kay, 1991). In contrast, on the USSES summer range beaver are present in all drainages that have appropriate habitat. Without tall willows and beaver in YNP, biodiversity is greatly reduced, many streams are downcut and the water tables are lowered (Kay, 1994b). Since beaver is a keystone species, its loss has ramifications far beyond the demise of a single species (Kay, 1994b). Keystone

species play pivotal roles in their ecosystems and a large part of the community is dependent upon them. Beaver create habitats used by many species and also regulate hydrology and other ecosystem functions (Naiman et al., 1988).

## Conclusion

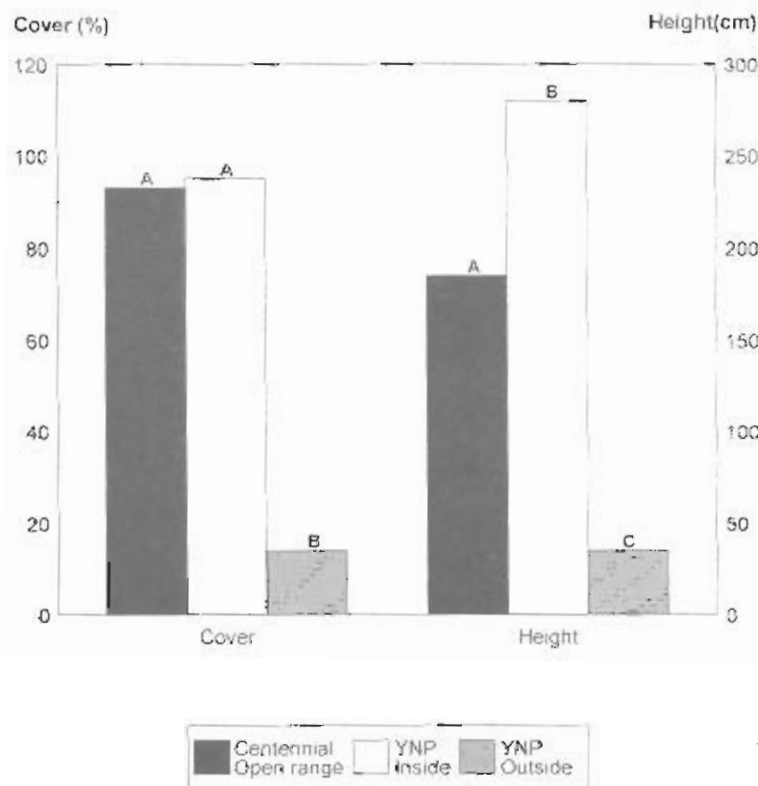
The loss or near loss of two major biotic components (beaver and tall willows) indicates the northern range of YNP is not in healthy ecological condition. We believe the differences between YNP's northern range and the USSES summer range are caused primarily by differences in levels of defoliation of willows by large ungulates. This conclusion is based on the dramatic fence-line contrast seen at elk-proof exclosures in YNP (Figure 5) and the decline in willow communities since the turn of the century demonstrated in the repeat sets of

photographs (Kay, 1990). Patten (1993) and Wagner et al. (1995) also concluded that elk grazing was the major reason willow communities have deteriorated on the northern range of YNP. We believe the major difference between the effect of grazing at these two locations is not the difference in species of herbivores but differences in level of management and the resultant differences in levels of defoliation. Similar conclusions were drawn in Australia where it was shown that over-stocking by either sheep or kangaroos (*Macropus giganteus*) had a similar effect on vegetation structure (Freudenberger and Palmer, 1996).

Environmental organizations and some government agencies appear to have different standards for ecosystem health depending upon whether the herbivore is native wildlife or domestic livestock. These differences have

important implications concerning the development of standards for rangeland health. Many environmentalists think of nature in its healthy condition as characterized by its independence (i.e., unaffected by human interference; Borgman, 1995). Furthermore, the impact of "natural" populations of wildlife on resources is apparently not a concern to some. Thus, regarding potential resource damage due to high elk numbers, Boyce (1991) asks the rhetorical question: "Is there anything necessarily unnatural or undesirable about soil erosion?" To which he answers: "Anthropogenic, excessive soil erosion maybe." In a similar line of thought Coughenour and Singer (1991) state: "The concept of overgrazing has no meaning in ecosystems where there are no humans to alter or evaluate natural processes." We disagree with the idea that the impact of herbivores on the vegetation and soil of an

Figure 2. Willow canopy cover and height inside and outside elk-proof exclosures in Yellowstone National Park (YNP) and on the USSES summer range. Bars within a group with different letters are significantly different ( $P < 0.05$ ).



**Figure 3. Tall-willow communities in Yancy's Hole on Yellowstone's northern range.**

(a) 1893 photo by F. Jay Haynes (H-3080) viewed east. Photo courtesy Haynes Foundation Collection, Montana Historical Society, Helena.



(b) That same area in 1988. Note the loss of tall willow communities, less than 100 years later. Other photos of this area show that the tall willows had been heavily browsed and were declining by 1921. Tall willows were absent in 1954 photos. Photo by Charles E. Kay (no.3051-12) August 20.



Photo was inadvertently reversed during publication.

Figure 4. A tall-willow community along Miners Creek in the west end of the Centennial Mountains, Idaho.

(a) 1910 photo courtesy of Jim Hagenbarth.



(b) That same area in 1994. Except for the new road constructed up Miners Creek, willows appear unchanged despite yearly grazing by cattle and sheep. Photo by Charles Kay (No. 3833-4).



ecosystem should be evaluated based on the species of animal causing the impact.

The same standards should be applied whether the herbivore is wild or domestic. Concerning livestock grazing, the Greater Yellowstone Coalition (GYC) state that sloughing of streambanks is of greater consequence to riparian ecosystem functioning than are utilization rates (Harting and Glick, 1994). Yet streambanks are sloughing throughout the northern range of Yellowstone National Park (Figure 6; Budiansky, 1996). The GYC also recommend, again concerning livestock grazing, exclosures to distinguish environmental and/or random variation from that attributable to land-uses or management (Harting and Glick, 1994). Yet at exclosures in the YNP, fence-line contrasts exist that are far greater than differences

normally seen at livestock exclosures (Figure 5).

Rangeland health is defined as an indication of proper or normal functioning of ecological processes resulting in the production of commodities or values (Committee on Rangeland Classification, 1994). Riparian ecosystems must have an appropriate composition of woody and herbaceous species to maintain their integrity and stability (Elmore and Beschta, 1987). These data show that the characteristics of willow communities on the northern range in YNP are not consistent with properly functioning riparian systems. The effect of overgrazing should be of equal importance to a conservationist whether the impacts are caused by livestock or wildlife. Current values and philosophies concerning the relationship of humankind to the environment are derived from the concept

that the moral community should be expanded to include "nature" (Leopold, 1970; Nash, 1988). The law requires that all persons be treated equally. If the moral community is expanded to include nature, as suggested by many environmentalists, it would be inappropriate to have double standards (i.e., one set of standards for wildlife and another set for livestock) for the relationships between society and nature. Livestock producers and other environmentalist should demand the same set of standards applied for wildlife be applied for livestock or vice versa.

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**Figure 5. Fence-line contrast along a willow exclosure in Yellowstone National Park. The Lamar-West exclosure shown here was constructed in 1962 and this photograph was taken 25 years later in 1987. Photo by Charles Kay (print from color slide).**



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Figure 6. Stream bank Sloughing on Slough Creek on the northern range Yellowstone National Park. Photo by Charles Kay, August 1996.





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