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Willows and Moose: A Study of Grazing Pressure, Slough Creek Exclosure, Montana, 1961-1986

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ABSTRACT

The Slough Creek Exclosure was constructed in October 1961 in the Gallatin National Forest to determine the response of willows (*Salix* spp.) protected from browsing. The objective of this study was to compare vegetational changes inside and outside the exclosure after 25 years. The exclosure was visited and resampled in August 1986. Four existing line-intercept transects were sampled, and six new 30.5-meter transects were established and sampled outside of the exclosure. The willow species in the area were identified for the first time. Willow height and canopy coverage inside the exclosure have increased steadily since 1961, while willows outside the exclosure have shown little change. Recommendations include periodic resampling of exclosure transects and use of historic photographs of the Slough Creek drainage to evaluate vegetation changes.

INTRODUCTION

An exclosure adjacent to Slough Creek, located in the Gallatin National Forest, Montana, was constructed by the U.S. Forest Service in 1961. Its purpose was to provide a reference area to study the response of browse plants, particularly willows, after they were protected from use by big game animals (Joy 1962). Because winter snow accumulation normally precludes use as elk winter range, winter browsing is generally limited to moose. However, elk occasionally use the area in late fall and early spring and, during years of low snowfall, in the winter (Puchlerz 1987). The objective of this study was to compare the vegetational changes in the exclosure, after 25 years of protection, with adjacent areas subject to browsing.

According to available historical records, moose were not observed in the northern range of Yellowstone National Park until about 1913 (Houston 1982). Early explorers in the Yellowstone area rarely saw moose; except for the observations of the Henderson party (1870), all recorded sightings were confined to the area south of Yellowstone Lake (Doane 1876, Norris 1880, Norris 1881). In addition, there have been no moose remains found in any of the archeological sites in the Yellowstone region (Wright 1979, Houston 1982, Wright 1984, Wright and Reeve 1981). During the early 1900s, Shiras (1913) "discovered" the Shiras subspecies of moose along the headwaters of the Yellowstone River above Yellowstone Lake. Since then, moose have extended their range into northern Yellowstone Park (Houston 1982) and the surrounding area (Stevens 1971, McDowell and Moy 1942).

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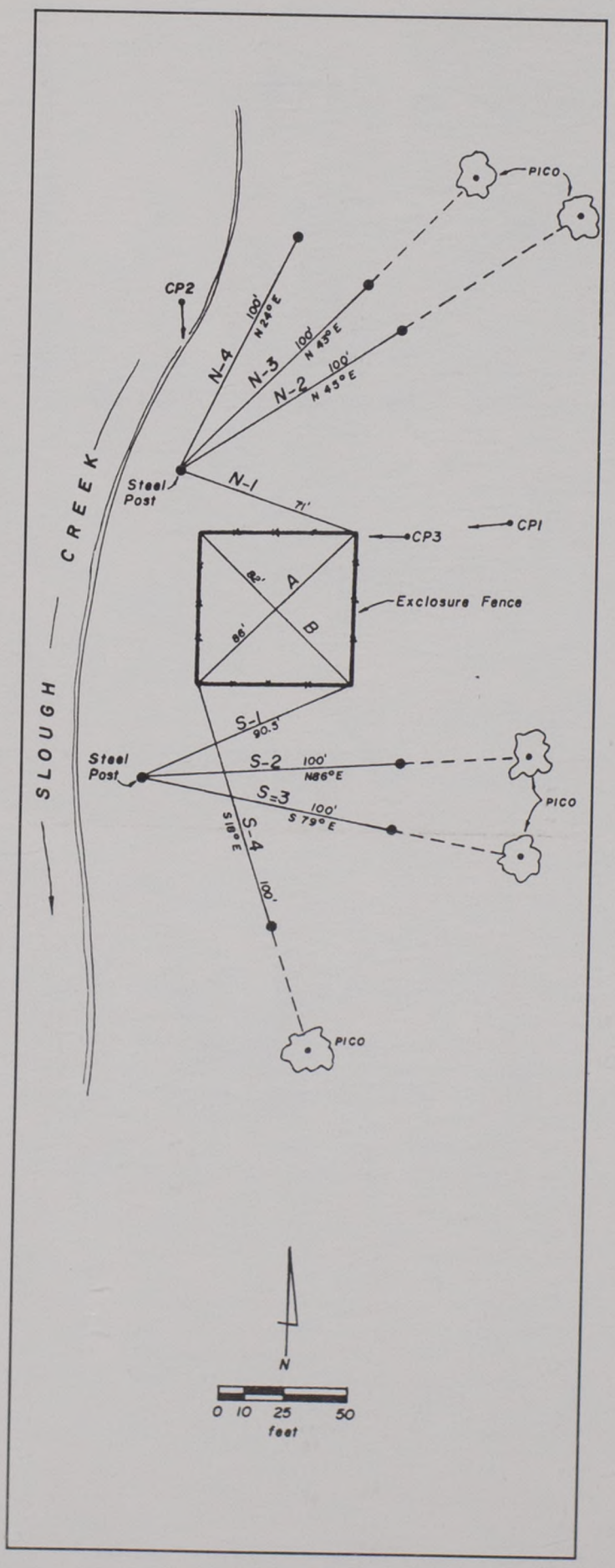

FIGURE 1
Slough Creek Exclosure
with Transect and Camera Point Locations

Few moose were observed in the upper Slough Creek drainage in the early 1920s. Local flora at the time included willows with shoots up to 5 centimeters in diameter, and willow clumps reached heights of 3 to 4.5 meters. South into Yellowstone Park, "willows along Slough Creek were taller than a moose's back in most of the area" (McDowell and Moy 1942). Increasing numbers of moose were seen along Slough Creek between 1930 and 1940. By the mid-1940s, tall live willows had all but disappeared, and fewer moose were observed in the area. By the early 1960s, tall willows had almost completely disappeared along Slough Creek, and progressively fewer moose were sighted each year (Joy 1962).

Most observers suspected that repeated browsing by moose was responsible for the change in the extent and structure of a once-common riparian community. Researchers hypothesized that the former Yellowstone Park policy of feeding ungulates during the winter, combined with predator control, may have encouraged unnaturally large increases in the moose population (Joy 1962); after the supplemental feeding program ended in the early 1930s, browsing pressure on willows became excessive.

Between 1961 and 1978, the moose population in the Slough Creek drainage was considered relatively stable (Erickson 1979). Swenson (1985) reported that moose populations have been increasing since 1978 due to conservative harvests of the animals.

METHODS

The Slough Creek exclosure is approximately 22 kilometers upstream from Yellowstone Park's Slough Creek campground. The site was described and sampled in 1962 through 1965 and partially sampled in 1979 (Erickson 1979).

In 1963, four line transects were established in the exclosure (Figure 1). Two transects (A and B) were inside the fenced area, bearing diagonally from corner to corner. Outside the exclosure, a transect (N-1) began at the northeast corner post; the other (S- 2) began at the southwest corner post. In 1986, six new transects (N-2, N-3, N-4, S-2, S-3 and S-4), each 30.5 meters long, were established outside the exclosure.

Willow species were identified along each transect line, and the length of each willow clump was recorded to the nearest inch. Until the 1986 survey, willows had not been identified beyond the generic level. The average heights of plants along the line were also measured. A list was made of species both in and adjacent to the exclosure; nomenclature followed Brunsfeld and Johnson (1985) for *Salix* spp. and Hitchcock and Cronquist (1973) for all other taxa.

Camera points, monumented in 1962, were photographed again in 1986 (Figure 1). The position of camera point 2 was approximated because it apparently had been washed out by Slough Creek.

A soil pit one meter deep was dug and examined inside the exclosure; another was dug and examined in a similar topographic position about 15 meters north of the fenced area. Horizon development, soil texture, depth of rooting and evidence of mottling or gleying were recorded.

RESULTS

Vegetation

Within the exclosure, the willow overstory completely covered the ground surface and intercepted 114 percent (sum of each species intersect distance) of the total transect length of 51.2 meters (Table 1). *Salix geyeriana* predominated, followed by *S. boothii* and *S.*

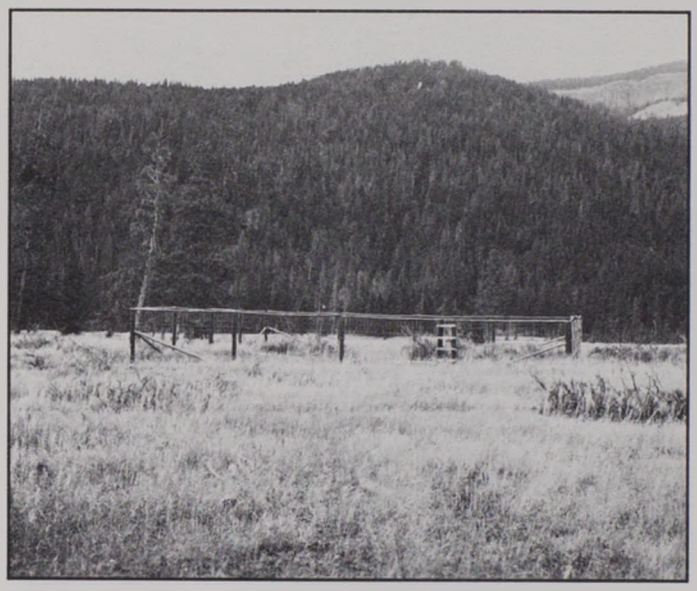

FIGURE 2A
Slough Creek Exclosure, Camera Point 1, October 4, 1962

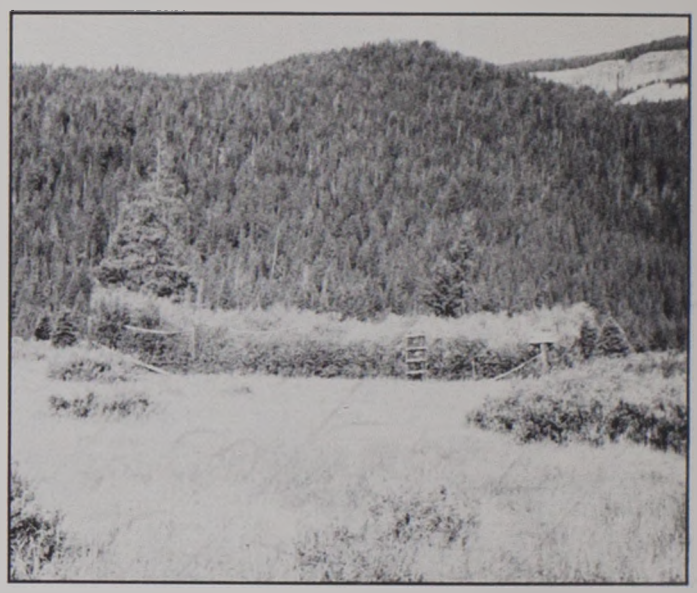

FIGURE 2B
Slough Creek Exclosure, Camera Point 1, August 20, 1986

drummondiana. Average willow heights varied from 2.3 meters for *Salix boothii* to approximately 3.1 meters for *S. geyeriana* and *S. drummondiana*.

Outside the exclosure, willows intercepted 36 percent of the total transect length of 232 meters (Table 2). *Salix geyeriana* and *S. boothii* were dominant species; *S. drummondiana* and *S. wolfii*, a low willow (about one meter), were present in lesser amounts.

As indicated by both transect data (Table 3) and photographs (Figures 2 and 3), changes within the exclosure since 1961 have included large increases in willow canopy coverage and height. Outside the exclosure, intercept and height values changed only slightly, with no apparent upward or downward trend.

There were also composition shifts, as indicated by comparisons of present willow cover inside and outside the exclosure (Tables 1 and 2). Unfortunately, it was not possible to make long-term comparisons of trends in individual willow species because of the lack of previous identification by earlier researchers.

The exclosure and adjacent area supported habitat similar to the *Salix geyeriana/Carex rostrata* riparian plant association described for northern Yellowstone Park (Chadde et al. 1988). Dominance in this type is shared by *Salix geyeriana*, *S. boothii* and *S. drummondiana*, and these species form an often associated group of ecologically equivalent species (Brunsfeld and Johnson 1985, Youngblood et al. 1985, Hansen et al. 1987).

Within the exclosure, understory coverage was sparse because of shade, but *Carex rostrata* and *Calamagrostic canadensis* were present as scattered individuals. Adjacent to the exclosure, *Carex rostrata* and *C. aquatilis* were common. Other common graminoids outside the exclosure included *Agropyron caninum*, *Bromus ciliatus*, *Phleum pratense*, *Poa pratensis* and *Stipa occidentalis*. Common forbs included *Achillea millefolium*, *Aster* spp., *Epilobium angustifolium*, *Geum macrophyllum* and *Taraxacum officinale*. A species list for the protected and adjacent unprotected areas is presented in Table 4.

Soils

Soils within the exclosure were characterized by a 5-centimeter accumulation of organic matter, composed of decayed willow leaves and stems, and a 30-centimeter moist, sandy-loam horizon. A medium-coarse sand was encountered at depths greater than 35 centimeters; woody roots were noted to a depth of about 40 centimeters.

There was a discontinuous layer of organic matter, in addition to more bare ground, outside the exclosure. A sandy loam with a high percentage of fibrous roots was found from the soil surface to 8 centimeters below it; this soil continued from 8 to 25 centimeters, with an increase in clay. Soil deeper than 25 centimeters was a moist sand with few roots. No evidence of mottling or gleying, which indicates fluctuating or high water tables, was observed in the upper meter of either profile. However, these characteristics are rare in coarse-textured soils (Rowell 1981).

DISCUSSION

The response of willows inside the exclosure indicates that the tall-growing species *(Salix boothii, S. drummondiana, S. geyeriana)* along Slough Creek cannot reach heights above 1 to 1.5 meters because of repeated browsing by ungulates. With protection from browsing, willow canopy coverages increased considerably. On the other hand, species diversity decreased in the exclosure due to competition and shading. However, in a broader prospective, the riparian vegetation of upper Slough Creek typically occurs as a mosaic of willows interspersed among herbaceous communities. Under a regime of no browsing or lower intensity browsing, a more structurally diverse habitat, typified by scattered patches of tall willows, would develop in the area.

Preferential browsing of *Salix geyeriana* may account for the differences in composition in and out of the exclosure. McMillan (1953) noted a preference by moose for *Salix geyeriana* over *S. wolfii in* willow communities in Yellowstone Park, and Gaffney (1941) ranked *S. geyeriana* as "valuable" winter browse for elk. However, since willows are very shade-intolerant (Argus 1973, Rawson 1974, Haeussler and Coates 1986), shade from the taller *Salix geyeriana* may be responsible for that species' preponderance in the exclosure, compared with the slightly shorter *Salix boothii* and the lower growing *Salix wolfii*, which was absent from the exclosure in 1986.

The available evidence suggests that moose are a recent introduction, via immigration, to the study area, and that they have effected

FIGURE 3A
Slough Creek Exclosure, Camera Point 3, October 4, 1962

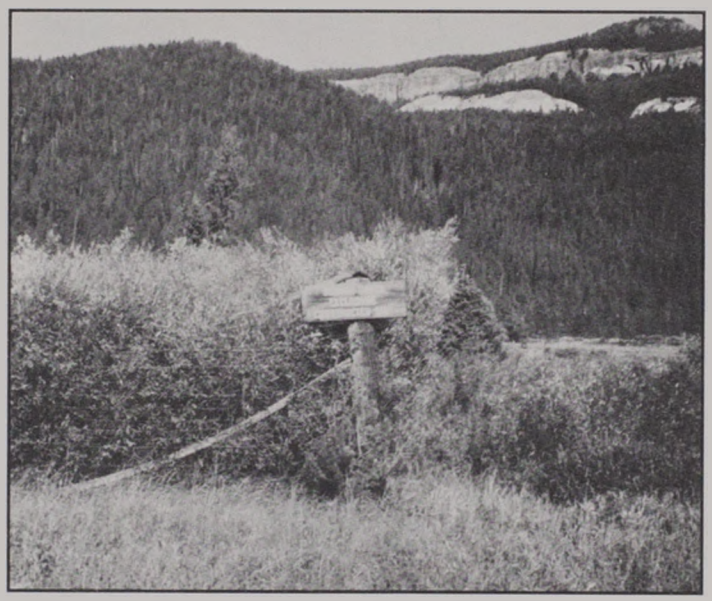

FIGURE 3B
Slough Creek Exclosure, Camera Point 3, August 20, 1986

a marked change in riparian vegetation, particularly willows. By reducing the stature and cover of woody species, moose and elk may have altered the overall character of riparian communities along Slough Creek and other drainages of the northern Yellowstone area. However, additional studies are necessary to separate trends because of other potential causative factors such as the extended drought of the 1930s or fire suppression.

RECOMMENDATIONS

- The Slough Creek exclosure should be maintained and resampled at intervals. Long-term records from exclosures and permanent plots provide valuable objective measures of vegetation change. Resampling every five to ten years should be adequate to detect significant vegetational trends.
- Historic photographs of Slough Creek should be located, and the area should be rephotographed for comparison. This would provide a useful evaluation of change in the drainage and verify the reliability of previous descriptions of the extent of tall willow communities.
- Because of moose impacts on shrub-dominated riparian communities, additional study is needed on the current status and population dynamics of moose and on moose-habitat relationships in the northern Yellowstone area.

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TABLE 1

Summary of 1986 willow data: *Inside* Slough Creek Exclosure. Total intercept length = 51 m.

Species	% of Total Intercept	Avg. Height (m)
Salix geyeriana	79	3.1
Salix boothii	24	2.3
Salix drummondiana	12	3.1
Total	114[1]	

1. Value may be greater than 100% when individual species canopy coverages overlap.

TABLE 2

Summary of 1986 willow data: *Outside* Slough Creek Exclosure. Total intercept length = 232.3 m.

Species	% of Total Intercept	% of Willow Intercept	Avg. Height (m)
Salix geyeriana	15	42	0.9
Salix boothii	15	42	0.9
Salix drummondiana	3	9	1.0
Salix wolfii	3	7	0.5
Total	36	100	

TABLE 3

Summary of willow intercept and height data, 1963-1986. Data from transects established in 1962.

Sample Date	% of Total Intercept	Avg. Height (m)
Inside Exclosure		
8/22/63	46	1.2
8/27/64	55	1.2
10/7/65	47	1.2
8/14/79	—[1]	—
8/20/86	114	3.0
Outside Exclosure		
8/22/63	20	0.8
8/27/64	32	0.7
10/7/65	28	0.8
8/14/79	36	1.9
8/20/86	28	1.0

1. Transect not sampled in 1979.

TABLE 4

Species list for Slough Creek Exclosure site, 1986.

	Inside Exclosure	Outside Exclosure
Trees		
Picea engelmannii	x	x
Pinus contorta		x
Shrubs		
Betula glandulosa		x
Lonicera involucrata	x	x
Potentilla fruticosa		x
Ribes sp.	x	x
Salix boothii	x	x
Salix drummondiana	x	x
Salix geyeriana	x	x
Salix wolfii		x
Forbs		
Achillea millefolium		x
Agoseris glauca		x
Antennaria sp.		x
Aster sp.	x	x
Astragalus sp.		x
Cirsium arvense	x	x
Cirsium scopulorum		x
Epilobium angustifolium	x	x
Fragaria virginiana	x	x
Galium boreale		x
Geum macrophyllum	x	x
Potentilla gracilis		x
Senecio pseudaureus	x	x
Solidago canadensis		x
Taraxacum officinale	x	x
Thalictrum fendleri		x
Graminoids		
Agropyron caninum		x
Bromus ciliatus	x	x
Calamagrostis canadensis	x	x
Carex aquatilis		x
Carex microptera	x	x
Carex rostrata	x	x
Danthonia intermedia		x
Phleum pratense		x
Poa pratensis		x
Poa sp.		x
Stipa occidentalis		x

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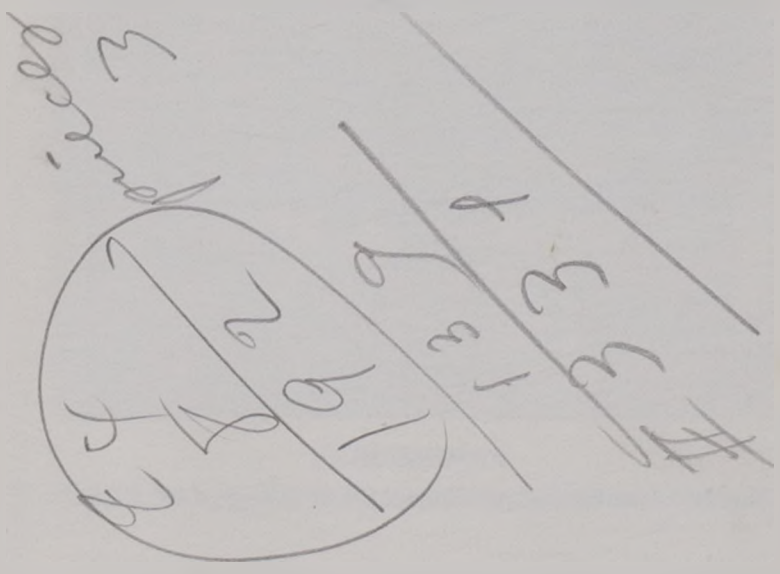

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