A Cross-Sectional Survey of California's Grazed Rangeland Ripairan Areas. A Preliminary Report

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ABSTRACT. There is significant concern about grazing impacts on rangeland riparian resources. The scientific literature shows that improper, and often undefined, grazing leads to negative impacts on rangeland riparian resources. Unfortunately, the literature does not provide a tool-box of field-tested, practical, and economically feasible grazing management recommendations to safeguard riparian resources. We are conducting a survey of 300 rangeland riparian areas across California to collect a consistent data set allowing identification of site by management combinations correlated with high and low riparian health scores. Data on over 200 variables has been collected at each site and can be grouped as: 1) EPA, NRCS, and BLM riparian health assessment scores, 2) site characterization variables, and 3) management and costs. Currently, assessments of 149 sites have been completed. There is a significant relationship between NRCS outcome score and Rosgen stream type ($p<0.001$, $R^2 = 0.25$). Indicating that riparian health, as measured by these common methods, depends upon the physical stream features defining Rosgen classification. Preliminary analysis also indicates that stream response to management varies by Rosgen type. For instance, person days per year spent fencing ($p=0.04$), days livestock allowed in pasture ($p=0.007$), and presence or absence of off-site water ($p=0.05$) were significant predictors of NRCS riparian health score for C streams, but not for A or G streams. We will continue to enroll sites in this project over the next year.

INTRODUCTION

Concerns about livestock and riparian "health" include grazing impacts on riparian vegetation, stream channel stability, water quality, channel morphology, streambanks, and habitat (Fleishner, 1994; Belsky, et al. 1999; Rinne, 1999). The concerned manager's question is ***What grazing system(s) will safe-guard riparian values, yet allow for economic use of the range resource?***

One would like to turn to the published literature for answers. The literature concerning the effects of grazing on riparian areas is extensive. However, various reviews have found the literature surprisingly lacking in examinations of "proper" grazing management in functioning riparian areas, as well as in scientific rigor (Allen-Diaz et al., 1999; Rinne, 1999; and Larsen et al., 1998). Larsen et al. (1998) evaluated 428 publications relating grazing to riparian areas and habitat. Of these, 248 contained original data and only 89 of those were experimental. The remainder were case studies, observational based reports, abstracts and posters. Three recurrent problems identified in the literature were: 1. Inadequate description of grazing; 2. Weak study designs; and 3. Lack of pre-treatment data. Reviewing the literature relevant to grazing in the Sierra Nevada, Allen-Diaz et al. (1999) agreed with Larsen et al. (1998), and found that many authors failed to give adequate study site descriptions. Much of the work has compared livestock grazing to livestock exclosure (no grazing). Often, grazing (stocking rate, species, timing, frequency, etc.) is not defined adequately enough to allow replication or application of the experiment. These problems make it difficult to interpret and apply much of the existing literature to answer the manager's question on a site-specific basis. It is clear from the literature that improper grazing does degrade riparian resources. What is not clear is a tool-box of tested proper grazing management recommendations and grazing impact assessment methods that can be adopted for use by on-the-ground managers.

Another logical place to look for answers is to examine existing riparian grazing sites across California's rangelands. In cooperation with landowners, managers, UCCE Advisors, California Cattleman's Association, California Farm Bureau Federation, CDFFP, USDA-FS,

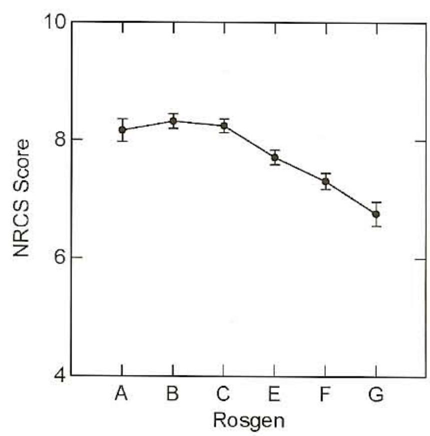
FIGURE 1. Sites located across the State indicated by stars.

USDI-BLM, and USDA-NRCS we are currently conducting a state-wide cross-sectional survey to: 1) identify and quantify grazing management and site characteristics associated with high and low "riparian health" or habitat quality; 2) analyze and synthesize data for site specific recommendations; 3) extend this information to grazing managers and; 4) develop a set of case studies to evaluate our recommendations over time. The objectives of this paper are to: 1) report on the preliminary results of this project; 2) generate interest in the conference participants and readers to capitalize on the knowledge base available on real world grazing systems.

METHODS

Study sites for this survey are located through out California, with a concentration in the Sierra Nevada Mountains (Figure 1). Each site consists of a 100 meter stream reach within a management unit, i.e. a pasture, allotment, or exclosure. Three riparian health assessments are completed on each reach according to the published protocols for each assessment method. The assessments employed in this survey are US EPA's Rapid Bioassessment (Barbour et al., 1999), USDA NRCS's Stream Visual Assessment (NRCS, 1998), and USDI BLM's Proper Functioning Condition (BLM, 1998). The EPA and NRCS assessments both examine aquatic habitat while BLM's assessment determines hydrologic function. Vegetation, habitat, and stream channel features of each site are characterized, and a management survey is completed with the on-the-ground manager to quantify historic and current management. The database being compiled is extensive, comprised of 162 independent variables (site characteristics and management), and 45 dependent variables (combined number of health questions as well as individual outcome scores). We currently have data for 149 sites. Our goal is to complete 300 sites by June 2002. Multivariate regression analysis, logistic regression, and Analysis of Variance (ANOVA) are being used to identify management practice by site characteristic combinations that are significantly related to high and low riparian health assessments (for this report, NRCS scores 0 = low health, 10 = high health). For this preliminary report, we examined the relationship of NRCS outcome score to Rosgen stream type. Because of the inherent differences between Rosgen stream types, it is necessary to account for the variance between stream types by grouping (blocking) the same stream types together for the evaluation of riparian health and analysis of data. Regression analysis of three management practices (the presence or absence of off-site water, number of days per year livestock are in the management unit, and the days per year fencing in that management unit, which may include maintenance and temporary fencing (electric or let down fences)) was examined to predict NRCS outcome. These management measures were selected because they represent fairly simple practices which conventional wisdom suggests will affect riparian health (positively or negatively). Again, analysis was performed by grouping for Rosgen stream type to evaluate the affect riparian grazing management will have on

FIGURE 2. ANOVA and mean separation by Rosgen classification for NRCS outcome score. Stream types A, B, and C are not significantly different from each other, while E, F, and G stream types are significantly different from each other and from A, B, and C streams ($p<0.05$).



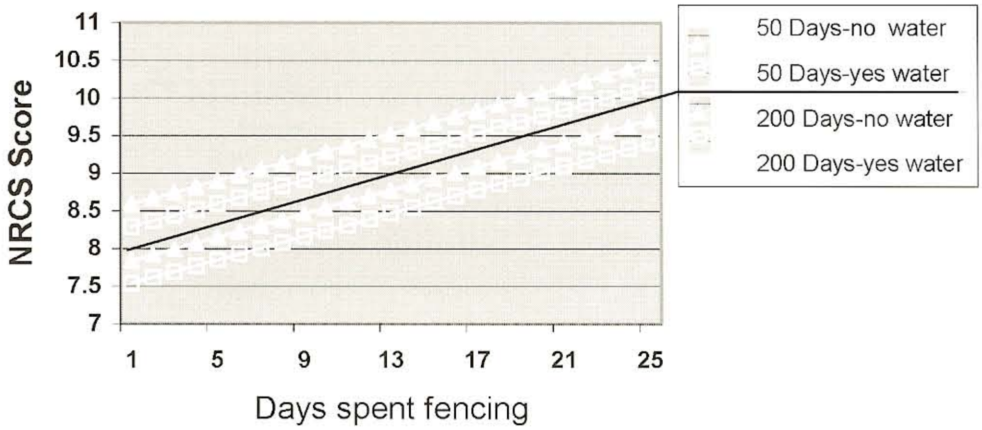


FIGURE 3. ANOVA model for C Streams displaying NRCS outcome score affected by days spent fencing, days livestock in the pasture (either 50 or 200 days per year), and absence or presence of off-site water.

riparian health. The three Rosgen types that were analyzed include A (high gradient, stable, mountain streams), C (valley streams with large floodplains), and G (degraded streams still actively eroding).

RESULTS

Preliminary analysis indicates that there is a significant relationship between NRCS score and Rosgen type ($p<0.001$, $R^2=0.25$) (Figure 2). ANOVA and mean separation indicate that NRCS outcome score for A, B, and C streams are not significantly different from each other ($p<0.05$), but they are significantly different from E, F, and G streams. E, F, and G streams are significantly different from each other and A, B, and C streams. Figure 2 illustrates that as stream type moves from G to F to E the mean NRCS score increases. This relationship makes biological, ecological, and hydrological sense because the gradient from E to F to G stream type represents a gradient from a hydrologically functioning to a degraded stream channel. As streams degrade it should be expected that they will have different habitat potentials, with stable systems having greater riparian health (Figure 2). Higher mean NRCS outcome scores for A, B, and C streams is also expected because the NRCS assessment keys strongly off of in-stream habitat features such as substrate types. The gravel and cobble substrate of A, B, and C streams insures they will get a higher NRCS outcome score than E, F, and G streams that are dominated by fine substrate materials. This result indicates the need to use multiple assessments to provide a holistic evaluation of riparian health. It also indicates that care must be taken when making comparisons of riparian health across stream types.

For this preliminary report, only Rosgen stream types A, C, and G are examined further. Results of regression analysis using ANOVA to predict NRCS outcome score are shown in Table 1, including significant p values for each independent variable in the model, overall model adjusted R_2, and sample size. While we would not propose that these preliminary models provide grazing recommendations, our sample size is far too small and our data set is currently skewed towards sites with high riparian health scores, they do illustrate some important points at this stage of the project. The results indicate that there is a gradient of NRCS outcome score response to these grazing management measures, moving from A (least responsive) to G to C (most responsive). This gradient follows conventionally wisdom, and indicated that evaluation of management affects on riparian health (positive or negative) should account for stream type differences. None of the three management measures were significantly related to NRCS outcome score for the A streams thus far enrolled in the project. A streams are inherently stable and would be the stream type least responsive to grazing impacts (positive or negative). All three of the management measures where related to NRCS outcome score for the C streams enrolled in the project at this point (Figure 3). One would expect the lower gradient, herbaceous/woody dominated C type streams in our survey to be responsive to the impacts of grazing management (positively or negatively). The negative coefficient for days pasture is grazed and the positive coefficient for days spent maintaining fencing in the pasture are as conventional wisdom would expect. Days spent fencing is a measure of active on the ground grazing management and days pasture is grazed is a component of the grazing pressure imposed on the stream. However, the increase in NRCS outcome score due to the absence of off-site water goes against conventional wisdom. Again, our sample size is currently too small and our data set too heavily weighted with high riparian health score sites to make strong conclusions. Also, covariates such as the distance of off-site water from the stream must be included in the analysis.

TABLE 1.

Stream Type	Constant	Days in Unit coefficient	Off-site water constant (Yes : No)	Days/yr fencing coefficient	R^2	n
A	8.05	-0.005 ns	0 : -0.09 ns	0.02 ns	0.03	11
C	8.46	-0.01 (0.007)	0 : 0.30 (0.05)	0.08 (0.04)	0.39	27
G	6.62	0.001 ns	0 : 0.32 ns	0.02 (0.03)	0.64	9

Only days spent fencing was a significant predictor of NRCS outcome score for the G streams currently enrolled in the survey. As days spent fencing increases, so does the NRCS outcome score. G streams are streams that have suffered some recent, massive disturbance (flood, channelization, etc.) and are essentially gullies. These streams must transition through F to E types as they recover. One would expect these stream types to be less sensitive to grazing management than C streams, and more sensitive that A streams.

The variability that exists in these systems requires a large sample size if reliable relationships between management, site, and health are to be established. The case is made even more difficult with the need to group by Rosgen type. The variability displayed in Table 1 also indicates that caution should always be employed in interpreting and applying the results of experiments examining riparian health response to grazing (positive or negative) as these results will be site specific.

CONCLUSION

We have shown that there are underlying stream physical characteristics that affect assessment outcomes and stream response to grazing management. It appears that this can be accounted for by grouping for Rosgen type, since Rosgen is a classification system that encompasses much of the variability resulting from these physical stream components, such as substrate, channel slope, channel width to depth ratio, etc.

Our experience from surveying approximately 150 sites is that quantifying riparian health, riparian grazing, and riparian characteristics on real world range systems is complex and not at all straightforward. Most land managers are not familiar with textbook definitions of grazing systems or range science terminology, and most are not applying grazing management practices as they are defined, researched, and published by range scientist. It is clear to us that an important step in the process of identifying grazing management that "safe-guards riparian health, yet allows for economic use of range resources" is for more collaborative efforts between applied scientists and on-the-ground grazing managers.

The power of this project is that it attempts to use scientific methods to capture knowledge from real world riparian grazing experimental units to provide managers with site-specific recommendations to improve riparian health. Our main task over the next year is to significantly increase our sample size, and to specifically target sites with low riparian health scores across Rosgen type. After the database is completed and analyzed, an economic survey will be conducted with a sub sample of the sites, in an attempt to quantify the cost of grazing practices positively correlated to riparian health. Approximately twenty case studies will be established and baseline data collected to provide long term conformation of grazing recommendations developed from this survey. The information that we gather from this project will be extended through existing programs, such as the UCCE/NRCS Ranch Water Quality Short Course, as well as through a *Handbook of Riparian Grazing*, and published in an applied scientific journal.

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