10 Steps To Evaluate Rangeland Riparian Health

These steps provide a simple, semi-quantitative guide for evaluating riparian health.

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In the widespread landscapes of the western United States there is a need for natural resource monitoring systems that allow ranchers, government agencies and private land owners to make land management decisions. There are no generally accepted and easily applied criteria for evaluating and comparing health of riparian ecosystems.

Riparian habitat quality measures how well it supplies various ecosystem functions, services and products. We have developed and tested a survey that focuses on 10 indicators of riparian health. These 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 authors and several riparian professionals.

In this article, we'll look at our 10 basic indicators of riparian health and demonstrate their application on the Montana Allotment in southeastern Arizona (See "A Grazing Success Story," page 24.)

Riparian Evaluation Methods

Several criteria for evaluating the health of riparian habitats in the western United States have been suggested by researchers in the past. Although these criteria are often oriented toward stream habitats for fish, they can be adapted for a wider range of organism classes, including birds. A riparian environment that is healthy for fish and birds is considered healthy for a wide range of other ecosystem organisms.

The 10 criteria we consider most useful to evaluate aquatic habitat are described in Table 1. The amount of flow and types of aquatic insects are included in perennial stream systems. Let's discuss these criteria:

1 & 2) Streambed Geology and Embeddedness— Streambed geology plays a critical role in maintaining a continuous flow of water, oxygen and food sources for various organisms. Stream geology can be 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. If more than 50% of material is comprised of gravels, cob-

Table 1. Description of health indices used to evaluate riparian habitat.

Parameter / Score	Excellent 4	Good 3	Fair 2	Poor 1
Riparian vegetation Structural diversity	3 height classes grass/tree/shrub	2 height classes	1 height class	sparse vegetation
Bank stability	>90% stable	50-90% stable	10-50% stable	<10% stable
Vegetation 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 shade	90% sun or	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, gravels	25-50%	10-25%	<10%

bles and boulders, the habitat is considered optimal. 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". If more than 50% of the substrate is gravels, cobbles and boulders the habitat is considered "excellent".

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

3) Width/Depth Ratio—The ratio of channel width to depth is optimal for fish and aquatic insect habitat if less than 7:1. 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. A tape measure and yard stick are used to measure the width and depth of the channel.

4) Bank Stability—Bank stability is considered excellent if less than 10% of the banks are vertical and unvegetated if not rock ledges. If more than 50% of bank area or length is in unstable and eroding condition, it is rated poor as this indicates degraded habitat for fish and aquatic insects.

5) Pool/Riffle Ratio— Optimal riffle to stream width values for aquatic insects and fish are given in Table 1. Aquatic communities thrive in an integrated environment (substrate, food availability, current, etc.). Maximum variability in streambed morphology generally supports highest species diversity. Upstream land use activities can profoundly change pool/riffle relationships. The evaluator uses a tape to measure the average distance between riffles and the width of the channel.

6) Buffer Width—Vegetative buffer strips are effective in filtering pollutants such as sediment and nutrients from streams. Twenty yards of buffer width is sufficient for healthy riparian conditions. Where riparian areas have very steep slopes and/or involve heavily fertilized agricultural runoff, a wider buffer may be necessary. The entire riparian buffer zone on the side of the stream nearest to disruption (road, housing development, row crop, etc) is measured. If the vegetated width is less than 20 feet, it is considered poor.

7 & 8 & 9) Vegetation Characteristics—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 considered optimum while less than six species is poor.

Vegetation cover, expressed as a percent, is estimated by randomly choosing a transect direction to walk and noting at toe point on every other step either live vegetation cover, litter, or bare soil. Greater than ninety percent vegetation cover is considered excellent for erosion control, while less than 50% is considered poor.

10) Canopy Shading—Shading provided by vegetation canopy cover is important in reducing summer water temperatures and mediating solar energy available for photosynthetic activity and primary production. Shade conditions are considered to be optimal when alternating areas of a stream reach receive direct sunlight, complete shade and filtered light. The evaluator estimates the percentage of sun and shade by looking upstream and downstream from the middle of the stream reach. The optimal is 50% of the stream receiving shade. Noon is the ideal time to do this survey.

Upland rangeland in excellent condition on the Montana Allotment in October 2000. In the period from 1984 to 2000 upland ecological condition has shown major improvement from a combination of conservative stocking, rest rotation grazing and improved livestock distribution.

The Montana Allotment: A Grazing Success Story

In late summer 2000, the authors were invited to do evaluations on the Montana Allotment focusing primarily on riparian conditions. Eight sites were selected for evaluation in California Gulch, the primary drainage on the Montana Allotment. Five sites were randomly selected and another three sites were chosen because they are used for monitoring by Forest Service biologists.

The Montana Allotment is located on the Coronado National 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 five 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, Mearn's quail, Gambel's quail, white-winged doves and mourning doves. The four 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 fall months and are not suitable year-long habitat for fish. However, the Sonora shrub 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 six-year period of fence-building and water development made possible the change from a two-pasture, yearlong continous 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 seven 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 five 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 16 years based on various surveys by range consultants and Forest Service range conservationists (Table 2). A significant shift in composition from short grasses (curly mesquite) to more productive, palatable midgrasses (sideoats grama) has occurred over the period from 1984 to 2000 (Table 2). 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 (Table 2) 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.

Table 2. Precipitation, stocking level, forage production, grazing use, and rangeland ecological condition on the Montana Allotment for the 1984-2000 period.[1]

	1984	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Precipitation (inches/year)	27.74	15.56	19.43	27.57	22.63	18.54	17.30	16.00	28.25	16.35	14.00
Actual cattle animal unit years	—	125	400	490	490	492	495	491	500	476	380
Fall perennial forage standing crop (lbs/acre)	—	—	—	—	—-	—	1,005	—-	—	986	—-
Forage use % (across all pastures)	—	—	—	—	—	—	—	—	23	23	25
Forage use % (grazed pastures)	—	—	—	—	—	—	—	—	36	35	38
Range ecological condition scores	21	—	—	—-	—	—	68	—-	—	69	—-

[1]Data from Forest Service range monitoring reports and range consultant reports (Holechek and Galt 1998, Galt and Holechek 2000).

Riparian Survey Results We applied the riparian health evaluation protocal described in the Flemming et al. "10 Steps" article in this issue to the Montana Allotment in southeastern Arizona over a two day period, and all eight sites were found to be in good to excellent condition (Table 3). The average riparian score was 3.54 (excellent). 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. Significant numbers of riparian tree recruits were observed. These included various willow species, ash, and cottonwoods.

Each site was rated for 10 parameters, except for 4 sites with insufficient flow to determine the pool/riffle ratio (Table 3). 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 3.5 and 4 was rated "excellent," between 3.0 and 3.5 "good," between 2.0 and 3.0 "fair," and less than 2.0 "poor." The eight sites received ratings ranging from 3.2 to 3.7, which are all in good or excellent categories.

We have quantitatively evaluated riparian health at several locations in the southwestern USA. The Montana Allotment is a positive standout among all the sites we have evaluated that received livestock grazing. The rest rotation

Table 3. Riparian health scores for 8 sites on the Montana Allotment on September 15-17, 2000.

Riparian Characteristic	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	*	*	*	*
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	Good	Excellent	Good	Excellent	Excellent	Good

*Stream dry.

grazing system in conjunction with conservative grazing over the past 10 years has promoted a high degree of riparian vegetation diversity and bank stability as well as excellent streambed geology conditions on the 7 grazed sites.

Our survey indicates that carefully controlled grazing may promote the same rate of riparian improvement as grazing exclusion on some sites. The Forest Service exclosure (Table 3) had a similar score to four of the other sites. Overall the seven grazed areas had a mean score of 3.5 compared to 3.6 for the exclosure. The Forest Service exclosure was in the grazing rotation until July 1998.

Range management effectiveness is based on ecological condition, trend, grazing intensity and grazing capacity (Holechek et al. 2001). Using these criteria, we consider the Montana Allotment to be a primary grazing management success story in the southwestern USA (Tables 2 and 3). Quantitative data and photographic records (Figure 1 and 2) collected by various range professionals on the Montana Allotment show both upland and riparian areas across the allotment to now be in high ecological condition.

A very strong upward trend has occurred over the past 16 years. Grazing intensity levels across the allotment have been light to conservative. A major increase in grazing capacity has occurred. Recent quantitative watershed health surveys have rated soil stability and water quality excellent across the Montana Allotment. Qualitative surveys by Holechek and Galt made these same observations.

The Montana Allotment case study provides strong evidence that rapid upland and riparian health improvement can occur under controlled grazing in the southwestern USA. The key features of the strategy on the Montana Allotment are that upland areas are managed for conservative use and a combination of herding, salting and strategic access to water results in uniform livestock distribution.

Alternate year summer grazing of Schumacher and Warsaw pastures, at conservative to moderate intensities, has been highly effective in promoting cover and biomass increases of desirable grasses and shrubs. Summer grazing of the two riparian pastures in alternate years accounts for part of the success. During the summer green grass and water are plentiful in the uplands which reduces cattle preference for the riparian lowlands. Alternate year grazing of each pasture facilitates tree recruitment and allows those plants that are intensively grazed to fully recover. Well-distributed water in upland areas in conjunction with herding has also greatly facilitated range improvement.

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Photo ID for page 22

Riparian habitat in excellent condition in California Gulch on the Montana Allotment in September 2000. A combination of conservative utilization and rest rotation grazing has given high rate of increase of desirable riparian grasses and woody plants.