Impacts of Cattle on Streambanks in Northeastern Oregon

J. BOONE KAUFFMAN, W.C. KRUEGER, AND M. VAVRA

Abstract

Impacts of a late season livestock grazing strategy on streambank erosion, morphology, and undercutting were studied for 2 years along Catherine Creek in northeastern Oregon. Streambank loss, disturbance, and undercutting were compared between grazing treatments, vegetation type, and stream-meander position. No significant differences were found among vegetation types or stream-meander location. Significantly greater streambank erosion and disturbance occurred in grazed areas than in exclosed areas during the 1978 and 1979 grazing periods. Over-winter erosion was not significantly different among treatments. However, erosion related to livestock grazing and trampling was enough to create significantly greater annual streambank losses when compared to ungrazed areas.

Vegetation is an important component of the riparian/stream ecosystem (Campbell and Franklin 1979, Jahn 1978). The effects from livestock grazing in these ecosystems have been shown to vary greatly depending upon the nature of the stream studied. Behnke and Zarn (1976), Dehlem (1979), Duff (1979), Gunderson (1968), and Heede (1977) found livestock grazing and excessive trampling caused a decrease in bank undercuts, increases in channel widths, and a general degradation of fish habitat. Buckhouse et al. (1981), Hayes (1978), and Knight (1978) found that stream channel movement did not occur more frequently in grazed riparian ecosystems than in ungrazed riparian ecosystems.

In 1978 a study was initiated to examine effects of late season cattle grazing in riparian ecosystems that are separated from upland communities. The objectives of this study were to compare streambank morphology, erosion, and undercutting between areas of streambanks that were grazed under a late season grazing strategy and areas of streambanks that were totally excluded from livestock grazing.

Study Area

The study area is located on the Hall Ranch, a unit of the Eastern Oregon Agriculture Research Center in the southwestern foothills of the Wallowa Mountains. The study area included a 3 km by 50-m section of Catherine Creek, a fourth order tributary of the Grande Rhonde River, which flows into the Snake River. Catherine Creek has an average discharge of 3.4 m^3/s (119 ft^3/s) (USGS 1981). Peak annual flows usually occur in late April, May, and early June. During the spring runoff period, discharges of over 14.2 m^3/s (500 ft^3/s) are common.

Approximately one-half of the streambank has been excluded from grazing by the construction of 5 exclosures alternating with grazed portions of the creek. Prior to the establishment of exclosures, there was a total of 5,473 m of streambank on the study area with 3,492 m considered accessible to livestock use. Accessible streambank is defined as an area where livestock movement was not impaired by steep cliffs, fences, or dense woody vegetation. Stocking intensity before the construction of exclosures was approximately 48–50 m of accessible streambank (MAS) per animal unit month (AUM). After exclosures were built, approximately 1,804 m of streambank were accessible to cattle, which increased stocking to 25–30 MAS/AUM with no change in cattle numbers in the pasture. The stocking rate during the study was approximately 1.3–1.7 ha/AUM.

Methods

Prior to grazing in 1978, 125 one-quarter inch diameter steel stakes were established along the bank using a stratified random selection process. Sixty-seven stakes were placed in exclosures and 58 stakes were in grazed areas. Stake locations were stratified according to 3 broad vegetational types. These types were streambanks with a herbaceous cover, a shrub cover, or a tree cover. Further stratification was based on stream-meander position, top-outside, middle-outside, and bottom-outside of the meander. The convex portion of the streambank was considered the outside bank, that portion of the streambank receiving the greatest amount of erosive energy from streamflows. Straight portions of the streambank as well as fill areas were also included.

At each sampling station, the distance from the sampling stake to streambank edge and depth of the bank undercut was measured. In addition, the bank height which was the distance between the top of the uppermost soil horizon and the stream bottom at banks' edge was measured. An azmuth reading of the exact direction of the line from the stake to the bank was recorded to insure the same points were measured each sampling period. Measurements were taken prior to grazing in 1978, after the 1978 grazing period, prior to the 1979 grazing period and immediately after the 1979 grazing period.

Streambank erosion or loss was tested using a $2 \times 3 \times 4$ factorial design. Factors included grazing treatment (grazed or exclosed from grazing), vegetation type (herbaceous, shrub, or tree) and channel morphology (straight, top-outside, middle-outside, and bottom-outside).

Changes in the mean depth of undercuts were tested between treatments using the Student's *t*-test. A disturbance index was formulated to monitor any disturbance or alteration to the streambank. The disturbance index was a measure of absolute change in stake to bank measurement, whether it was a loss or increase in distance. The index not only accounted for disturbance due to bank sloughoffs, but also accounted for an actual increase in the stake-bank distance caused by animal trampling, or other factors which, by breaking down the bank, could change the bank morphology and cause an increase in the stake to bank distance. The differences in disturbance index responses by grazing treatments was also tested with the Student's *t*-test. Percent of sampling points that were disturbed for grazed and ungrazed portions of the streambank were tested using chi-square techniques. A chi-square test was also used to compare differences among grazing treatments of the percent of sampling points with undercuts greater than 7.5 cm. Throughout this paper the term significant refers to $p \leq .05$ unless specified otherwise.

Seventy-six sampling stations were used in analysis as many stakes were lost due to several causes such as high flows, major channel changes, and vandalism. Stakes placed within gravel bars were also omitted because these did not provide reliable data since definition of streambank edge was particularly difficult.

Authors are former graduate research assistant and professors, Department of Rangeland Resources, Oregon State University, Corvallis, respectively. Vavra is located at Eastern Oregon Agricultural Research Center, Union, Ore.

This article was submitted as Technical Paper No. 6600. Oregon Agricultural Experiment Station, Corvallis.

Manuscript received November 3, 1983.

Table 1. Streambank alterations along Catherine Creek 1978-1979.

	Grazing season 1978	Winter 1978-1979	Grazing season 1979	Combined grazing seasons 1978+1979	Total annual change Aug. 1978–Aug. 1979
			Streambank Loss (cm)		
Exclosure	2	9	4	6	9
Grazed	14*	15	13*	27*	27*
	Disturbance Index (Mean cm. change from pre-treatment readings)				
Exclosure	3	14	5	7	14.0
Grazed	15*	25	15*	30.0*	40.4*

*Significant at $P \leq .05$, when comparing exclosure to grazed for each column.

Results and Discussion

Grazed areas had significantly greater streambank losses compared to exclosed areas (Table 1). No significant differences were found in the amount of annual streambank loss for either vegetation types or stream-meander position.

Herbaceous covered banks dominated by Kentucky bluegrass *(Poa pratensis),* sedges (*Carex* spp.), rushes (*Juncus* spp.), and forbs had mean annual erosion losses of 14 cm, ranging from 0–107 cm. Shrub covered banks dominated by hawthorne *(Crataegus douglasii),* snowberry *(Symphoricarpos albus),* and/or Wood's rose *(Rosa woodsii)* had mean annual bank erosion of 28 cm, ranging from 0–188 cm. Tree covered banks dominated by black cottonwood *(Populus trichocarpa)* and/or thin leaf alder *(Alnus incana)* had mean annual bank erosion of 26 cm, ranging from 0–69 cm.

There were also no significant differences in bank erosion loss when comparing sampling points according to their stream-meander position. Sampling points on the top-outside of a meander in the creek had mean annual erosion losses of 18 cm. Middle-outside positions had mean annual erosion losses of 23 cm, bottom-outside positions had mean annual erosion losses of 5 cm, and straight sections of the streambank had mean annual erosion loss of 14 cm.

Grazed portions of the streambank had significantly greater disturbance indices and significantly fewer undercuts, less than 7.5, cm compared to areas exclosed for 2 years.

There was no significant difference in bank erosion or streambank loss during the nongrazing periods (late September–early August). This period included losses due to high winter and spring runoff events (Table 1).

At the onset of the study (August 1978), average bank undercuts in grazed and exclosed portions of the streambank were 23 cm and 16 cm deep, respectively, which were not significantly different. Approximately 72% of the undercuts were greater than 7.5 cm in both grazed and exclosed areas. Immediately after the 1978 grazing season there was still no significant difference in undercut depths with a mean depth of 19 cm and 15 cm in grazed and exclosed areas, respectively. Similar trends were noted during the 1979 grazing season. After 2 years of no grazing, 81% of the sampling points in exclosed areas had undercut depths greater than 7.5 which was significantly different from the 48% of the sampling points in grazed areas that had undercut depths of greater than 7.5. cm. Mean undercut depths in grazed areas had significantly decreased after 2 grazing seasons from 23 cm (August 1978) to 13.0 cm (September 1979). Changes in undercutting through time in the exclosed portions of the streambank was not significantly different.

Since there was no change in undercutting of streambanks in exclosures that were grazed at almost half the current stocking rate for several years, the significant decrease in both the number and depth of undercuts in grazed areas is probably a function of the substantially increased intensity of use in grazed areas. This suggests there may be a threshold of response of rate of undercutting to stocking, but this study was not designed to determine response thresholds.

Overwinter events such as high water and ice floes also caused a great amount of streambank disturbance and erosional loss of banks along Catherine Creek. Late season grazing resulted in significantly greater annual bank sloughoff; however, there was no significant difference in total streambank loss between grazed and ungrazed areas when comparing only the overwinter period. Significantly greater streambank disturbance (e.g. undercut collapse, cave-ins, and sloughoffs) occurred in grazed areas compared to ungrazed areas at this time ($p \leq .10$). Livestock grazing may have weakened the streambank structure through trampling and forage removal to the point where ice floes and high water had a more damaging effect on grazed portions of the streambank.

Forage utilization along streambanks varied greatly among the vegetation types sampled. Herbaceous dominated streambanks were usually the most heavily utilized followed by shrub/herbaceous and tree/shrub/herbaceous covered streambanks. Streambanks dominated by grasses and/or grasslikes were utilized from 35 to 85% in grazed areas with a mean of 59% (Kauffman 1982). The shrub and tree dominated banks had lower utilization ranging from 10 to 60% with a mean of 22%. Vegetation utilization of communities in the exclosures was always less than 20%, which was primarily used by big game.

Streambanks dominated by grasses and grasslikes were composed of deep, moderately to well-developed fine textured soils. Soils in shrub and tree dominated streambanks characteristically were unstructured, medium-coarse textured, and rocky. Though degree of livestock utilization was greatest on herbaceous covered banks, streambank losses were not significantly different when compared to those of shrub and tree covered banks. Grazing preferences possibly mediated streambank losses among vegetation types with these different soil structures.

The accelerated erosion and increased bank disturbance related to livestock grazing is similar to findings of Behnke and Zarn (1976), Dahlem (1979), Gunderson (1968), and Marcuson (1977). The accelerated streambank loss along Catherine Creek is unlike the findings of Buckhouse et al. (1981) and Hayes (1978), who reported similar utilization rates. Hayes (1978) implied that utilization of the riparian vegetation was under 60%. Utilization of vegetation associated with the stream studied by Buckhouse et al. (1981) was 65–70%.[1] Buckhouse et al. (1981) found that while moderately grazed portions of Meadow Creek in Oregon had higher mean annual erosion losses than ungrazed areas, the differences were not significant. Most bank cutting losses on Meadow Creek were attributed to overwintering periods when high water, ice floes had a major influence on channel morphology.

Management Implications - Conclusion

After construction of exclosures animal use days increased from 48-50 MAS/AUM to 25-30 MAS/AUM. This increased animal use was significantly related to a following decrease in streambank undercuts in these grazed areas. Comparisons between grazed and exclosed areas for streambank erosion and disturbance are made only under the grazing intensity of 25–30 MAS/AUM accessible streambank. At these intensities significantly greater streambank

[1]File data, Pacific Northwest Forest and Range Experiment Station, United States Department of Agriculture-Forest Service, LaGrande, Oregon.

erosion and disturbance were measured in grazed areas compared to ungrazed areas.

When the status of streambank erosion, morphology, and bank undercuts are important considerations in making management decisions, it may be more useful to measure intensity of use with the numbers of animals per length of streambank rather than density of animals per unit area. Under this experimental design, the stocking rate of 1.3–1.7 ha/AUM was found to have few impacts on riparian vegetation (Kauffman 1982); however, streambank use at 25–30 MAS/AUM had significant impacts on streambank erosion.

These findings illustrated a greater erosional hazard for Catherine Creek than Buckhouse et al. (1981) or Hayes (1978) found with similar light to moderate intensities of livestock utilization. It is likely that some streams are more susceptible to disturbance by livestock than others. The implications of the level of accelerated erosion on Catherine Creek with respect to natural changes in this dynamic system are not clear. This level of erosion undoubtedly influences short-term changes in streambank morphology and perhaps siltation of the water column. Long term impacts related to aquatic life, water quality, terrestrial wildlife, stream structure, shape, and the perpetuating capabilities of riparian vegetation is difficult to precisely predict with currently available models. However, it is unlikely that responses remain linear over long time periods. It does appear, that for the present, management plans need to be geared for each particular riparian/stream ecosystem as responses from land use activities do vary greatly from stream to stream.

Literature Cited

Behnke, R.J., and M. Zarn. 1976. Biology and management of threatened and endangered western trouts. U.S. Forest Serv. Gen. Tech. Rep. RM-28.

Buckhouse, John C., Jon M. Skovlin, and Robert W. Knight. 1981. Streambank erosion and ungulate grazing relationships. J. Range Manage. 34:339-340.

Campbell, Alsie G., and Jerry F. Franklin. 1979. Riparian vegetation in Oregon's western Cascade Mountains: composition, biomass, and autumn phenology. Coniferous Forest Biome, Ecosystem Analysis Studies, U.S. I.B.P. Progr. Bull. No. 14.

Dahlem, Eugene A. 1979. The Mahogany Creek watershed—with and without grazing. *In:* Proc., Forum-Grazing and Riparian/Stream Ecosystems. Trout Unlimited Inc. p. 31-35.

Duff, Donald A. 1979. Riparian habitat recovery on Big Creek, Rich County, Utah. *In:* Proc., Forum-Grazing and Riparian/Stream Ecosystems. Trout Unlimited Inc.

Gunderson, D.R. 1968. Flood plain use related to stream morphology and fish populations. J. Wildl. Manage. 32:507-514.

Hayes, Frank A. 1978. Streambank and meadow condition in relation to livestock grazing in mountain meadows of central Idaho. M.S. Thesis, Univ. Idaho, Moscow.

Heede, Burchard H. 1977. Case study of a watershed rehabilitation project: Alkali Creek, Colorado. USDA Forest Serv. Res. Pap. RM-189.

Jahn, L.R. 1978. Values of riparian habitats to natural ecosystems. *In:* Strategies for Protection and Management of Floodplain Wetlands and Other Riparian Ecosystems. USDA Forest. Serv. GTR-WO-12:157-60.

Kauffman, J. Boone. 1982. Synecological effects of cattle grazing riparian ecosystems. M.S. Thesis, Oregon State Univ., Corvallis.

Knight, Robert W. 1978. Streamside erosional response to animal grazing practices on Meadow Creek in northeastern Oregon. M.S. Thesis, Oregon State Univ., Corvallis.

Marcuson, Patrick E. 1977. The effect of cattle grazing on brown trout in Rock Creek, Montana. Montana Dep. Fish and Game Fed. Aid Prog. F-20-R-21-11a.

United States Geological Survey. 1981. Water resources data for Oregon: Surface water records for eastern Oregon. Volume 1. U.S. Dep. Int. Geological Survey.