SOIL EROSION RATE ON THE MONTANA ALLOTMENT, ARIVACA, ARIZONA
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A CONSULTING REPORT

by

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and

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Summary

1. Soil erosion across 10 sites on the Montana Allotment averaged 0.32 tons/acre/year. This is below what is considered to be the natural rate of erosion (0.4 tons/acre/year) for this type of rangeland.
2. All 10 sites on the Montana Allotment had erosion rates below the tolerable rate (1 ton/acre/year).
3. Soil health across the Montana Allotment is considered to be excellent based on this survey of soil erosion and various other surveys of vegetation health.
4. There is no evidence of accelerated erosion due to cattle grazing on the Montana Allotment. Some accelerated erosion may be occurring in a few locations due to roads, mining, and camping activities.

Introduction

Accelerated soil erosion is the most serious consequence of unsound grazing practices on rangelands (Holechek et al. 2001). One thousand years or more are required to form 1 inch of soil (Brady and Weil 2002). However an inch or more of soil can be lost within one or two years when heavy livestock or wildlife grazing is coupled with severe drought (Brady and Weil 2002, Holechek et al. 2001). Separation of geological (natural erosion) from accelerated erosion has long been a major challenge facing range managers in the western United States. Various equations have been developed to predict soil loss based on a combination of variables typically including plant cover, vegetation composition, soil texture, percent slope, length of slope, amount of annual precipitation, and precipitation intensity (Blackburn et al. 1986). Although these equations may be satisfactory for measuring relative erosion rates among sites, they have generally been considered unreliable for measuring actual erosion (soil loss).

An alternative, reliable approach is to measure actual sediment collection in livestock ponds of known age in small, closed watersheds where the land area can be accurately calculated. Although this is a practical, reliable approach for determining erosion rates on western rangelands, its actual utility has not been demonstrated.

In March 10, 2002 Dr. Bill Fleming and Dr. Jerry Holechek were formally requested by Mr. Jim Chilton to do a survey of soil erosion on Ruby, Schumacher, and Warsaw Pastures. These pastures are part of the Montana Allotment under a U.S. Forest Service grazing permit, and are south of Arivaca, Arizona near the Mexican border. Dr. Bill Fleming, a hydrologist, and Dr. Jerry Holechek, a range scientist, accepted the assignment.

Montana Allotment and Chilton Ranch Description

The Montana Allotment is located on the Coronado Nation Forest south of Arivaca, Arizona just north of the Mexican border. The Chilton Ranch purchased the grazing lease for the Montana Allotment from the previous rancher in 1991 and added this allotment to their existing private, National Forest and State Trust grazing lands. Mr. Chilton's family has been ranching in Arizona for 5 generations since their ancestors drove covered wagons and livestock into the Territory in the late 1800's.

Elevations on the Montana Allotment range from 3,500 feet at the Mexican border to 5,376 feet at the summit of Montana Peak. Precipitation varies from 16 to 22 inches annually depending on the elevation, with normal peaks in February and August and a dry season from April through June. Rainfall is often minimal in the September through November period, and maximal during July and August.

The vegetation type is Sonoran Desert Chaparral/Grassland. Dominant plant species include various liveoaks, mesquite, sideoats grama, plains lovegrass, cane beardgrass, tanglehead, green sprangletop, slender grama and curly mesquite. In riparian areas, deergrass, bullgrass, and giant sacaton are dominant grasses. Significant palatable browse plants include guajilla and range ratany.

Riparian trees include velvet ash, netleaf hackberry, Goodding willow, Bonpland willow, yewleaf willow, cottonwoods, and some walnut trees.

Several important game species are found on the Montana Allotment. They include whitetail deer, mule deer, mountain lion, javelina, Mearns quail, Gambel's quail, white-winged doves and mourning doves. The 4 pastures in the Montana Allotment (Schumacher, Warsaw, Ruby and Chimenea) have very high esthetic value and receive considerable recreational use by campers and hunters.

Most parts of California Gulch, the primary drainage on the Montana Allotment, are dry during the months of April-June and again in autumn months and are not suitable year-long habitat for fish. However, the Sonora chub in Mexico swims north into portions of Schumacher pasture in California Gulch when seasonal rains cause the Gulch to run. When temporary flows cease and the subflow can no longer resupply small pools, the trapped fish die.

Grazing management on the Montana Allotment involves a modification of the Santa Rita rest-rotation grazing system. This system was initiated on the Montana Allotment in 1990-91 after a 6-year period of fence-building and water development made possible the change from a 2-pasture, yearlong continuous grazing program.

Through cooperation between the Coronado National Forest and the Chiltons, the rest-rotation system designed and implemented on the Schumacher and Warsaw pastures provides for summer grazing in alternate years. After four months of summer grazing the grazed pasture is rested for a 20-month period. Schumacher Pasture is grazed in even numbered years while Warsaw Pasture is grazed in odd numbered years. Ruby Pasture is grazed in the spring every year and Chiminea Pasture is grazed in late fall and winter every year. Forest Service surveys in 1983 noted a total of 7 cottonwoods in all the drainages in the Montana Allotment and cited a general lack of riparian vegetation. Various

Forest Service range conservationists on the Coronado (Larry Allen, George Proctor, Duane Thwaits) have described a lack of deergrass cover in the bottoms, the near absence of riparian tree recruits and the dominance of annuals and shortgrasses on the uplands of the Montana Allotment prior to the 1990's.

In 1996, after the new grazing system had been in place for 5 years, all riparian trees in California Gulch were censused. Trees were identified and placed in age classes in each reach of the Gulch to create a quantitative record that could be updated in 5-year intervals to document trends in riparian recruitment under the rest-rotation grazing system. The census tallied hundreds of riparian trees growing in reaches where they had been mostly absent 13 years earlier.

Various grazing intensity surveys initiated by the Chiltons in spring 1998 show conservative use of Montana Allotment pastures. The Montana Allotment has been in a strong upward trend over the last 17 years based on various surveys by range consultants and Forest Service range conservationists. A significant shift in composition from short grass (curly mesquite) to more productive, palatable midgrasses (sideoats grama) has occurred over the period from 1984 to 2000(Fleming et al. 2001). Precipitation in this period was 104% of the long term average (18 inches). Most of this shift occurred in the 1990's. An intensive forage production survey in winter of 2000 showed perennial grass production averaged 986 pounds per acre across the allotment after a year of near average precipitation. This same survey showed about 69% of the climax vegetation remained on the allotment using the USDA-Natural Resources Conservation Service criteria for evaluating range condition. This is considered to be high good or late seral ecological condition. The primary perennial grass encountered on upland areas was sideoats grama. The reader is referred to Fleming et al. (2001) for a peer reviewed description of range management outcomes on both upland and riparian areas across the Montana Allotment.

Methodology for Determining Soil Erosion

Our basic experimental approach involved selection of 10 small watersheds ranging from 35 to 179 acres in size draining into a livestock pond of known age. In some cases the ponds had been cleaned within the last 10 years. In these cases the exact date of cleaning was known. Exact area of each watershed was determined from detailed maps and ground truthing. The area of each pond within the watershed was determined on site with the aid of a wheeled planimeter. The amount of sediment was determined by use of 5 equally spaced transects that spanned the length of each pond. Along each transect (across the pond width) five equally spaced measurements were taken of sediment depth using a specially designed depth probe purchased by Mr. Chilton. A total of 25 sediment depth measurements were taken per pond. Average sediment depth of the pond was multiplied by pond area to derive sediment volume. We assumed that the weight of a cubic foot of sediment is 100 pounds (Rollins 1981). Sediment weight (tons) for each pond was divided by pond age in years to derive tons/year of sediment accumulation. This number was then divided by the area (acres) of the watershed and then divided by the estimated sediment delivery ratio (0.5) to derive the erosion rate (tons soil loss/acre/year).

The sediment delivery ratio (0.5) we used was derived from Brooks et al. (1997) and is based on the size of the watershed drainage area. Sediment delivery ratio is defined as the ratio between the sediment yield at a particular point in a watershed and the total erosion from the watershed above that point (Brooks et al. 1997). The sediment delivery ratio increases as watershed size decreases. Basically the sediment delivery ratio provides an estimate of soil loss from various sites on a particular watershed that has not yet accumulated as sediment in the watershed outlet (pond or reservoir). As an example only 30% of hill slope soil loss reached the outlet in small watersheds (120-1200 acres) in northwestern Colorado (Hadley and Shown 1976).

We refer the reader to Renard and Stone (1981) for more details on our methodology and its applications on southern Arizona rangelands. This survey was accomplished on May 16-19, 2002 by Dr. Bill Fleming, Dr. Jerry Holechek, and Mr. Jim Chilton.

Results

Soil loss across the 10 sites we evaluated averaged 0.32 tons/acre/year (tay) (Table 1). Holden pond had the lowest erosion rate (0.02 tay) while Nogalito pond had the highest (0.78 tay). There is some evidence that current grazing management (last 10 years) on the Montana Allotment has reduced the soil erosion rate compared to previous management. The average erosion on ponds 15 years or older was 0.4 tay compared to 0.27 tay for ponds under 10 years of age (Table 1).

The tolerable rate of erosion for rangelands in the western United States is considered to be 1 tay (Rollins 1981, Pimentel 1995). Based on experimental watersheds near Tombstone, Arizona (Renard and Stone 1981), the natural (geological) rate of erosion for most sites on the Montana Allotment is probably near 0.4 tay. Our survey shows the well managed cattle grazing that now occurs on the Montana Allotment (see Fleming et al. 2001) is having no effect on soil erosion. This finding is supported by various vegetation and soil surveys by Dr. Dee Galt and Dr. Jerry Holechek summarized by Fleming et al. (2001) that have consistently found high vegetation cover levels, light to conservative grazing intensities, and clear water in all ponds across the Montana Allotment.

Conclusion

Our survey of 10 small watersheds well distributed across the Montana Allotment showed no evidence of accelerated erosion. The average erosion rate of 0.32 ton/acre/year across the 10 sites is below what is considered to be the natural rate of erosion for this type of rangeland (0.4 tons/acre/year). Based on this survey of soil erosion rate and various others of vegetation health (Fleming et al. 2001), we consider soil health and stability on the Montana Allotment to be excellent.

Cattle grazing under the present management plan on the Montana Allotment is having no effect on soil erosion. However at some locations mining, roads, and campsites could be causing some degree of accelerated erosion.

Table 1. Sediment yield and soil loss rates on the Montana Allotment, Arivaca, Arizona.

Stock Pond	Watershed Area (acres)	Pond Age (years)	Sediment Weight (tons)	Sediment Yield (tons/acre/year)	Soil Loss[1] tons/acre/year
Japanese	109	16	514	0.29	0.58
Narrows	58	9	84	0.16	0.32
Warsaw	51	72	832	0.23	0.46
Lower Warsaw	90	9	71	.09	0.18
Company Well	58	9	63	0.12	0.24
Nogalito	35	9	123	0.39	0.78
Mujeres	77	56	804	0.19	0.38
Alta Schumacher old	147	44	316	0.05	0.10
new	147	9	43	0.03	0.06
Pico	50	15	367	0.24	0.48
average	91			0.16	0.32

[1] Sediment delivery ratio is considered to be 0.5 based on Brooks et al. (1997).

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