Riparian Health
on the
Montana Allotment
August 25-27, 2000

by

William Fleming*

October 6, 2000

* Dr. William Fleming is a hydrologist and associate professor in the Community and Regional Planning Program, School of Architecture and Planning University of New Mexico, Albuquerque, NM 87131.

Summary

1. Eight carefully selected riparian bank sites within the Montana Allotment were found to be in excellent condition using 10 criteria to quantitatively assess riparian health. Six sites were located in Schumacher pasture and two sites were located in Warsaw pasture.

2. Riparian vegetation diversity, bank stability, and streambed geology received an excellent rating at all sites.

3. Canopy shading and width/depth ratio could be improved on a few of the sites.

4. A riparian pasture within Schumacher pasture would permit better control of grazing timing and intensity. It would further facilitate riparian improvement.

5. The Forest Service exclosure had a similar riparian health score (3.6) to grazed areas (3.5 average). This indicates that riparian improvement on some sites can occur as quickly under controlled grazing as under no grazing.

Introduction

In late July Dr. William Fleming was formally contacted by the Chilton Ranch and Cattle Company regarding a survey of riparian health in California Gulch on the Montana Allotment south of Arivaca, Arizona. This grazing allotment is administered by the U.S. Forest Service. It is in a mountainous area with 20-25 inches of average annual rainfall and approximately 4,000 to 4,500 feet in elevation. My survey would focus on Schumacher pasture which contains the bulk of the riparian habitat within the Montana Allotment. I accepted the assignment.

Montana Allotment Description

The Montana Allotment is part of the Coronado National Forest, west of Nogales, Arizona (Holechek and Galt, 1998). Elevations range from 3,500 feet at the Mexican border to 5,376 feet at the summit of Montana Peak. Precipitation varies from 16 to 25 inches annually, with peaks in February and August and a dry season from April through June (Holechek and Galt, 1998).

I characterize the vegetation as Sonoran Desert Chaparral/Grassland. Dominant plant species include various liveoaks (*Quercus emoryi, Quercus oblongifolia*), various cacti (*Ferocactus wislizenii, Opuntia engelmannii, Fouquieria splendens*), side oats grama (*Bouteloua curtipendula*) plains lovegrass (*Eragrostis intermedia*), cane beardgrass (*Bothriochloa barbinodis*), and tanglehead (*Heteropogon contortus*). In riparian areas, deergrass (*Muhlenbergia rigens*), bullgrass (*Muhlenbergia emersleyi*), and giant sacaton (*Sporobolus wrightii*) are dominant grasses while velvet ash (*Fraxinus velutina*), Goodding willow, (*Salix gooddingii*) Bonpland willow, (*Salix*

bonplandiana) netleaf hackberry (*Celtis reticulata*), and yewleaf willow (*Salix taxifolia*) are the primary riparian tree species. Hymenoclea and Baccharis are common in the longer, drier reaches of the California Gulch system. Plant species diversity is quite high with 20 or more species present at most riparian areas.

Several important game animals are found on the survey pastures. They include white-tailed deer, mule deer, cougar, javelina, Mearn's quail, Gambel's quail, white-winged doves and mourning doves. When town of Ruby lakes overflow into the Gulch, bass, catfish, mosquito fish and green sunfish occupy the temporary pools and reaches with water during rainy seasons. Long reaches of California Gulch are usually dry during late spring and often during late fall in years of no fall tropical storms.

The Chiltons have owned the Montana Allotment for more than nine years (since April 1991). Mr. Jim Chilton grew up on a ranch in Arizona and has a lifetime of cattle ranching experience. He holds one M.S. degree in economics and another in political science.

Grazing management on the Montana Allotment involves a modification of the Santa Rita rest rotation grazing system discussed by Martin (1978). This system was initiated on the Montana Allotment in the 1989-90 period after a six-year period of fence building and water development. Under the system used on the Montana Allotment, Schumacher and Warsaw pastures receive only summer grazing (four months) in alternate years. After four months of summer grazing, they receive a 20-month rest period. In the past three years use in Warsaw and Schumacher pastures has been between 32% and 38% (Galt and Holechek 2000) Ruby pasture is grazed each spring and receives light use in the fall of every year as cattle are moved through it to winter range (Chimenea pasture).

Survey Methods

Survey Rationale

In the extensive landscapes of the western United States, there is a strong need for natural resources monitoring so that public agencies and private land owners can make timely land management decisions, regional bodies can make effective growth management choices, and local communities can anticipate the effect of proposed changes in land use. This requires frequent assessments and continuous awareness of changes in the condition of the land. Monitoring techniques should be adaptable to different scales, including the "ecological site" and the "ecological landscape" (Allen 1994).

There are no generally accepted criteria for evaluating and comparing health of riparian ecosystems. Riparian "health" is defined here as a set of environmental conditions that result in the long-term sustainability of the riparian habitat. The quality of the riparian habitat refers to how well it supplies the physical, chemical and biological needs of the organisms living there. Riparian ecosystem structure and function respond to both abiotic and biotic forces. This survey focuses on 10 indicators of riparian health that range from vegetation cover to streambed geology. Each criterion is semi-quantitatively evaluated on a scale of 1 to 4, with 4 the healthiest and 1 the least healthy. This approach is based on riparian survey experience gained by the author in more than 20 watersheds.

Riparian Evaluation Methods

Several authors, such as Barbour and Stribling (1991) and Jacobi et al (1995), have suggested criteria for evaluating the health of riparian habitats in the western United States. Although their criteria are oriented toward stream habitats for fish, their indices can be adapted for a wider range of

organism classes, including birds (e.g., Fleming and Schrader 1998). A riparian environment that is healthy for fish and birds is considered healthy for a wide range of ecosystem organisms (Chiras 1998; Nebel and Wright 1998). Table 1 describes the 10 criteria I consider most useful to evaluate aquatic habitat. In perennial stream systems the amount of flow and types of aquatic insects are included, but for the ephemeral systems like most of California Gulch they are excluded. I will provide a brief discussion of the 10 criteria I used to evaluate riparian health in California Gulch.

Streambed Geology and Embeddedness

Streambed geology and embeddedness are critical for the maintenance of necessary void spaces in the substrate for macroinvertebrate habitat, which need a continuous flow of water, oxygen and food sources (Frissell et al. 1986). Stream reaches are evaluated by walking in a zig-zig pattern, and stopping every two steps to determine the size of material in front of the evaluator's toe (Potyondy and Hardy 1994). If more than 50% of material is comprised of grain sizes in gravel, cobble and boulder categories, the habitat is considered optimal (Barbour and Stribling 1991). At least 20 samples should be selected in each stream reach and size percentages calculated. If more than 50% of the substrate is sand size or smaller, the habitat is considered "poor." Even though a somewhat coarse evaluation, an estimate of the percentage of fine material is considered a valuable indicator of upstream watershed disturbance (Frissell et al. 1986).

Embeddedness measures how much of the surface area of larger substrate particles is surrounded by fine sediment (sand, silt and clay; Platts et al. 1983). This parameter allows an evaluation of the substrate as a habitat for benthic macroinvertebrates and fish spawning (Barbour and Stribling 1991). Heavy silting is an indication of upstream watershed disturbance and is known to cause a reduction in insect diversity and production (Minshall 1984).

Width/Depth Ratio

The ratio of bankfull channel width to depth is optimal for fish and aquatic insect habitat if less than 7:1 (Rosgen 1994). The bankfull channel width is considered to be the width at the top of the bank when full of water which usually occurs once in two year. A very wide and shallow stream with a width/depth ratio of more than 25:1 is considered poor habitat for fish and the macroinvertebrate food supply they depend on (Gibson 1994; Ball 1982). A tape measure and meter stick are used to measure the width and depth of the channel.

Bank Stability

Upper bank stability is considered excellent if less than 10% of the banks are vertical and unvegetated. When more than 50% of their base area is unvegetated banks are considered to be in an unstable and eroding condition. Therefore, it is rated poor (Barbour and Stribling 1991). Streams with unstable banks often have degraded instream habitat for fish and aquatic insects (Plafkin et al. 1989). Steeper banks have greater likelihood for erosion and loss of soil into the stream because they are less likely to support vegetation cover (Ball 1982).

Riffle/Pool Ratio

If the ratio of distance between riffle/pool width is between 5:1 and 7:1, heterogeneity for aquatic insects and fish is optimal. In contrast a ratio of more than 25:1 is considered a poor habitat (Frissell et al. 1986). Since benthic communities thrive as a result of integrated environmental factors (substrate, food availability, current etc.), and species have preferences for alternative substrate types, it follows that maximum variability in streambed morphology should support higher species diversity (Barbour and Stribling 1991). Upstream land use activities can profoundly change pool/riffle relationships, as well as human-caused changes in flood and low-flow discharge (Frissell et al. 1986).

The evaluator uses a tape to measure the average distance between riffles and the width of the channel.

Buffer Width

Vegetative buffer strips are effective in filtering pollutants such as sediment and nutrients from streams. Several authors consider 18 meters of buffer width to be sufficient for many riparian situations (Schueler 1987). Where riparian areas have very steep slopes and/or agricultural runoff with a high fertilizer concentration, a buffer of more than 18m may be necessary. This parameter rates the entire riparian buffer zone on the side of the stream nearest to disruption (road, housing development, row crop, etc.) If the vegetated width is less than 6m, it is considered poor (Barbour and Stribling 1991). A tape is used to measure the width of the least buffered side of the stream reach.

Vegetation

Vegetative diversity is evaluated by determining how many species occur in the riparian area. Twenty or more perennial plant species in the riparian zone is scored as optimum while less than six species is considered poor. The concept of species evenness, or relative proportion of each plant species in the riparian zone, is not considered here, but could be included in future method refinements. Vegetation cover, expressed as a percent, is estimated by randomly choosing a transect direction to walk and noting at every other step either vegetation cover or bare soil. Ninety percent vegetation cover is considered an adequate cover for erosion control, while less than 50% is considered poor (Brooks et al. 1996, Fleming 1998).

Canopy Shading

Shading provided by a vegetative canopy cover is important in reducing summer water

temperatures and as a mediating factor in the solar energy available for photosythetic activity and primary production (Barbour and Stribling 1991; Platts et al. 1983). Shade conditions are considered to be optimal when alternate areas of a stream reach receive direct sunlight, complete shade and filtered light (Barbour and Stribling 1991). The evaluator estimates the percentage of sun and shade by looking upstream and downstream from the middle of the stream reach.

Site Selection

Eight riparian sites were selected for evaluation in Schumacher Pasture (six sites) and Warsaw Pasture (two sites) (Figure 1). Site selection criteria were based around adequately sampling riparian conditions in California Gulch in general as well as those locations of special concern.

Results

The overall riparian score was 3.54 (Table 2). All eight sites were considered to be in excellent condition. Vegetation diversity, bank stability, and streambed geology received a 4 at all sites. Canopy shading and width/depth ratios could be improved on a few of the sites.

Each site was rated for 10 parameters, except for 4 sites with insufficient flow to determine the pool/riffle ratio (Table 2). Although the survey was undertaken during the primary rainy season and period of normal peak flow in these desert grassland washes, most reaches were dry and only four locations had enough water to permit evaluation for all 10 parameters. Numerical ratings were summed for each site and the total divided by the number of parameters evaluated to determine the rating. A site with a score between 3 and 4 was rated "excellent," between 2 and 3 "good," between 1 and 2 "fair," and less than 1 "poor." The eight sites received ratings ranging from 3.2 to 3.7, which are all within the "excellent" category.

Discussion

I have quantitatively evaluated riparian health at several locations in northern New Mexico. I consider the sites I evaluated on the Montana Allotment a real positive standout among all the sites I have evaluated that received livestock grazing. The Chiltons' rest rotation grazing system in conjunction with conservative grazing over the past 10 years apparently has promoted a high degree of riparian vegetation diversity and bank stability as well as excellent streambed geology conditions for the ecological potential of the eight sites. I do believe that creation of a riparian pasture within Schumácher pasture as proposed by the Forest Service could further promote riparian improvement by facilitating the Chiltons' control over grazing intensity and timing. It would also result in more efficient use of upland forage by improving cattle distribution.

My survey indicates that carefully managed grazing can promote a riparian recovery rate equal to grazing exclusion on some sites. The Forest Service exclosure (Table 2) had a similar score to four of the other sites. Overall the grazed areas (7) had a mean score of 3.5 compared to 3.6 for the exclosure.

In conclusion I consider the Montana Allotment to be a primary riparian success story in the southwestern USA. It provides strong evidence that in some situations managed utilization of forage in riparian areas followed by an appropriate regrowth period can lead to rapid riparian improvement.

Literature Cited

Allen, Craig D. 1994. "Ecological Perspective: Linking Ecology, GIS, and Remote Sensing to Ecosystem Management." In Alaric V. Sample (ed.) 1994. Remote Sensing and GIS in Ecosystem Management. Washington, DC: Island Press.

Ball, J. 1982. "Stream classification guidelines for Wisconsin." In Water Quality Standards Handbook, US Env. Prot. Agency, Wash. DC.

Brooks, K.N., Folliet, P., Gregerson, H. and F. Thomas. 1997. Hydrology and the management of watersheds, 2nd ed., Iowa State Univ. Press, 357.

Barbour, M.T. and J.B. Stribling. 1991. Use of Habitat Assessment in Evaluating the Biological integrity of Stream Communities. Biological Criteria: Research and Regulation: 25-38. EPA-440/5-91-005. Washington, DC: Office of Water, US EPA.

Fleming, W.M. 1998. Watershed health: An evaluation index for New Mexico. Rio Grande Ecosystems Toward a Sustainable Future, June 2-5, Albuquerque, 9 p.

Fleming, W.M. and R.E. Schrader. 1998. New Mexico Watershed Watch Handbook. Santa Fe: NM Game and Fish Dept. Special Report, 56 p.

Frissell, C.A., W.J. Liss, C.E. Warren and M.D. Hurley. 1986. Environmental Management 10(2):199-214.

Galt, D. and J. Holechek. 2000. Grazing capacity and range conditions on them Montana Allotment, February 2000. Western Range Consultants, Las Cruces, NM.

Gibson, G.R. 1994. Technical guidance for streams and small rivers: biological criteria. US Environmental Protection Agency Technical report. 822-B-94-001.

Holechek, J.L., R.D. Pieper and C.H. Hervel. 1998a. Range Management: Principles and Practices. 3rd ed. Prentice-Hall Publ. Co., Upper Saddle River, NJ.

Holechek, J.L. and D. Galt. 1998b. Survey of grazing intensity and soil conditions on the Montana Allotment, Chilton Ranch, Arivaca, Arizona: November 6-7, 1998. Consulting report prepared for the Chilton Ranch.

Jacobi, G., J.E. Sublette, S. Hermann, M.D. Hatch and D.E. Cowley. 1995. Development of an index of biotic integrity utilizing aquatic macrobenthic invertebrates for use in water resource and fishery management. NM Dept. Game and Fish Aquatic Resources Report 95-01.

Marlin, S.C. 1978. The Santa Rita grazing system. Proc. Intn'l Rangel. Congr. 1:573-575.

Minshall, G.W. 1984. Aquatic insect substratum relationships. In V.H. Resh and D.M. Rosenberg, eds. The Ecology of Aquatic Insects. Praeger Pub., New York, pp. 323-356.

Oswood, M.E. and W.E. Barber. 1982. Assessment of fish habitat in streams: goals, constraints and a new technique. Fisheries 7(3):8-11.

Pimentel, D. 1995. Soil erosion worldwide. Cornell Univ. Press, 468p.

Plafkin, I.L., M.T. Barbour, K.D. Porter, S.K. Gross and R.M. Hughes. 1989. Rapid bioassessment protocols for use in streams and rivers: benthic macroinvertebrates and fish. US EPA/444/4-89-001.

Platts, W.S., W.F. Megahan and G.W. Minshall. 1983. Methods for evaluating stream, riparian and biotic conditions. Technical Report IN-138, US Forest Service, Ogden, Utah.

Potyondy, John P. and Terry Hardy. 1994. Use of Pebble Counts to Evaluate Fine Sediment Increase in Stream Channels. Water Resources Bulletin, v. 30, no. 3.

Rosgen, D. 1994. River restoration utilizing natural stability concepts. Land and Water, July/Aug: 36-40.

USDA, 1974. Rainfall intensities. Soil Conservation Service Ag. Bull. 568.

Figure 1. Riparian sites (* Vernon Dale R) and upland soil loss sites (e.g. x site 1) in Schumaker Pasture, September 2000.

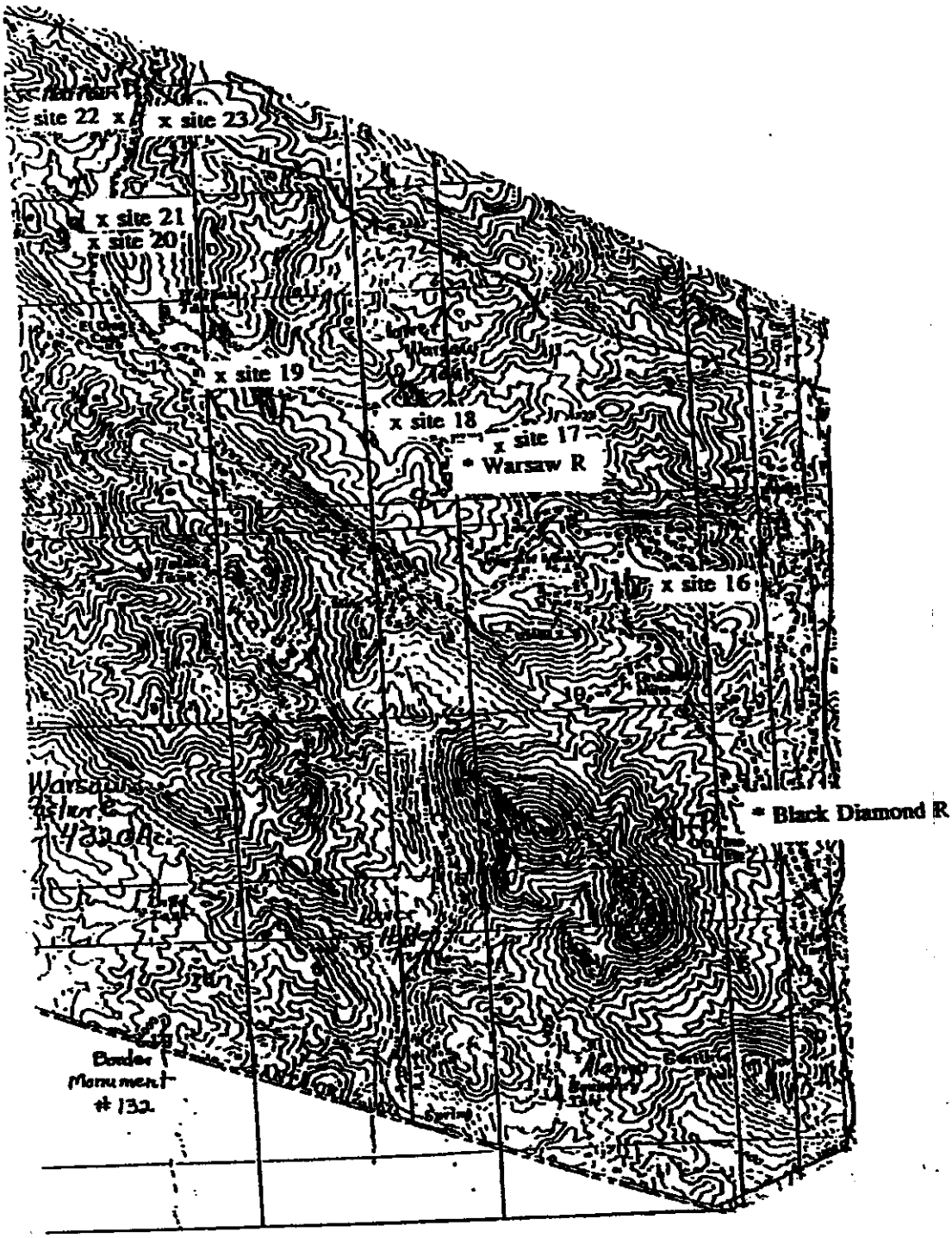

Figure 1 (continued). Riparian sites (* Vernon Dale R) and upland soil loss sites (x site 1) in Warsaw Pasture, September 2000.

Table 1. Description of riparian health indices used to evaluate the Montana Allotment on August 25-27, 2000 by William Fleming.

Parameter Score	Excellent 4	Good 3	Fair 2	Poor 1
Riparian vegetation structural diversity	3 height class grass/tree/shrub	2 height classes	1 height class	sparse vegetation
Bank stability	>90% stable	50-90% stable	10-50% stable	<10% stable
Bank cover	>90%	70-90%	50-70%	<50%
Buffer width	>18 m	12-18 m	6-12 m	<6 m
Vegetation diversity	>20 species	15-20	5-14	<5
Embeddedness	<25%	25-50%	50-75%	>75%
Canopy shading	mixed/sun shade	sparse canopy	90% sun or shade	no shade
Width/depth ratio	<7	8-15	16-25	>25
Pool/riffle ratio	<5	6-15	16-25	>25
Streambed geology	>50% boulders cobbles, gravel	25-50%	10-25%	<10%

Table 2. Riparian health scores for 8 sites on the Montana Allotment on September 15-17, 2000.

Site	Vernon Dale	Tinaja*	Casa Piedra	Forest Service Exclosure	California Gulch	Lower** Tinaja	Black Diamond	Warsaw
Parameter								
Riparian vegetation structural diversity	4	4	4	4	4	4	4	4
Bank Stability	4	4	4	4	4	4	4	4
Vegetation Cover	3	4	3	3	2	3	3	2
Buffer Width	3	4	4	4	4	4	4	4
Vegetation Diversity	4	4	4	4	4	4	4	4
Embeddedness	4	3	3	3	3	3	3	3
Canopy Shading	4	3	2	4	2	3	4	3
Width/Depth Ratio	4	3	3	2	2	3	3	3
Pool/Riffle Ratio	3	4	3	4	n/a	n/a	n/a	n/a
Streambed Geology	4	4	4	4	4	4	4	4
Score	**37**	**37**	**34**	**36**	**29**	**32**	**33**	**31**
Score/#parameters	**3.7**	**3.7**	**3.4**	**3.6**	**3.2**	**3.6**	**3.7**	**3.4**
Rating	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**

* Tinaja site is in a grazed area above the Forest Service Tinaja exclosure

** Lower Tinaja site is located down stream from the Forest Service Tinaja exclosure.