GRAZING MANAGEMENT INFLUENCES ON TWO BROOK TROUT STREAMS IN WYOMING

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1985
Symposium Proceedings WWRC-85-42

In

Riparian Ecosystems and Their Management:
Reconciling Conflicting Uses
First North American Riparian Conference
Tucson, AZ

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Grazing Management Influences on Two Brook Trout Streams in Wyoming[1]

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Abstract.--Brook trout abundance and instream habitat characteristics were evaluated in two rangeland streams. Heavily grazed and lightly grazed reaches of two streams with different grazing management were compared. Relationships between stream morphology, riparian zone characteristics, and trout abundance were observed.

INTRODUCTION

The impacts of cattle grazing in riparian zones of small western streams on trout habitat quality and trout abundance have been described by numerous authors, but published accounts of case histories are not abundant (Gunderson 1968, Lorz 1974, Marcuson 1977). The rate of trout habitat deterioration under varying grazing intensities and the degree of grazing that can be experienced without impact on trout habitat are poorly understood.

The most common management alternative employed to renovate grazing-impacted riparian areas and stream habitats is exclosure of cattle by fencing (Platts and Wagstaff 1984). Observations on rangeland trout stream habitat changes in response to fencing have been made by Claire and Stork (1977), Stork (1979), Duff (1977, 1979), Keller et al. (1979), Dahlem (1979), Van Velson (1979), and Platts (1981a, 1981b, 1981c). In general, with cessation of heavy grazing the stream channel narrows and deepens, pool development is accentuated, stream banks stabilize with establishment of vegetation, and greater overhead cover forms (Bowers et al. 1979). Two rangeland brook trout (Salvelinus fontinalis) streams in Central Wyoming that have been influenced by grazing over several decades provided an opportunity to assess two aspects of riparian zone grazing management. Past management of Pete Creek enabled a comparison of trout habitat quality in stream reaches grazed by cattle for many years with reaches grazed by horses, wildlife and a few cattle. Cherry Creek had been grazed by cattle, but two riparian-area exclosures constructed in 1980 reduced cattle grazing over a portion of the stream, enabling assessment of trout habitat response to reduced grazing intensity.

Pete Creek and Cherry Creek are adjacent similar watersheds located on the north side of the Ferris Mountains (T27N, R88W) in the North Platte River Basin approximately 70 km north of Rawlins, Wyoming. The water source for the creeks consists of numerous mountain springs. The upper end of the watersheds (3,000 m elevation) is steep with conifers, shrubs, and grasses on the slopes. As the streams descend from the mountains, the gradient decreases and the watershed is dominated by shrubs and grasses. The riparian area contains woody vegetation, primarily willows (Salix spp.). The average frost-free period in the study area is 90 days with an average annual precipitation rate of 30 cm, mostly in the form of winter and spring snow. Within the study area, both streams had low gradients (mean = 2.2% for Pete Creek, 2.9% for Cherry Creek) and the average elevation was 2,000 m.

Both streams were under multiple-use management by the United States Bureau of Land Management (BLM). In addition to grazing, the streams were used for recreation (fishing, hunting, camping). The fisheries were exclusively brook trout (Salvelinus fontinalis) of a relatively small size (<250 mm total length).

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[1]Paper presented at Riparian Ecosystems and Their Management: Reconciling Conflicting Uses. First North American Riparian Conference, Tucson, Arizona, April 16-18, 1985.

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Pete Creek enabled assessment of the influence of a long period (>25 years) of cattle grazing on trout stream habitat. The study area was on BLM rangeland where a grazing allotment had been fenced into a large cattle pasture and a smaller horse pasture. The fence ran parallel to the general direction of Pete Creek and separated meanders of the stream into the two pastures. The cattle pasture was grazed between June and October each year. As many as 500 cattle would concentrate on <20 hectares of riparian area (2.5 km long) at some times in the cattle pasture. Obvious impacts included an almost total lack of woody vegetation, as well as numerous bare and eroding banks. The horse pasture was grazed by horses, wildlife, and occasionally a few cattle. The riparian area within the horse pasture contained dense willow growth and the stream banks were heavily vegetated with little evidence of bare or eroding areas.

The influence of a 4-year old exclosure on the riparian area of Cherry Creek, a grazed rangeland was assessed. The Cherry Creek study area was a BLM allotment (15,300 ha) which had 4,800 animal-unit-months of grazing, between May 10 and October 10 for at least 25 years. A habitat management plan was developed by the BLM in cooperation with the Wyoming Game and Fish Department in 1979. The plan responded to the BLM's directive to initiate stream improvement and to recognize livestock manipulation as a management tool. Subsequently, two exclosures were constructed over 6.4 km of the stream and completed in 1980. A 100 m-long water gap was left between the two exclosures. Since 1980 some grazing has occurred within the exclosures by wildlife and trespass cattle.

Methods

Selected 75-m-long reaches of each creek were assessed during Summer 1984. Within each stream reach the abundance of brook trout was estimated and several stream habitat variables were measured. Trout abundance (kg/km) was determined by electrofishing using a three-pass removal-depletion technique (Platts et al. 1983). The Zippin (1958) method for computing the estimate was used.

Stream habitat conditions were measured across transects at 7.5-m intervals over the reach. At one-quarter, one-half and three-quarters the width of the stream the substrate and water depth were measured. Substrate was ocularly classified as silt-sand, gravel, rubble or boulder according to the criteria of Duff and Cooper (1978). The width at each transect was measured, as well as the linear distance of overhanging bank cover (Wesche 1980) and overhanging vegetative cover. Overhanging vegetation was defined as vegetation which extends as least 15 cm over the stream and shades the water at mid-day. The area of the reach shaded between 1000 and 1400 hours was estimated by measuring the linear distance shaded on each transect and computing the percentage of cumulative measured width covered by shade.

Over each study reach the Stream Reach Inventory Channel Stability Index was computed (Phankuck 1975). The quality of the three uppermost pools in each reach was rated (Duff and Cooper 1978). Ten, 5-m transects at right angles from the stream, at 7.5-m intervals on alternating sides of the stream, were measured in each reach to determine the amount of bare soil and litter in the riparian zone immediately adjacent to the stream using the line intercept method. The percentage of the total transects distance covering bare ground or litter was used as the estimator.

Results and Discussion

Pete Creek

Three study reaches were assessed within each pasture on Pete Creek. The abundance of brook trout varied with the reaches in the cattle pasture having a mean density of 8.0 kg/km (0.0 - 12.6 kg/km range). The reaches in the horse pasture had densities of 116.4 and 65.6 kg/km in the upstream areas, but only 10.0 kg/km in the lowest reach. The lowest reach was downstream from a long reach in the cattle pasture where overhanging vegetation was totally lacking and the stream channel was wide and shallow. It is expected that water temperature increased through this reach and negatively impacted downstream brook trout.

Several stream habitat variables showed a statistically significant ($p \leq 0.05$) difference between the cow pasture and the horse pasture (Table 1). Stream reaches in the horse pasture were narrower and deeper, had more variation in depth, and had deeper pool and run areas. In addition, these reaches had greater quantities of overhanging bank cover, overhanging vegetation, and shaded area. The combination of deeper, narrower stream reaches with overhanging cover and shade indicated a much better habitat for brook trout in the lightly grazed reaches than in the cow pasture (Bowers et al. 1979).

Cherry Creek

Eight stream reaches were evaluated on Cherry Creek: two upstream from the exclosures, two within each of the two exclosures, and two downstream from the lower exclosure. The riparian area inside and outside the exclosures had substantial woody vegetation (Salix spp.). Several cottonwoods (Populus spp.) occurred within the exclosures, but were absent outside. Bare banks along the stream were evident outside of the exclosures.

The average biomass of brook trout inside (30.1 kg/km) and outside (28.3 kg/km) the exclosures was similar. Biomass estimates ranged from 12.1 to 56.3 kg/km with the lowest and highest estimates occurring in reaches outside the exclosure.

Several stream habitat characteristics showed a statistically significant difference between reaches inside and outside the exclosures (Table 2). Stream reaches inside the exclosures were narrower and deeper, and had more pool and run area >22 cm deep. Within the exclosures there was significantly less bare soil and litter along the stream banks, as well as less silt on the stream bottom. No pre-exclosure data are available. It is possible the differences in channel morphology between reaches inside and outside the exclosures existed prior to fencing, and our results should be interpreted with this in mind.

While trout population responses have been observed in several streams following construction of exclosures (Platts and Wagstaff 1984) no difference in brook trout abundance was observed between reaches of Cherry Creek inside and outside the exclosure. This may be because the stream habitat had not been highly degraded prior to exclosure construction, little change in habitat quality has occurred inside the exclosures since 1980, or fishing pressure being greater inside the exclosure. Our data indicated reaches outside the exclosure of Cherry Creek had not been as severely impacted as the portions of Pete Creek inside the cattle pasture. Reaches of Pete Creek within the horse pasture had 3-4 times more fish, were narrower and deeper, and had more overhanging more bank cover, overhanging vegetation, and shaded area (Tables 1 and 2).

In Cherry Creek, differences in channel morphology, substrate composition, and vegetative cover along the stream banks were observed after four years within stream reaches where exclosures prevented cattle grazing; but measurable differences in trout cover and trout abundance were not observed. Responses associated with recovery of woody vegetation (overhanging vegetative cover and shade) may require 8-10 years to show up (Duff 1979, Richard and Cushing 1982). Our observations suggest that a quick response in riparian vegetation will not always result in rapid fishery benefits.

General Trends

The sampled stream reaches of Pete Creek and Cherry Creek represented a range of grazing intensity, thereby enabling the influence of grazing intensity on stream habitat characteristics and brook trout abundance to be assessed. Correlations (n=13) between measured habitat variables and trout abundance were significant for average width ($r = -0.527$, $p = 0.032$), average depth ($r = 0.671$, $p = 0.006$), width-depth ratio ($r = -0.580$, $p = 0.019$), proportion of stream with water depth exceeding 22 cm ($r = 0.48$, $p = 0.045$), and pool rating ($r = -0.531$, $p = 0.031$), as well as percent rubble substrate ($r = -0.541$, $p = 0.028$). The data from Pete Creek and Cherry Creek (Tables 1 and 2) indicated that statistically significant habitat variables, with the exception of rubble substrate, respond to grazing intensity.

Correlations between the habitat variables associated with trout abundance and other riparian zone characteristics responsive to cattle grazing indicated the influence of cattle on trout. The abundance of riparian shrubs, overhanging vegetation, and overhanging bank cover in the study reaches of Pete Creek and Cherry Creek were correlated ($p \leq 0.05$) with instream habitat variables (depth and pool quality) that influence brook trout abundance. Grazing and bank trampling by cattle impact these riparian zone features with a subsequent effect on instream habitat and trout abundance. The Pete Creek and Cherry Creek cases illustrated the impacts of long-term cattle grazing on brook trout streams in Central Wyoming, and further indicated that the response of trout habitat to cattle exclusion is not rapid for these streams.

Table 1.--Mean values of stream habitat variables measured in heavily and lightly grazed reaches of Pete Creek in 1984 (*indicates statistically significant difference at $p \leq 0.05$, **indicates difference at $p \leq 0.10$).

Variable	Mean Value (n = 3)	
	Heavily Grazed	Lightly Grazed
Width (m)	2.9	2.2 *
Depth (m)	0.07	0.11 *
Width/depth ratio	43	21
Coefficient of variation in depth	47.3	66.6 *
%greater than 22 cm deep	9.0	22.3 **
%silt substrate	35	52
%gravel substrate	35	31
%rubble substrate	24	14
%bedrock-boulder substrate	1	3
SRI/CSI	112	110
%overhanging bank cover	2.7	30.0 *
%overhanging vegetation	0.0	11.7 *
%shaded area	0.7	18.3 *
%bare soil along banks	19.7	13.3
%litter along banks	7.0	6.0

Table 2.--Mean values of stream habitat variables measured inside and outside exclosures on Cherry Creek in 1984 (*indicates statistically significant difference at $p \leq 0.05$).

Variable	Mean Value (n = 4)		
	Outside Exclosure	Inside Exclosure	
Width (m)	2.9	2.5	*
Depth (m)	0.08	0.09	*
Width/depth ratio	37	28	*
Coefficient of variation in depth	57	71	
%greater than 22 cm deep	6.7	21.0	*
%silt substrate	22	13	*
%gravel substrate	23	20	
%rubble substrate	39	48	
%bedrock-boulder substrate	16	20	
SRI/CSI	111	93	
%overhanging bank cover	24.0	15.3	
%overhanging vegetation	8.5	18.0	
%shaded area	23.5	28.0	
%bare soil along banks	22.8	12.3	*
%litter along banks	10.0	6.8	*

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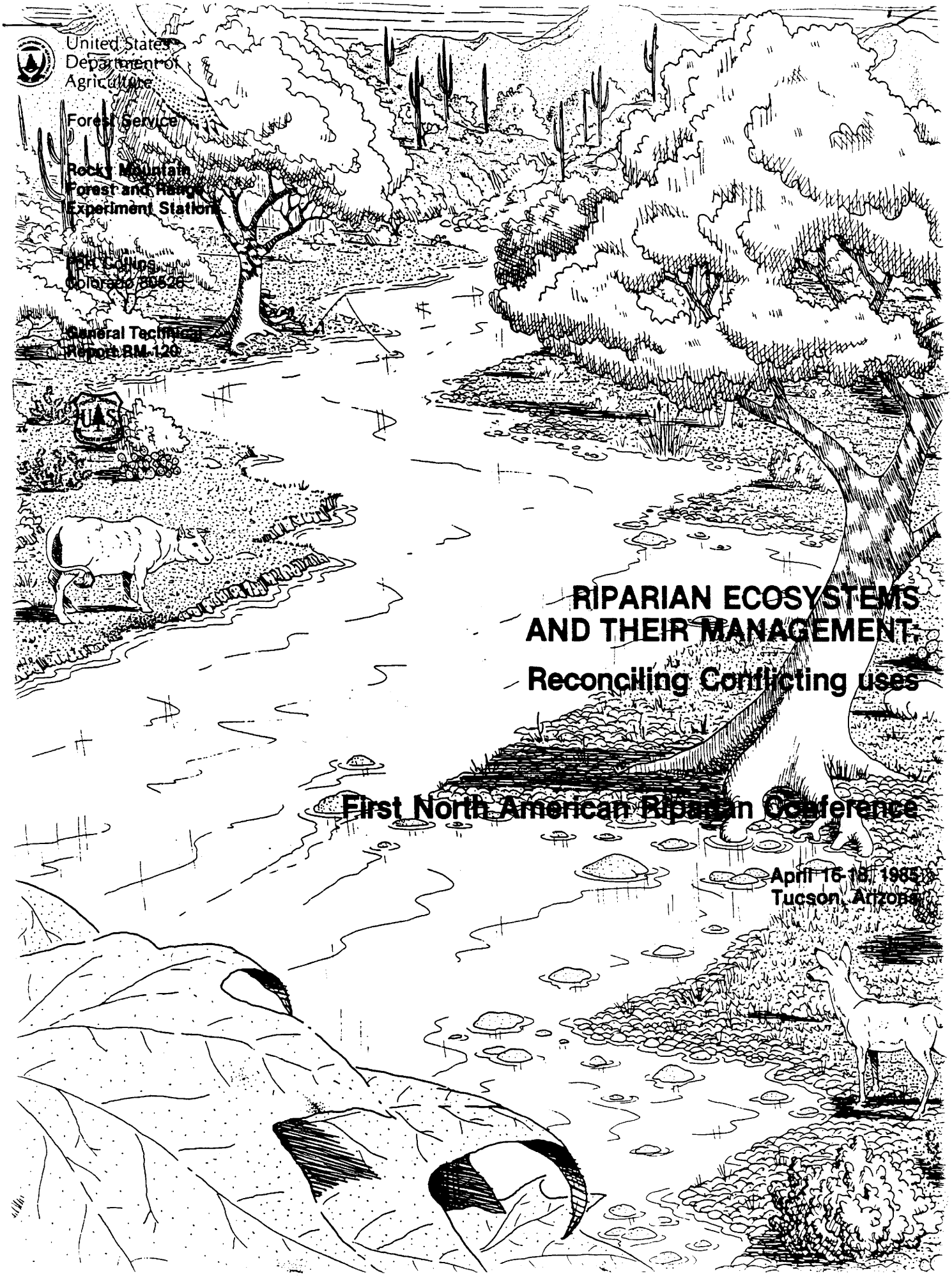

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1985

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Acknowledgments

Any meeting of this size and scope owes its success to a large number of individuals and organizations. First, we thank the sponsoring organizations (listed on the Title Page) whose financial support and encouragement helped make the conference a reality. The 360 registrants and approximately 100 additional persons who attended selected sessions demonstrated a sizable constituency for enlightened riparian management.

We are especially grateful to those who presided over the many concurrent sessions, or who donated their time on the technical and publications committees. Members of the University of Arizona Student Chapter of the Wildlife Society provided invaluable support both during and before the conference, as did personnel of the National Park Service Cooperative Resources Studies Unit at the University.

Two outstanding individuals, both with advanced degrees in science and law, contributed to the success of the conference--Bruce Babbitt, Governor of Arizona, and Dr. Jon Kusler, Chairman, The Association of State Wetland Managers, Inc. Governor Babbitt took time from a busy schedule to present a conference address demonstrating his understanding of riparian ecosystems both as a scientist and as a politician. Dr. Kusler spent many hours meeting with study groups, contributing both his scientific and legal expertise to aid in the formulation of model draft riparian legislation (see Proceedings Appendix, p. 515) and to address other riparian concerns.

Finally, we thank the speakers at the conference for preparing their papers in camera-ready form to expedite publications of the proceedings. Each contributor is responsible for the accuracy and style of his or her paper. Statements by contributors do not necessarily reflect the policy of the USDA Forest Service or other conference sponsors.

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