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Comparison of two riparian assessment surveys : Proper Functioning Condition and the New Mexico Watershed Watch Riparian Survey

Katherine A. Smith

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A Professional Project Report Submitted in Partial Fulfillment of the Requirements

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Committee Approval

The Master of Water Resources Professional Project Report of **Katherine Ann Smith** is approved by the committee:

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Abstract

Riparian areas perform functions which in turn provide economic and environmental benefits. Many of the riparian areas in the Southwest are in degraded states. There is a need to determine the health of these ecosystems, in order to decide which need rehabilitation or restoration. Long term monitoring is necessary to assure projects are progressing towards goals, and prevent further degradation in response to new disturbances.

Two riparian assessment surveys currently in use are the Proper Functioning Condition (PFC) and the New Mexico Watershed Watch Riparian Survey (NMWWRS). The PFC tool is a qualitative method utilized by government agencies such as the BLM and the Forest Service. The NMWWRS combines quantitative and qualitative measurements and is currently used by students and community members. The surveys are used to gather information regarding vegetation and geomorphology. The NMWWRS also includes parameters for stream flow and macroinvertebrates.

This study compares the author's results of these two surveys as well as the results for the PFC method as determined by BLM and Forest Service riparian specialists on 15 stream reaches in New Mexico. The evaluations using the two methods resulted in similar ratings for all 15 reaches. The BLM and Forest Service PFC ratings were on average a category higher (of three categories possible) for the Forest Service sites and one to two categories higher for the BLM sites, as compared to the author's ratings.

Differences were attributed to the varying training of the researchers, along with different interpretations of the criteria for the surveys, as stated in the manual. Additional problems were the lack of reference sites or historical information that contributes to knowledge of potential of a site when available. It was concluded that the BLM and Forest Service agents were not able to perform PFC as was intended for the evaluation. Training time was non-existent or a few hours, rather than the three days specified. Prioritization for restoration sites was not carried out as recommended in the PFC protocol. Constraints of time and staffing prevented the collaborative assessments by the required four person team.

Utilizing the NMWWRS may be an alternative "rapid bioassessment" tool for agencies. Training takes one hour. Initial assessments could be performed by teams comprised of both professionals and community members, with ongoing monitoring carried out by community members, providing more timely and dependable assessments.

Introduction

Riparian areas are transition zones between terrestrial and aquatic ecosystems. Riparian health is reflected in the quality of the aquatic ecosystem. Riparian vegetation provides habitat, bank stability, flood attenuation and improved water quality. Impacts from human activities have altered the structure and function of these areas. Bioassessment procedures are needed to determine current conditions, provide the groundwork for remedial actions, and evaluate progress of projects through long term monitoring.

As watershed boundaries for streams cross public and private lands, assessment methods are needed for both areas. Declining funding for federal and state environmental evaluations limits the abilities of management agencies to assess and monitor riparian zones within their jurisdictions. Community members and students can be trained to evaluate and monitor stream and riparian ecosystems, while working in cooperation with employees of the management agencies. One value in community based science is the basic education obtained in the process. Routine monitoring also provides the opportunity to voice local concerns about environmental disruption, while providing reliable data to managers (Heiman, 1997). This study compares the results of stream assessments, utilizing two methods. One method requires more technical knowledge and is currently performed by government agencies. The other method is carried out by high school students and community members. The study also looks at results obtained on the same stream sites by Forest Service and Bureau of Land Management (BLM) assessments, compared to the author's evaluations of the sites.

Description of Riparian Areas

A riparian area is the area that parallels the edges of all stream channels and lakes (United States Department of the Interior, 1998). It is a transition zone between aquatic and terrestrial habitats, where the water is usually at or near the land surface. The terrestrial system through which the stream flows rules the stream in many ways. Lithology determines the components of the soil, the availability of ions, and the slope of the valley (Hynes, 1975). The soil and climate determine the vegetation, and the vegetation supplies the organic matter for stream organisms at the bottom of the food chain. The height and density of the vegetation determine the amount of shading for the stream, and thus the water temperature and chemical reactivity, as well as the types of plants and algae that grow in the water.

The roots of trees, shrubs and forbs hold the soil together to resist the erosive force of flowing water. Roots and fallen logs slow stream flow, providing additional protection against erosion, while creating pools that form microenvironments for insect and fish habitat. Debris from riparian vegetation slows and traps sediments in surface runoff, giving nutrients time to infiltrate into the ground, where they may be stored or removed by microbial action or vegetative growth. Nutrients are recycled from the stream, back uphill, in the form of biomass, such as emergent insects, or as food eaten by those animals who occupy or traverse the riparian zone. Thus, the riparian forest, created from the climate and soil, maintains the structural and functional integrity of the stream.

Functions and Degradation

As described previously, riparian areas perform many functions which in turn provide economic and environmental benefits. They reduce floodwater size and destructiveness; provide water storage during floodpeaks, allowing slow recharge to the aquifer; improve water quality by filtering or absorbing nutrients or contaminants; provide habitat for fish, waterfowl, and other animals, as well as migration corridors, thereby increasing biodiversity; and support both recreational and educational activities (NMED, 1999).

The Environmental Protection Agency estimates that there are 108,000 miles of perennial or intermittent streams in New Mexico (NMED, 1999). The state of New Mexico has determined that 3,400 miles are impaired by water pollution. Twenty-one of New Mexico's 83 watersheds have enough data compiled to make an assessment. All 21 are listed in Category 1 of the Unified Watershed Assessments as being in need of restoration (NMED, 1999).

The decline of healthy riparian areas has resulted from numerous human activities. Overgrazing, logging, mining, changing of fire regimes, trapping and near extermination of beavers, railroad and road construction, impoundment of water for flood control, agriculture, and municipal water supply, and spread of urbanization, are all contributing factors to riparian degradation.

Given the desirable functions and benefits of a healthy riparian system, and the current state of New Mexico's streamside ecosystems, it follows that many measures are being initiated to improve the situation.

The Need for Riparian Assessment

The New Mexico Environment Department (NMED) identifies the need for "integration and understanding of approaches (*utilized in assessing riparian areas*) to expand the knowledge of wetland/riparian areas" (NMED, 1999). They further state that the Environmental Protection Agency (EPA) recently encouraged research and monitoring that would lead to the restoration and biological integrity of wetlands and riparian areas.

Among the listed approaches currently used by both state and federal agencies is the *Proper Functioning Condition* (PFC) assessment tool. This was developed by the Bureau of Land Management (BLM), the Fish and Wildlife Service (FWS), and the Natural Resources Conservation Service (NRCS) in 1988. However, limitations of economics, time and infrastructure often prevent government agencies from assessing and monitoring riparian zones that lie within their jurisdiction on an ongoing basis.

The *New Mexico 2000 Wetlands Conservation Plan* states the desire to "develop a riparian habitat analysis technique that can be used by anyone (especially private land owners) interested in knowing the condition of a specific riparian habitat" (NMED, 1999). The NMED proposes that actively engaging stakeholders in providing ongoing assessments of riparian areas would encourage the existence of statewide and regional watershed groups to work together on issues related to water quality and uses (NMED,1999). The PFC method is taught to ranchers to assess and monitor areas on private land and on their grazing allotments, but there are concerns that this method may be too technical to be used by researchers with insufficient scientific backgrounds or experience (Deason, 2000).

Another analytical tool currently in use is the *New Mexico Watershed Watch Riparian Survey* (NMWWRS*)* (Fleming and Schrader, 1998). This method is one of four utilized to assess the health of a watershed. The survey may be used as a "rapid bioassessment" of a riparian area, in order to characterize its ability to support a healthy and productive aquatic ecosystem (Fleming and Schrader, 1998). It was designed to provide an assessment of the biological condition of a riparian area in comparison to a reference site from a similar stream order within a particular watershed. The reference site should have the characteristics of a riparian area that is not degraded. The PFC method similarly recommends that potential functionality of a site be determined from comparison with similar sites. "Potential" is the highest ecological status a riparian area can attain. In areas where no site exists that has not been degraded, it is recommended that historic photos or documents be researched to determine past condition. Fleming and Schrader (1998) state that the NMWWRS may be used without a reference site, as long as the user recognizes that the interpretations may be limited by the lack of knowledge about the biological potential of the area.

Comparing Professional and Community-based Riparian Assessments

The study covered in this report compares the results of assessing stream reaches utilizing the PFC and the NMWWRS. Data were collected by Robin Just and myself, both students in the Water Resources Program at the University of New Mexico, during the fall of 1999. Ms. Just and I were trained in PFC by Gilbert Borrego, the riparian specialist for the New Mexico State Land Office. We were introduced to the NMWWRS by participating in Dr. Fleming's *Watershed Management* class at the University of New Mexico. The purpose was to discover if the NMWWRS, currently used by New Mexico high school students as part of the *New Mexico Watershed Watch Program*, provided comparable assessments of streams with the PFC, which calls for an investigative team of four professionals. This report compares our results with those from the Forest Service and BLM, and addresses the issue of bias, as government agencies may be reluctant to challenge the organization that employs them or entities that contribute funding to their agencies.

The assessed sites are located in the Santa Fe National Forest, northeast of the town of Cuba, and within the Albuquerque District's BLM lands, predominately along the Rio Puerco. All sites were intended to be assessed by the end of 1999, or had already been evaluated by the management agency. These results were not reviewed until after our comparative reports were compiled.

The PFC method is a qualitative analysis, while the NMWWRS combines both quantitative and qualitative information. Thus, the two methods could not be directly correlated. Instead, ratings were assessed for each site and examined to determine if they fell into similar general categories. The ratings and resulting actions will be addressed in the sections specific for each method.

New Mexico Watershed Watch Riparian Survey

The NMWWRS is one of four methodologies utilized to assess the health of a watershed. It was adapted from a set of criteria used to evaluate stream health in terms of fish habitat, in order to include a wider range of species such as aquatic macroinvertebrates (Fleming, 1999). The twelve indices evaluated are shown in the following table. Each parameter is scored with a rating of 1 to 4, where 4 is optimal, 3 is sub-optimal, 2 is fair and 1 is poor.

Parameter	Optimal 4	Sub-optimal 3	Fair 2	Poor 1
Riparian Veg. Structural Diversity	>3 height classes grasses/shrubs/trees	2 height classes mostly trees	1 height class grass/forb	1 height class sparse veg.
Lower Bank Stability	Stable, no erosion	Some erosion	Unstable/erosion	Unstable/eroding
Bank Cover	90% cover	70-89% cover	50-69% cover	< 50% cover
Veg. Buffer Width	>18 meters	12-18 meters	6-12 meters	<6 meters
Veg. Diversity	> 20 plants species	15-19 plant species	5-14 plant species	0-5 plant species
Embeddedness	Substrate surrounded by <25% fine sediment	25-50%	50-75%	>75%
Flow m3/sec Cfs Cold vs. warm	>0.05 (2cfs) >0.15 (5cfs)	0.03-0.05 (1-2) 0.05-0.15 (2-5)	0.01-0.03 (0.5-1) 0.03-0.05	<0.01 <0.03
Canopy Shading the Water	Mixed sun and shade	Sparse canopy Filtered light	Nearly complete sun or shade	No shade Complete sun
Width to Depth Ratio of Lower Bank	<7	8-15	15-25	>25
Pools to Riffle Ratio	5 to 7	7-15	15-25	>25
Streambed Geology	> 50% bolders, cobbles, gravel or logs	25-50	10-25	<10%
Benthic Invertebrates	Mayflies, stoneflies, caddisflies (dominant)	Mayflies and caddisflies	Midges, mayflies, or caddisflies	Midges and others (no stone., may., or caddisflies)

Table 1. Parameters for Measured NMWWRS.

While Barbour and Stribling (1991) favored a **streamside cover** of predominantly shrub sized vegetation for providing optimal fish habitat, the NMWWRS rates a mixture of trees, shrubs and grasses as 4, as this would provide additional habitat for nesting and perching sites for birds, as well as habitat for other animals.

Bank stability is determined by observance of recent or potential movement of bank soil into the stream (Barbour and Stribling, 1991). The lower bank is that which is intermittently submerged during normal water flow. The upper bank is adjacent to the top of the lower bank and is within the floodplain. Steep banks will be eroded more rapidly by high velocity waters. Plant root systems hold the soil together to resist the erosive force of water. The **bank cover** parameter measures the percentage of vegetation on a bank.

The **vegetative buffer zone** is measured on the side of the stream nearest to disruptions, such as roads or pastures. The height and density of the vegetation determine the amount of shading for the steam. A smaller buffer zone results in less shade, and thus higher water temperatures. Higher water temperatures can have additional impacts, such as lowered dissolved oxygen concentrations and increased sedimentation. Buffer zones also filter runoff materials from roads, increase groundwater recharge by slowing surface runoff, and shelter wildlife from human encroachment.

Vegetative diversity is evaluated by counting the number of species in the riparian zone. Greater than 20 is optimal, while 0 to 5 is poor. Vegetal variety not only provides a greater diversity of habitat, but also results in less chance of the vegetation being totally eradicated by disturbances such as disease, fire, or floods.

Embeddedness is measured to determine what percentage of the dominant substrate is buried in sediment. This parameter evaluates the bottom substrate as potential habitat for benthic invertebrates or fish spawning and egg incubation. High levels of embeddedness will reduce niche space and attachment viability (Barbour and Stribling, 1991). A rating of "optimal" is given if the rocks sampled have less than 25% of their surface embeddded in sediment.

Stream discharge greater than 0.05 cubic meters per second for cold water streams is considered necessary to support a healthy aquatic habitat for fish and insects. For warm water streams, greater than 0.15 cubic meters is required.

A diversity of **canopy** cover is given a 4 rating, in which different areas of the stream reach receive direct sunlight, complete shade, or filtered light. Solar energy affects water temperature as well as primary production. Shaded streams support algal communities dominated by diatoms, a species favored by macroinvertebrates that scrape the algae from the bottom. More direct sunlight is conducive for growth of filamentous algae, consumed by crayfish and a few insects (Alliance for the Chesapeake Bay, 1996).

Width to depth ratio of the lower bank determines the stream's ability to contain normal peak flows, regulate temperature, and provide habitat for fish. Movement of cattle in and out of streams often results in erosion of streambanks, resulting in wider, shallower streambeds and degraded habitat for fish and aquatic insects.

Higher ratios for **pools to riffles** as well as a greater variety of **streambed geology** provide a wider variety of habitat for fish and **macroinvertebrates.** Dominance of specific aquatic invertebrates is an indication of the water quality of a stream. Stoneflies (Plecoptera) are generally the most sensitive to pollutants such as sewage and may be the first to disappear in response to human impact. Mayflies (Ephemeroptera) and caddisflies (Tricoptera) are also sensitive to disturbances, although some families of caddisflies can live in highly degraded areas

(Fleming and Henkel, 2000). Waters dominated by midges or worms, or those containing no insects, are usually of poor quality.

The final rating for the riparian zone is obtained by dividing the total score by the number of parameters. Currently, results of this survey are used by government agencies to define objectives in watershed management, which may include actions to improve riparian conditions.

Proper Functioning Condition Method

The following information on the PFC assessment tool is taken from *A User Guide to Assessing Proper Functioning Condition and the Supporting Science for Lotic Areas*, TR 1737-15, (USDI, 1998). PFC is a qualitative method for assessing the condition of riparian-wetland areas. Synthesized information from a checklist is used to determine the overall health of the individual riparian area. The PFC method can be used in watershed analysis by aggregating "reach" assessments for the watershed, but additional information is needed, such as an inventory of habitat quality. The criteria describe physical attributes of the riparian area. If conditions are at an optimal level, they will provide a resilient system capable of holding together during high flow events, such as 5, 10, or 20 year floods. The resiliency in turn allows an area to produce desired values, such as fish or bird habitat, or forage over time.

Each riparian area is judged against its capability and potential. "Capability" is the highest ecological status an area can attain given political, social, or economical constraints. These constraints are only those which cannot be eliminated or changed by an agency's management action. Therefore, practices such as logging and grazing do not limit capability, while a dam that affects flow regimes would be such a factor. "Potential" is the highest ecological status a riparian area can attain, given no political, social, or economic constraints. A stream bordered by bedrock walls has no potential to supply woody debris to the immediate area;

therefore, the potential of the site needs to be considered and a not/applicable (N/A) rating given to this parameter. "Potential" of a site is often determined through historic records of what the ecosystem previously included in terms of flora and fauna, or by comparison with a reference site.

The criteria chosen were those attributes and processes that were common and important to all riparian areas and could be assessed visually. The intent was that any agency utilizing this method would enlist a four person team including soil, vegetation, hydrology, and biology experts. However, in speaking with the riparian specialists for the Cuba Forest Service Ranger District and the Albuquerque BLM, this is not always possible given time and staffing constraints.

There are four possible ratings assigned after the riparian area is assessed. They are proper functioning condition (PFC), functional at risk, non-functional, and unknown. A riparian area is considered to be in PFC when adequate vegetation, landform, or large woody debris is present to

-dissipate stream energy associated with high waterflow, thereby reducing erosion and improving water quality;

-filter sediment, capture bedload, and aid in floodplain development;

-improve floodwater retention and groundwater recharge;

-develop root masses that stabilize streambanks against cutting action;

-develop diverse ponding and channel characteristics to provide the habitat and water depth, duration and temperature necessary for fish production, waterfowl breeding, and other uses;

-support greater biodiversity.

"Functional-at-risk" is an area that is in functional condition, but an existing soil, water or vegetation attribute makes it susceptible to degradation. Jim Eaton, the riparian specialist for the Cuba Forest Ranger District, stated that the fuel load conditions in the Santa Fe National Forest made any stream within that forest functional at-risk, at best.

A "non-functional" rating is given to an area that is not providing adequate vegetation, landform, or large woody debris to dissipate stream energy associated with high flows. "Unknown" applies when there is insufficient information to make a decision.

The PFC assessment is used for prioritizing restoration activities. Those reaches with a rating of "functional-at-risk" are the first priority, in that restoration activities may halt the decline to a degraded condition, at a much lower cost than for one already degraded. For functional-at-risk, it is helpful to establish if the trend is upward or downward. If the previous condition is unknown, then evidence of recruitment and establishment of riparian species that indicate an increase in soil moisture may be a useful indicator of upward trend. Management strategies for restoration must address the entire watershed, as upland and riparian areas are interrelated and cannot be considered separately. Ongoing monitoring of all sites is desirable, so that changes in conditions, as well as achievement of goals can be assessed.

PFC Criteria

The following information is also taken from *A User Guide to Assessing Proper Functioning Condition and the Supporting Science for Lotic Areas*, TR 1737-15. The checklist for PFC addresses the common attributes and processes that must be present for a riparian area to function properly. The general categories are hydrology, vegetation, and erosion/deposition. A "yes" or "no" answer ascertains if the site possesses the particular quality.

Hydrology

1. **Floodplain Evaluation.** The first item under *Hydrology* asks if the floodplain is frequently inundated in flood events. Periodic flooding of the floodplain is necessary to promote and sustain riparian vegetation. If channels are severely downcut, flood peaks can no longer access the floodplain. Many of the items on the list are interrelated and sometimes overlap. This question provides the chance to explain why sufficient vegetation may not be present, as all items answered "no" require discussion as to why not.

2. **Beaver Dams**. The next item is "where beaver dams are present are they active and stable?" Active dams aid in floodplain establishment. The manual states that answering "yes" to this question implies that sufficient woody vegetation is present. However, on the Rita Leche (BLM) site that we surveyed, which had active beaver dams, the channel was downcut, with no lower bank vegetation and little upper bank vegetation. Above the floodplain, beaver had cut down the last large cottonwood in the area. Woody vegetation was minimally available for this area.

3. **Sinuosity, Width/depth Ratio in Balance with Landscape**. These parameters resulted in the most discussion. Here, the NMWWS aided in answering the question, as we had to determine the width/depth ratio, and the pools to riffle ratio, or river bends to width ratio. In general, we knew that a decrease in stream length relative to its valley length was not optimal, as it would result in higher velocities of stream flow, and thus accelerated erosion. If the landscape permitted meandering, but the stream channel proceeded straight through the valley, we knew we had a "no". Exposure to similar sites within the same watershed also aided in the decision.

4. **Extent of Riparian Wetland.** "Riparian wetland is widening or has achieved potential extent." This criterion sometimes resulted in a "liner" answer between yes and no, when both upland and riparian plants were present. (A "liner" refers to marking a criterion on the line

between "yes" and "no" when neither answer is entirely correct). Because we visited each site one time, we were not able to ascertain which plants were increasing. A "yes" answer was easily determined at sites where the ground was saturated and riparian plants abounded.

5. **Upland Watershed**. The fifth item consistently rated a "no", regarding upland watershed conditions that did not contribute to degradation. Grazing and/or roads were upland land uses causing increased erosion.

Vegetation

1. **Age-class Distribution**. The first issue addressed age-class distribution for recruitment and for maintenance and recovery. Two age classes are required, but these must be for riparian plants, not upland vegetation.

2. **Diverse Composition**. The manual states that two species of riparian plants are required to rate a "yes" answer in order to accommodate shifts in the water table.

3. **Riparian Soil Moisture.** This item states that species composition indicates maintenance of riparian-wetland soil moisture characteristics as evidence that the water table level is being maintained or is rising. For perennial streams, this means that some of the plants must be obligate wetland plants (OBL), such as Salix exigua, coyote willow, or Carex aquatilis, water sedge, and/or facultative wetland plants (FACW), such as Populus angustifolia, narrowleaf cottonwood, or Baccharis salicifolia, seepwillow (Muldavin et al., 2000). For intermittent streams, dominance by facultative plants (FAC), such as Phragmites australis, or common reed is sufficient.

4. **Root Masses**. Species such as alder, cottonwood and willow, as well as sedges, rushes and bullrush, have extensive root masses which prevent undercutting and collapse of streambanks. Upland species such as sagebrush, Kentucky bluegrass and blue grama do not. If upland

species dominate, then high flow events may cause changes in width/depth ratio and sinuosity.

5. **Health and Vigor of Riparian Plants**. On one reach of the Senorita stream we assessed an area where the water table seemed to be declining, the willows were dying, and upland plants were increasing. At a short distance downstream from this site, the stream was dry. Plant vigor became more difficult to assess on the Forest Service streams, as data collection continued later in the fall months.

6. **Bank Protection**. "Adequate riparian-wetland vegetation cover is present to protect banks and dissipate energy during high flows." Both live and dead plant material extending into the flow can reduce shear forces acting upon the bank. In addition, root masses hold together soil to resist erosive forces. The criterion was assessed by looking at both the percentage of plant coverage and what was actually happening on the banks in terms of excessive erosion. Evidence of a stream's failure to resist high flow events was usually present and aided in the assessment. Examples were lateral cuts or exposed root masses.

7. **Woody Debris**. The last parameter is interrelated with the previous one in that it addresses adequacy of sources of woody debris carried from the riparian area into the stream. Woody debris captures bedload, aids floodplain development, and dissipates peak flood energies. This criterion determines if the amounts of trees or shrubs in the area is sufficient. It also evaluates if coarse or large wood is needed at all for individual systems. Large woody material is not required for some small, low gradient streams.

Erosion

1. **Floodplain and Channel Characteristics**. The first item asks if floodplain and channel characteristics are adequate to dissipate energy. Live vegetation and woody debris are again

addressed, but so is channel gradient, sinuosity, channel roughness and structure. Backwater areas, oxbows, and overflow channels are other structures that dissipate peak flood energies.

2. **Revegetation of Point Bars**. The second item addresses point bars, which are areas of sediment deposition that alternate with areas of natural erosion at the bends of streams. Revegetation over time with riparian plants captures sediment and prevents bank erosion.

3. **Lateral Stream Movement**. Is lateral stream movement associated with sinuosity? This assessment determines if erosion is excessive relative to how the stream meanders through the landscape over time. Stable streambanks, particularly between meanders, and movement of the channel with little width to depth ratio change results in a "yes" answer for this description. Movement of cattle in and out of streams causes unnatural lateral movement, with increased width to depth ratios.

4. **System is Vertically Stable**. The manual recommends that in order to assess this item repeated measurements of bed elevations must be made over time. However, recent slumping of banks into the streams, headcuts, and banks lacking stabilizing vegetation often presented sufficient observation to answer "no".

5. **Stream in Balance**. The NMWWRS measurement of embeddedness helpes determine the criterion addressing the last item, an evaluation of the equilibrium of the water and sediment supplied by the watershed. Presence or absence of mid-channel bars was another determining factor. The size and amount of rocks in the stream, and presence of woody debris along with riparian vegetation would influence this parameter.

Comparison of the Two Surveys

The NMWWRS includes both quantitative and qualitative assessments; the PFC method is a qualitative assessment derived from the quantitative method of *Ecological Site Assessment.*

Both support the proposition that a healthy riparian area provides habitat for wildlife, particularly birds and fish. This proposition directs attention to items that need to be examined within the riparian area, such as evaluation of substrate and channel morphology (Barbour and Stribling, 1991) or floodplain characteristics (Pfankuch, 1978). The items that constitute essential information determine the criteria of the surveys, which provide the means to collect and analyze relevant data. The surveys provide the means for a holistic approach to habitat analysis in which knowledge of the parts is aggregated into knowledge of the whole. The results help the researcher in deciding what is to be done after the data are collected (Yin, 1994). For the PFC, this entails prioritizing restoration sites and deciding what changes are needed to bring about ecosystem recovery. For the NMWWRS, the results may provide managing agencies with continuous riparian monitoring data that will in turn lead to timely, cost-effective and scientifically credible land management decisions (Fleming and Henkel, 2000).

There is agreement within the two systems that upland and riparian areas are interconnected, and thus the functional status of the upland and stream tributaries will contribute to the assessment of the entire watershed. The PFC and the NMWWRS methods both require that the researcher go into the field and get close to the sources of data in order to increase understanding. Authors of the two systems acknowledge that there will be variations in local sites determined by reference databases. The qualitative analysis is useful for capturing the differences (Patton, 1990).

The criteria for the two surveys assess the elements necessary to provide what is defined as "proper functioning condition", i.e. that the riparian area can dissipate stream energy associated with high water flows; filter sediment, improve flood-water retention and ground-water recharge; and develop root masses that stabilize streambanks against downcutting. The

PFC and the NMWWRS methods believe that ongoing monitoring of riparian areas is equally important as the initial evaluation in order to track the status of a healthy or recovering riparian and aquatic ecosystem.

Two differences are that the PFC method assesses beaver dams as a contributor to flood plain development, while the NMWWRS decides which benthic organisms are dominant as an indicator of water quality. The following table demonstrates how the two surveys' parameters are interrelated in the process of evaluating riparian health.

Proper Functioning Condition	N.M. Watershed Watch Riparian Survey
Floodplain above bankfull is inundated in "relatively frequent" events	Width/depth ratio. Vegetation diversity. Vegetation buffer.
Sinuosity, width/depth ratio are in balance with the landscape.	Width/depth ratio. Pool/riffle ratio.
Riparian-wetland is widening. Species present indicate maintenance of riparian soil moisture. Riparian plants exhibit high vigor.	Vegetation buffer. Vegetation diversity.
Vegetation age class distribution (for maintenance and recovery). Vegetation composition diversity (for habitat).	Vegetation structural diversity for habitat. Vegetation composition diversity.
Streambank vegetation with root masses capable of withstanding high streamflow events. Adequate riparian veg. cover is present to protect banks and dissipate energy during high flows. System is vertically stable.	Bank cover. Bank stability.
Plant communities are an adequate source of large woody material.	Riparian veg. structural diversity. Rating of 4 = grass/shrubs/trees. Rating of 3=mostly trees.
Floodplain and channel characteristics are adequate to dissipate energy. Pointbars are revegetating.	Streambed geology (% of boulders, cobbles, rocks, gravel, and logs).
Lateral stream movement is associated with natural sinuosity.	Width/depth ratio. Bank stability
Stream is in balance with the water and sediment supplied by the watershed.	Embeddedness. Streamflow. "The flow parameter indicates the ability of a stream to produce and maintain a stable environment in the substrate.(Barbour and Stribling, 1991)."
Beaver dams.	
	Macroinvertebrates.

Table 2. Interrelated parameters for the PFC and NMWWRS methods of evaluation of riparian ecosystems.

Methodology

Study Sites. Stream reaches for assessing PFC and the NMWWRS methods were chosen from the Santa Fe National Forest in the Cuba Forest Service Ranger District, NM, and from the land managed by the BLM between Cuba and San Ysidro. Eight reaches were chosen within the Forest Service area and seven were chosen within the BLM district. The stream sections on BLM land had been previously assessed using the method, PFC, while the Forest Service sites were in the process of being surveyed. Jim Eaton, the riparian specialist for the Cuba Ranger District, and McKinley-Ben Miller, the specialist for the BLM, gave us directions to and descriptions of the streams.

The areas were surveyed between September 24, 1999 and October 22, 1999. We chose to assess the Forest Service sites first, due to higher elevation and possibility of snow. The streams chosen were Clear Creek (2 reaches), American Creek, the Rito de las Palomas, the Rio de las Vacas (2 reaches), Rock Creek, and the Rito Penas Negras. Three sites in each reach were evaluated. The sub-riparian areas or sites, were chosen based on observable differences in landform, geology, geomorphology, vegetation or some combination that suggested separate ecological units. Where the study area appeared uniform on Forest Service land, the reach was divided into 3 sections based on the time it took to walk the riparian area in a linear fashion, and an assessment was done within each section.

The BLM reaches are in Senorito Canyon, and on the Rito Leche, the Rio Salado, and the Rio Puerco. The reaches on the Rio Puerco are called Wilson Canyon, Coal Creek, and Lost Valley. On three of the BLM reaches, where there was no water in the 3rd section or sites were consistent in description, only one or two assessments were done per reach. Detailed descriptions of the reaches and sites are provided in Appendix A. Maps of the study site locations and the headwater regions of the streams are provided on the following pages.

Surveys. For the PFC assessment, parameter ratings were determined by observation and discussion. Five of the NMWWRS ratings were determined in a similar fashion, while the remaining parameters required specific measurements. These criteria were vegetation diversity, riffle/pool ratio, embeddedness, streambed geology, stream flow and width to depth ratio.

To determine width to depth ratio, three measurements were taken for the width of the lower bank at the top of the bank and averaged. Three were also taken for the depth from the top of the lower bank to the bottom of the stream, and then averaged. The width to depth ratio was then computed as the average width divided by the average depth.

Embeddedness was evaluated by determining the percentage of the cobbles or small boulders that were surrounded by sediment. Three to five rocks were examined per site. Streamflow was determined as the average velocity for three trials, in which an object floated down a specific distance. Average velocity was multiplied times the average of three widths times the average of three depths (of the lotic portion) to give an estimate of discharge in cubic meters per second.

The parameter for dominance of benthic invertebrate types was eliminated from the total count for several reasons. First, this criterion was not addressed in the PFC method. Also, the methods recommended that at least one hundred insects be collected per site. The author of this study has an aversion to killing large numbers of insects that is sometimes necessary for positive identification. In addition, the time allotted for data collection was not sufficient to identify 3,800 insects. Instead, benthic insects were identified from each site using a three rock method, in which three rocks (from riffle areas when possible), were removed and agitated in a pan of

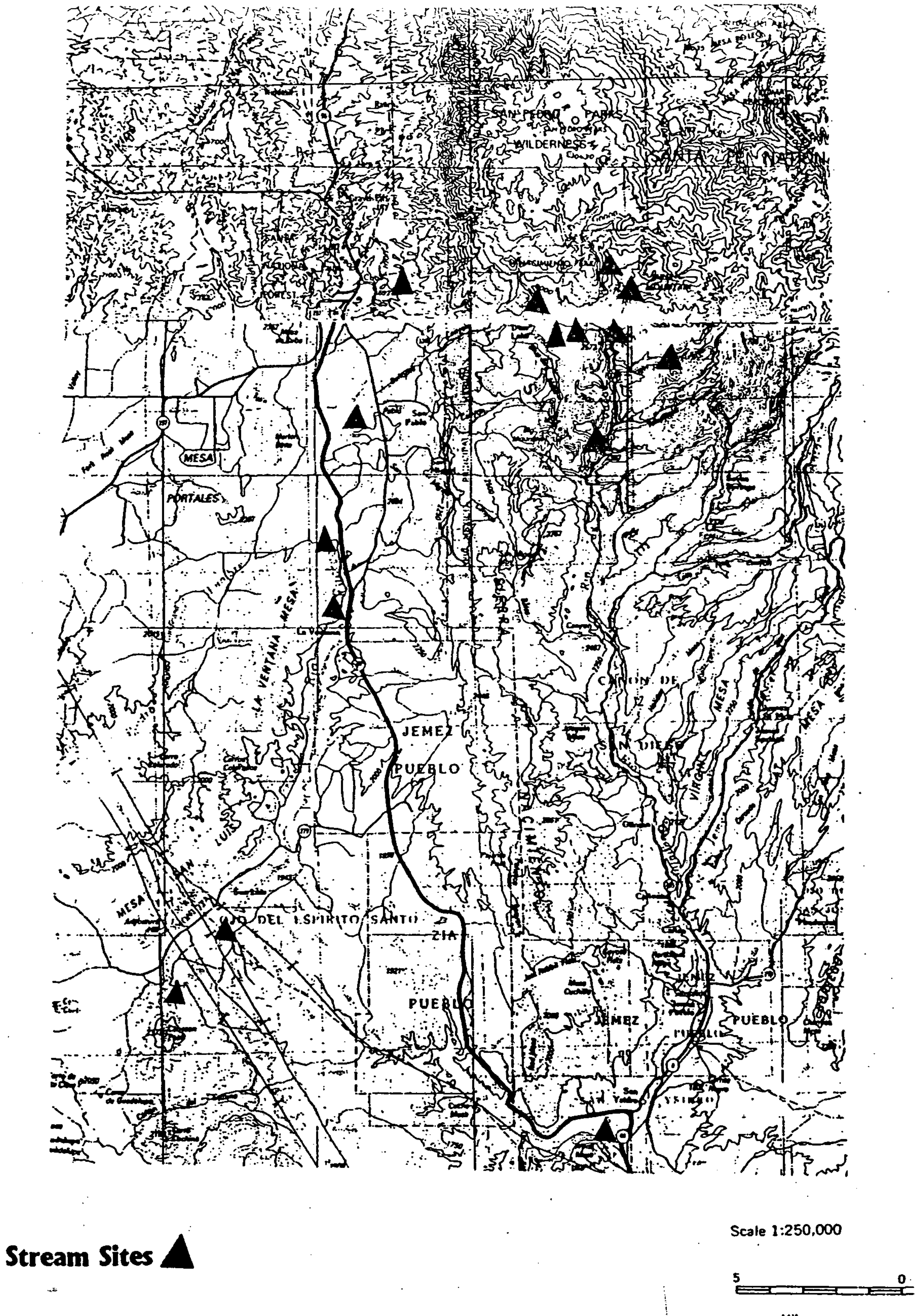

Figure 1. Stream reaches that served as study sites.

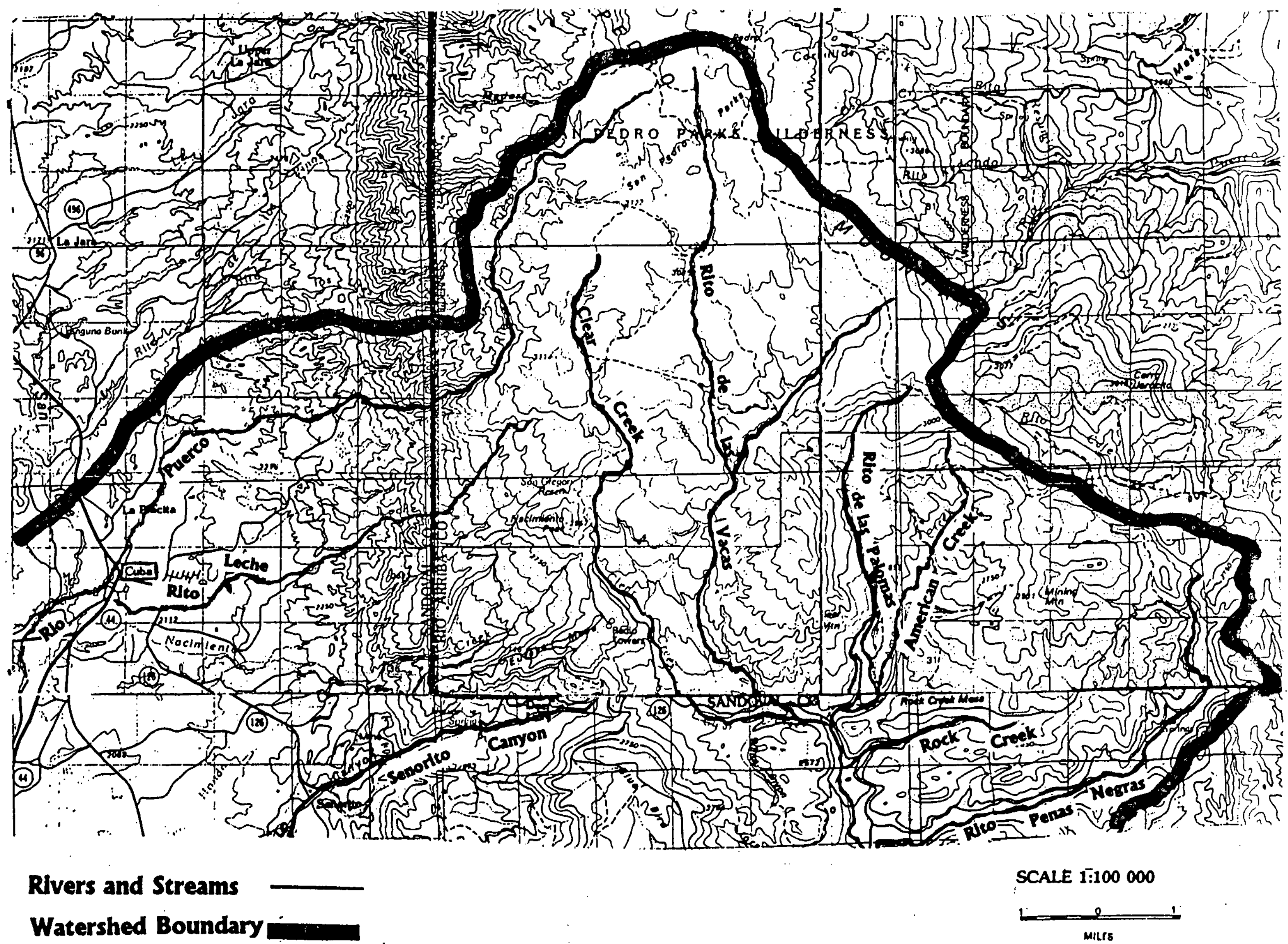

Figure 2. Map of headwater region of stream sites.

water. This would loosen most insects. Then, any remaining insects on the rock and those in the pan would be identified with a hand lens and placed back in the stream. Occasionally specimens were removed from the area for identification under a dissecting microscope when not identified in the field. The dominance of insects from these smaller samples are listed at the bottom of the data tables (Appendix B) only as additional information. If equal numbers of two specimens were found, then an equal sign occurs between the two abbreviations.

Results

The results are in two categories. The first category is the rating for the individual sites within each reach for the PFC and NMWWRS. A reach rating was averaged or determined for each method from the individual site ratings. The second category is the comparison of the PFC ratings for the reaches as determined by Robin Just and Kathy Smith and by government employees. These will be presented only in the *Discussion* section. The assessments for all of the Forest Service reaches were not completed by the Cuba District Ranger as of August, 2000, and therefore only those available will be addressed.

Individual site ratings for the Forest Service area resulted in three PFC ratings, ten functional –at risk ratings and eleven non-functional ratings (Table 3). The NMWWRS ratings that corresponded to these sites ranged from 3.3 to 3.7 for the PFC assessed sites, 2.7 to 3.4 for the functional-at risk, and 1.8 to 2.7 for the non-functional assessed sites. The average and median ratings were 3.4 and 3.3, 3.02 and 3.05, and 2.8 and 2.3, respectively.

Reach ratings for the Forest Service area were five F-at risk ratings and three non-functional (Table 4, next page). The ratings using the NMWWRS and corresponding to the F-at risk sites ranged from 2.8 to 3.1 with an average of 2.98 and a median of 3.0. The range of ratings corresponding to the non-functional sites was 2.0 to 2.6, with an average of 2.27 and a median of 2.2.

Santa Fe National Forest Sites	Clear Creek 1-1 9-24	Clear Creek 1-2 9-24	Clear Creek 1-3 9-24	Clear Creek 2-1 9-25	Clear Creek 2-1 9-25
PFC	PFC	PFC	NF	F-at risk	F-at risk
N.M. Watershed Riparian Survey	L 3.4 R3.18, Average3.3	L3.6 R3.7, A 3.7	L2.18 R2.3, A2.2	L3.1 R3.1	L3.1 R3.1
Santa Fe National Forest Sites	Clear Creek 2-3 9-25	Palomas 1-1 9-28	Palomas 1-2 9-28	Palomas 1-3 9-28	American Creek 1-1 9-28
PFC	F-at risk	PFC	F-at risk	F- at risk	F-at risk
N.M. Watershed Riparian Survey	L 2.9 R2.8, A2.9	L3.2 R3.3, A3.3	L2.7 R2.7	L3.2 R2.9, A3.1	L3.4 R3.3, A3.4
Santa Fe National Forest Sites	American Creek 1-2 9-28	American Creek 1-3 9-28	Las Vacas 1-1 10-2	Las Vacas 1-2 10-2	Las Vacas 1-3 10-2
Functional Rating	F-at risk	F-at risk	F-at risk	F-at risk	NF-road
N.M. Watershed Riparian Survey	L2.8 R2.8	L3.2 R3.1, A3.2	L3 R2.9, A3.0	L2.9 R2.9	L2.4 R2.4
Santa Fe National Forest Sites	Las Vacas 2-1 10-6	Las Vacas 2-2 10-6	Las Vacas 2-3 10-6	Penas Negras 1-1 10-8	Penas Negras 1-2 10-8
Functional Rating	NF	NF	NF	NF	NF
N.M. Watershed Riparian Survey	L2.7 R2.7	L2.7 R2.6, A2.7	L2.5 R2.2, A2.4	L2.0 R2.0	L1.7 R1.9, A1.8
Santa Fe National Forest Sites	Penas Negras 1-3 10-8	Rock Creek 1-1 10-8	Rock Creek 1-2 10-8	Rock Creek 1-3 10-8	
Functional Rating	NF	NF	NF	NF	
N.M. Watershed Riparian Survey	L2.2 R2.2	L2.3 R2.4, A2.4	L2.4 R2.2, A2.3	L2 R1.9, A2.0	

Table 3. Individual Forest Service site ratings as evaluated by Smith and Just.

Reach	Clear Creek 1	Clear Creek 2	Palomas	American	Las Vacas 1	Las Vacas 2	Penas Negras	Rock Creek
Smith/Just PFC	F-at risk	F-at Risk	F-at Risk	F-at risk	F-at Risk	NF	NF	NF
NMWWRS	3.0	3.0	3.0	3.1	2.8	2.6	2.0	2.2

Table 4. Average ratings for Forest Service reaches as evaluated by Smith and Just.

Individual site ratings for the BLM area were fourteen non-functional (Table 5). The corresponding NMWWRS ratings ranged from 1.4 to 1.8 with an average and median of 1.6. The reach appraisals for the BLM were also all non-functional (seven total) (Table 6). The corresponding ratings ranged from 1.5 to 1.8 with an average of 1.6 and a median of 1.5.

Bureau of Land Management Sites	Rito Leche 1-1 10-12	Rito Leche 1-2 10-12	Rito Leche 1-3 10-12	Coal Creek 1-1 10-12	Coal Creek 1-2 10-12
Functional Rating /Trend	NF/U Exclosure	NF/U Exclosure	N/F	N/F	N/F
N.M. Watershed Riparian Survey	L1.9 R1.6, A1.8	L1.9 R1.6 A1.8	L2 R1.5 A1.8	L1.6 R1.6	L1.6 R1.5, A1.6
Bureau of Land Management Sites	Wilson Canyon 1-1 10-16	Wilson Canyon 1-2 10-16	Lost Valley 1-1 10-20 (north)	Lost Valley 10-20 (north)	Lost Valley 10-20 (south)
Functional Rating /Trend	NF	NF	NF	NF	NF
N.M. Watershed Riparian Survey	L1.5 R1.5	L1.5 R1.5	L1.6 R1.6	L1.5 R1.3, A1.4	L1.5 R1.5
Bureau of Land Management Sites	Rio Senorito 1-1 10-22	Rio Senorito 1-2 10-22	Rio Salado 1-1 10-22	Rio Salado 1-2 10-22	
Functional Rating /Trend	NF/U	NF/U	NF	NF	
N.M. Watershed Riparian Survey	L1.7 R1.7	L1.6 R1.6	L1.5 R1.5	L1.5 R1.4, A1.5	

Table 5. Individual BLM site ratings as evaluated by Smith and Just.

Site	Rito Leche	Coal Creek	Wilson Canyon	Lost Valley (N)	Lost Valley (S)	Senorito East	Rio Salado
Smith/Just PFC	NF	NF	NF	NF	NF	NF	NF
NMWWRS	1.8	1.6	1.5	1.5	1.5	1.6	1.5

Table 6. Average ratings for BLM reaches as evaluated by Smith and Just.

Discussion

After stream assessments were completed, data evaluated, and ratings assigned, several issues came to light. Had these issues been discovered beforehand, they would have directed this study in a different manner. Initially, Robin Just and I were trained by Gilbert Borrego, the riparian specialist for the NM State Land Office in a half day session. Prior to the training, Ms. Just and I reviewed the PFC manual in order to prepare any questions we had concerning this method. During the training, we accompanied Mr. Borrego to two contrasting sites on the Santa Fe River in order to note differences between a PFC and non-functional rating. Subsequently, I was informed that a minimum of three days is considered sufficient time for training in the PFC method, which includes numerous on-sight assessments.

The original intent of this study was to correlate the two rating systems of PFC and the NMWWRS. In a discussion with Dr. Claudia Isaac, director of Community and Regional Planning at UNM and an instructor for a *Qualitative Data Analysis* class, I learned that it is inappropriate to attempt to correlate quantitative and qualitative data. Only the similarities, differences, strengths and weaknesses of the assessment tools may be addressed, as well as how the data results are utilized.

My initial opinion was that the PFC method, utilized by government officials to assess riparian areas and contribute to watershed evaluations and management, was the higher standard of the two surveys although both were derived from rigorous scientific bases utilized to evaluate riparian health. The PFC was designed to provide a common methodology with consistent language and understanding of the parameters utilized. This was deemed necessary as watershed boundaries frequently cross jurisdictional boundaries. Therefore, data could be aggregated from various agencies in order to decide on management decisions at a watershed level. The NMWWRS had been utilized by high school students to evaluate and continue monitoring of stream systems and watersheds, thereby providing an ongoing database. This tool had also been recommended as a rapid bioassessment methodology for streams on private land, particularly on rangelands, as well as an adjunct to government surveys to provide ongoing monitoring.

The reality of utilization of the PFC method by the government employees who aided me in this project was the following. The riparian specialist for the Cuba Ranger District had a "crash course" on PFC during a range management meeting that occurred over a few hours. Instead of a four member team carrying out the survey, Mr. Eaton frequently carried out the assessments solo or occasionally with a range specialist or a hydrologist. He commented that if the hydrologist accompanied him, a single "no" answer to a parameter would result in a non-functional rating rather than the entire system and criteria being considered. Chris Massingill, a consultant to the task force team that developed the PFC method, and a current instructor of the process, stated that surveys carried out with less than a four person team may only be considered an estimate of PFC. Further evaluations are required.

McKinley-Ben Miller, who performed the PFC surveys for our BLM sites prior to our assessments, had no training in the PFC method at the time of his field work. In general, his team consisted of three or four members with only one or two having had training in PFC. Two members were wildlife biologists, and one was a range specialist. There were no soil, hydrology or vegetation specialists on the teams as recommended. Therefore, neither my team, nor the BLM or Forest Service teams met the requirement for providing an adequate PFC assessment.

The BLM also deviates from the recommended priority listing of sites for restoration actions. Their top priority sites are those with a non-functional rating, rather than a functional-at-risk rating. An additional factor of BLM policy is the frequency with which the sites are revisited. A site with a PFC rating is scheduled for evaluation every six years, even with livestock present. Repeated exposure of a riparian area to excessive livestock use may result in excessive damage. McKinley-Ben Miller said the system relies on cooperation between the permittee of the site and the range manager to ensure that damage will not occur as a result of grazing. Current status of BLM lands implies that this cooperation can not be guaranteed. A functional-at–risk category stream requires monitoring every two years, and the non-functional, once a year. Fleming and Henkel (2000) cite Johnson and Holtheusen (1999) in pointing out the need for more timely awareness of changes in ecosystem health in order to prevent loss of ecological resilience. The New Mexico Watershed Watch handbook recommends annual monitoring.

When the PFC ratings were assigned for sites in this study, Ms. Just and I were following the premise that the riparian area and stream had to meet the criteria for a "proper functioning condition" as defined in the manual. That is, there had to be adequate vegetation, landform or large woody debris to hold together a system when faced with a 5, 10, or 20 year flood. In addition, the system would filter sediment, capture bedload, aid in floodplain development, improve water quality and develop diverse ponding and channel characteristics to provide habitat for fish, waterfowl, and other wildlife. A functioning system but at risk might possess some of the elements in the definition, but at least one of its attributes or processes would give it a high probability of degradation with a high flow event. The "non-functional" system usually results in a preponderance of "no" answers on the checklist, although a few "yes" conditions may be present. The decision to apply a "functional –at-risk" versus a "non-functional" rating at times becomes subjective.

Two examples are the Rock Creek and the Rio Salado reaches. Rock Creek had a preponderance of "no" answers due to eroding banks (the placement of the one gabion was proof of intent to begin to correct this problem) and little riparian vegetation with root systems that would dissipate high flow energies. The first site contained a small wetland area, which we felt was increasing in size, but the majority of the reach was dominated by upland plants. We gave it a non-functional rating, which would have resulted in this stream being labeled a "lost cause". Yet according to Jim Eaton, this system had greatly improved due to a change in grazing practices and the attempt to stabilize the northern bank. His rating for the stream was functional-at-risk with an upward trend. Trend may be specified as upward or downward. A previous assessment aids in determining this. If the protocols from the PFC manual were being followed by the Forest Service, a functional-at-risk rating is one which ranks first for intervention. Ironically, Mr. Eaton stated that his assessments have no influence on which streams are a priority for restoration. His supervisor makes those decisions independent of the PFC ratings (Eaton, 2000). Our ignorance of whether this stream section was moving in the direction of processes that were functioning properly was a result of our assessment being restricted to a one time visit. Again, the need for frequent, reoccurring visits should be stressed in the PFC manual.

Another misinterpretation of the PFC evaluation again came to light from a discussion with Chris Massingill. Jim Eaton had informed Ms. Just and me that most of the Forest Service sites would be given at most, a functional-at-risk rating, due to the heavy fuel load existing in the forest, which presents a constant fire potential. Ms. Massingill explained that "at-risk" pertains to an incident already occurring, such as mining tailings making their way towards a stream.

The Rio Salado stream system represented a second example of our difficulty in arriving at an accurate rating. This system consists of soil described as one which supports little vegetation because of frequent flooding and reworking by water (USDA, 1968). We were unaware of this at the time of our assessment. What we saw was a flat, wide stream channel with little water and no woody debris, landform or cobble to dissipate high streamflows. The predominant riparian vegetation was saltcedar and Russian olive. Saltcedar was intentionally planted historically, for bank stabilization, but these banks were eroding. We gave this system a non-functional rating. This stream probably supported cottonwoods historically, which if successfully reintroduced, would support greater biodiversity (Kelly and Finch, 1999). However, without having researched historical conditions or existence of a reference site, I remain unaware of the potential of this system. Our rating was based on the preponderance of "no" answers on the PFC checklist. Chris Massingill, while instructing a PFC class, rated this stream as functional-at-risk, based on the soil properties and the presence of phreatophytes in the riparian area. The BLM rating agreed with our rating of "non-functional".

Lack of a reference site frequently detracts from the ability to apply a correct assessment rating. As riparian areas were the choice locations for most settlements in the Southwest due to the general scarcity of water, few streams escaped human impact that eventually led to their degradation. Researching historic documents or reviewing aerial photos to determine prior potential again requires time and staffing, which are equally constraining factors for government agencies. Drs. Fleming and Henkel stress the importance of including knowledge from local community members when deciding management decisions impacting natural resources (Fleming and Henkel, 2000). This is also considered a component of adaptive management (Johnson and Holthausen, 1999), which most government agencies profess to follow.

Where historic documents or a reference site are difficult to access, utilizing community information about a site contributes to general knowledge and involves stakeholders in the process. Jim Eaton commented that it was discussion with some of the "local oldtimers" that contributed to his knowledge of prior conditions of local stream systems within the Cuba Ranger District. The PFC manual states that PFC method is most useful when the condition of the stream at a watershed scale is determined by local information, in addition to knowledge of its process and functions.

Ms. Just and I had information regarding the historic description of the area for the BLM sites that were reaches on the Rio Puerco,. In *An Environmental History of the Rio Grande* Scurlock (1998) quotes historic accounts of the Rio Puerco, such as a "rapid stream with cottonwoods" flowing through a valley, which was "lush, rich and fertile". Governor Vargas described this river in 1692 as having "water so deep that the soldiers had to carry their provisions and equipment on their shoulders." The valley was one "rich in grasses, bosques, springs, and charcos, small lakes or ponds." Specifically, the area near Cabezon (the Lost Valley sites), was described during 1830 as a "grassy wilderness with swampy vegas, clear water, and willow lined banks" (Scurlock, 1998).

Channel depths that were 10 to 20 feet historically have now eroded to depths of 25 to 50 feet or higher. The historic depths can provide a reference of past conditions, but cannot be attained quickly in response to remediation. However, the vegetation communities could possibly be restored with management intervention. Therefore, the current rating of functional-at risk, as decided by the BLM, is too high. Vegetation communities presently consist mainly of saltcedar and Russian olive. Very little wetland area remains. The channel is wide and shallow with little streamflow. A reduction or elimination of livestock grazing, replacement of exotic species with native vegetation and placement of instream structures designed to recreate meanders may eventually return the riparian area to near historic condition. The current condition supports a rating of non-functional.

As stated earlier, on-going monitoring of important ecosystems is necessary to prevent loss of ecological resilience. Ecological resilience is the ability of an ecosystem to recover in response to a disturbance. Utilizing the PFC method has already proven difficult for government employees for the initial assessment. Professional team members are rarely available as a group.

The difficulty in arriving at a consensus rating for a site has been demonstrated by examples provided in this paper. If priority decisions for restoration sites are based on ratings partially derived from previous knowledge of the site, the difficulty continues.

The NMWWRS, in utilizing criteria that are categorized quantitatively, provides a system that can be used repeatedly with a consistent determination of rating. By evaluating riparian health with criteria that can be predominantly measured, such as lower bank cover of 90%, 70-89%, 50-69%, or<50%, assessments can be carried out more precisely and in a timely manner. This avoids the subjective discussion involved in determining PFC. Training for the NMWWRS can be accomplished in an hour as opposed to three days for the PFC method. On-site assessment is estimated at a half hour, while the PFC process can continue until a consensus rating is or is not agreed upon.

In comparing outcomes for the two assessment tools for our Forest Service riparian sites, those with ratings of PFC did correspond to the higher numerical ratings of the NMWWRS, (3.3 to 3.7). The functional at-risk sites corresponded to 2.7 to 3.4 (slight overlap), and the non-functional sites, 1.8 to 2.7. These were for individual sites. The BLM sites only received non-functional ratings with NMWWRS categories of 1.4 to 1.8 or somewhere between poor and fair. These corresponding categories suggest a break in ratings of 1 to 2.7 for non-functional, 2.7 to 3.3 for functional at-risk, and 3.3 to 4 for PFC. Direct correlation was deemed inappropriate, and further studies would be necessary to support such a comparison. More importantly, similarities in ratings support the proposition that the 2 surveys evaluated interrelated parameters.

Forest Service	PFC	PFC	Functional-at-risk	Non—functional
	NMWWRS	3.3-3.7	2.7-3.4	1.8-2.7
BLM	PFC			Non-functional
	NMWWRS			1.4-1.8

Table 7. Comparison of categories for the PFC and NMWWRS methods as evaluated by Smith and Just.

Poor" status NMWWRS areas are the highest priority sites for intervention, in contrast to the PFC methodology that suggests non-functional status riparian areas be listed as low priority. Government agencies may need to "give up" on a stream, based on staffing and financial restrictions. Facilitators of the NMWWRS process may enlist community, private or educational institutions to implement changes and sustain monitoring (Fleming and Henkel, 2000).

The differences of our PFC ratings with those of the government empolyees raises additional questions. Those ratings for the Forest Service sites were 2 PFC and 2 functional-at-risk versus our ratings of 2 functional-at-risk and 2 non-functional, respectively.

Site	Clear Creek 1	Clear Creek 2	Palomas	American	Las Vacas 1	Las Vacas 2	Penas Negras	Rock Creek
Forest Service	Not Done	Not done	PFC	Not done	PFC	F-at Risk	Not done	F-at risk
Smith/Just	F-at risk	F-at Risk	F-at Risk	F-at risk	F-at Risk	NF	NF	NF

Table 8. Comparison of PFC ratings as evaluated by Forest Service and Smith and Just.

The Rock Creek difference was explained previously. The remaining stream that we rated non-functional was the second Las Vacas reach. Mr. Eaton's checklist contained 5 "yes' responses out of 17 criteria, resulting in a majority of "no" responses. Problems listed are cut banks, heavy grazing of willows, noxious weeds and heavy recreational use. His trend was stated as downward. Our only "yes ' answers were that the floodplain was inundated on two sites, and that the plants exhibited "high vigor". These qualities aren't enough to resist erosive forces of high flood peaks.

The remaining two sites that Mr. Eaton evaluated as PFC, the first Las Vacas reach and the Palomas, he qualified with factors that also led to our rating of functional-at risk. The Palomas reach was impacted by sediment from logging roads. We also noted areas with trampled and eroding bank sites, although these were not the dominant riparian condition. However, these occurrences were enough to classify the system as "at risk." Mr. Eaton noted that the Las Vacas reach had few young willows as well as a few "raw" banks. He attributed these features to recreation, as grazing is limited to around one month in the fall. Sediment was also excessive from road impacts. These indicators were adequate for us to classify this system as "at risk". Comparative PFC ratings for the BLM and the author's are as shown in the following table.

Site	Rito Leche	Coal Creek	Wilson Canyon	Lost Valley (N)	Lost Valley (S)	Senorito East	Senorito West	Rio Salado
BLM	PFC	F-at risk,U	F-at-risk U	F-at-risk,U	F-at Risk,U	PFC	PFC	NF
Smith/Just	NF	NF	NF	NF	NF	NF	Not done, No Water	NF

Table 9. Comparison of PFC ratings as evaluated by BLM and Smith and Just.

The Rio Puerco and Rio Salado reaches were discussed previously. The BLM locations on the Rito Leche and the Senorito differed in that Mr. Miller rated these as PFC. We placed them in the non-functioning category. Only two of our sites pertain to the reach assessment for the BLM Rito Leche report, because one site was outside the exclosure. We were aware that the condition was improving in this area. Riparian species composition and abundance were increasing. However, there remained evidence that the system was still recovering. Sediment deposition in this steam was excessive. The only macroinvertbrate was a chironomid found at one site. Future condition will probably include sufficient woody debris to capture sediment load as riparian vegetation increases. Because Mr. Miller had seen both this reach and the Rio Senorito in what he called "nuked" conditions, his perception was that these current systems appear to be flourishing. The Senorito also had insufficient riparian vegetation to withstand high flows in some areas and was in an upward trend.

Determining the macroinvertebrate communities of these streams is an important piece of additional information for evaluating the health of the stream ecosystems. Our sampling numbers were too small to contribute sufficient information to be a contributing parameter. However, those steams with the higher amounts of sediment and lowest variety of bed geology had the least insects.

A final issue addresses factors affecting both the tools utilized and team members collecting the data. Patton (1990) states that changes in qualitative data used in assessment can result from "shifts in knowledge, as well as variations resulting from differences in training, skill and experience among different researchers." Ms. Just and I noted that our confidence in assessing sites grew as our understanding of the PFC parameters increased with each additional evaluation. Training differences of the BLM and the Forest Service employees, the graduate students, and Ms. Massingill proved important in arriving at a classification for stream reaches.

The validity and confidence of a research design arises from the reliability of the methodology (Patton, 1990). The reliability of the surveys is assured when there is a strong probability that a later investigator, following the same procedures and conducting the survey on the same site, would arrive at an identical rating. This did not occur in this study, as consistent ratings for the same reaches were found. The NMWWRS method was validated in a study of two Santa Fe, New Mexico watersheds in which professionals conducted surveys on the same sites assessed by students from the Santa Fe Indian School. Percentage of differences in average categorical ratings between the students and professionals ranged from 3.2% to 9.4% (Fleming and Henkel, 2000).

Additional factors that impact observational data include the interests, biases, backgrounds and values of researchers (Patton, 1990). Ms. Just and I have undergraduate degrees in biology. Our approach to riparian assessment is in keeping with evaluating suitable habitat for wildlife. Mr. Miller and Mr. Eaton both have forestry and range management backgrounds and experience. Both employees work for government offices whose missions involve sustaining resources for extractive purposes such as mining, logging or grazing. However, in speaking with these agents, I was aware of their ability to note impacts on streams from logging roads and cattle grazing with impartiality. Mr. Miller spoke of the difficulty of getting management to carry out rehabilitative suggestions for riparian areas when persons of political clout were connected to specific allotments. He stated that as a site improved there was mounting pressure to allow livestock to reenter the system for grazing, often before he thought a site was ready. Mr. Eaton's recommendation in response to one PFC rating was to remove cattle from the area. Their experience and training provided them with the ability to report what they were seeing, regardless of the accuracy of the PFC ratings.

Conclusions and Recommendations

Riparian areas perform many functions which provide economic and environmental benefits such as reduction in flood damage, improved water quality, groundwater recharge and habitat for wildlife. As water is a scarce resource in the Southwest, humans have settled in these areas both historically and in the present. Human activities have often resulted in degradation of these ecosystems. Assessment, restoration interventions and ongoing monitoring are now required to heal and preserve these vital ecosystems.

The PFC method is one such evaluation tool utilized by government employees on public lands. The PFC method also is currently taught to ranchers to assess riparian areas on grazing allotments and private land. This qualitative method, to be utilized properly, requires a minimum of three days training and a four person team consisting of experts in hydrology, soils, vegetation, and biology. Unfortunately, this method is not being taught or utilized properly in the field, due to constraints of time, finances and staffing. A non-degraded reference site or historic knowledge of the chosen study site is necessary to ascertain the potential of the system. Again, limitations of time and staffing often prevent this first step in PFC analysis from happening. This results in inaccurate ratings. If the prioritization system in the PFC manual is not followed as suggested, systems requiring intervention or more frequent monitoring may be mismanaged as a result of inaccurate categorizing.

The New Mexico Watershed Watch Riparian Survey includes both quantitative and qualitative data collection. The parameters are converted to a numerical rating system, corresponding from "poor" to "optimal" classification for the riparian ecosystems. The technique can be taught in an hour to community members and/or students. This increases the ability of this method to be used to assess the health of aquatic ecosystems in their community, thereby expanding community members' knowledge of the condition of their water resources. The more systematic method of measuring parameters in this survey also provides the means for establishing an ongoing database with consistent interpretation of the ecosystem into the future.

Both of these tools supports the proposition that a healthy riparian system provides habitat for a diversity of wildlife, particularly fish and birds. The criteria of the surveys provide information regarding essential components of the ecosystem, such as the geomorphology, soils and vegetation. Therefore, the parameters of the two methods are interrelated. This contributed to arriving at similar results for descriptions of conditions of study sites when utilizing both tools. Those systems receiving non-functional ratings for the PFC method corresponded to the lower numerical ratings for the NMWWRS. Those sites receiving the PFC rating corresponded to higher numerical ratings. The difference is that (in the PFC system) those with the lower ratings would have been regarded as too degraded to warrant intervention, while those same sites would have called for the higher priority for intervention (in the NMWWRS system). Both research approaches require that the entire watershed be considered including upland land use.

Differences in ratings between government employees and ours resulted from variations in training and lack of knowledge of soil types, historic conditions (both long ago and more recent), and reference sites. Given staffing and training limitations of the employees as well as their department supervisors' reluctance to follow protocol in response to the ratings, the question becomes whether this method is appropriate for assessing public riparian areas?

Jim Eaton described the final impact of PFC for him as providing some "idea" of the condition of the stream reaches. The results were utilized to prioritize restoration sites for McKinley-Ben Miller, although not according to protocols. Some of the headwaters for the BLM sites are located in the Cuba Ranger District of the Santa Fe National Forest, and the watersheds cross agency boundaries. The PFC method was supposed to provide the means to make management decisions for watersheds, based on a common understanding of this assessment approach. These men are the employees responsible for riparian assessment. They would collaborate on decisions if a watershed approach were utilized. However, their training and interpretation of the method varies. This is another indication that the intention for the PFC method as a commonly understood evaluation tool is not being fulfilled under current practices.

The NMWWRS may be a solution for a consistent rapid bioassessment tool for government agencies as well as stakeholders, such as ranchers, community members and students. Initial teams comprising professionals and lay people could set the stage for collaborative research and monitoring while providing the opportunity to input local knowledge of the study sites. The monitoring process would be carried out by community members with more timely repeat visits to areas. This would result in repetitive contributions of information to those individuals making management decisions. More detailed measurements of soil, vegetation and hydrology could follow where appropriate to contribute to specific management decisions. The same monitoring process utilizing the NMWWRS could be used to determine if the sites were progressing toward management goals. Ongoing studies of the projects could then determine if this technique is successful in providing effective assessment for riparian areas.

The PFC assessment is a qualitative method requiring 3 days training and a 4 person team of experts to identify problems in riparian functionality. Priority for remediation of sites is highest for those systems currently functioning, but at risk. The NMWWRS combines qualitative and quantitative evaluations. It can be taught in 1 hour to students and community members. Prioritization for site restoration are those systems with the lowest ratings. Both analyses recommend identifying a reference site or the historic conditions of the study site and ongoing monitoring of the stream reaches. Both methods agree that a healthy riparian habitat supports habitat for a diversity of wildlife. However, as the PFC method is not being utilized as intended, the NMWWRS may be more effective as an assessment and long term monitoring tool.

Glossary of Terms

Aquatic Ecosystem – The stream channel, water and biotic communities and the habitat features that occur therein, forming an interacting system.

Benthic – Association with the bottom of a water body.

Coarse Wood – Small pieces of wood which create hydraulic modifiers. Important in smaller streams, and then typically only when trapped in jams.

Community Type – An aggregation of all plant communities distinguished by floristic and structural similarities in both overstory and undergrowth layers. A unit of vegetation within a classification.

Diversity – The distribution and abundance of different plant and animal communities.

Facultative (FAC) Species – Plant species that are equally likely to occur in wetlands or non-wetlands.

Floodplain – A relatively flat landform adjacent to a stream that is composed of primarily unconsolidated depositional material derived from the stream and that is subject to periodic flooding.

Large Wood – Pieces of wood in a stream that affect channel morphology by splitting flows, dissipating stream energy, and capturing and storing sediment/bedload.

Lotic – Pertaining to a running water system.

Obligate Wetland (OBL) Species – Plant species that occur almost always under natural conditions in wetlands.

Riparian Areas – Geographically delineable area with distinctive resource values and characteristics that are comprised of the aquatic (and riparian) ecosystems, which depend on surface flow and associated ground water.

Riparian vegetation – Plant communities dependent upon the presence of free or unbound water near the ground surface.

Appendix A-Site Descriptions

Cuba Ranger District Sites

Clear Creek had 2 reaches assessed. The first was north of State Highway 126 and east of Forest Road 264. Elevation ranged from 8600 to 8800 feet. The soil type for the entire 1st site is considered river wash, which is a mixed alluvial soil with moderate erosion hazard. Riparian slopes are zero to 10%. Upland slopes are 15 to 40%. The upland area is a gravelly to cobbly loam with moderate to severe risk of erosion. The soil loss in tons per hectare, estimated in 1990 for slopes with both moderate and severe risk of erosion, was 2.1 tons per hectare per year. The vegetative community is mixed conifer. All soil types, erosion risks, and vegetative communities for the Santa Fe National Forest (unless stated observed) sites are taken from the *Terrestrial Ecosystem Survey of the Santa Fe National Forest* (USDA, 1993). Erosion risks are based on predicted erosion amounts if slopes were denuded of vegetation.

The southernmost site was comprised of a rock escarpment on the east side with boulders bordering the west, and a small flat floodplain below the boulders. Pines, shrubs, forbs and grass made up the riparian community. Woody debris had accumulated at the southern end of the reach. The second site had many riffles and pools formed from large boulders both in and bordering the stream. The streamside boulders were interspersed with grass and forbs. The 3rd site was a flat, slightly sinuous stream portion, with meadow as the surrounding riparian area. There were many cows here, resulting in bare soil and eroded streambanks.

Clear Creek, reach 2, begins south of Clear Creek Campground and flows east to the confluence with the Las Vacas stream. Elevation ranges from 8320 to 8200 feet. Soils range from loam at the west end of the site to loam, clay loam, and silty loam at the east end. Riparian soils have a moderate risk of erosion. Upland soils have severe risk. Slopes are zero to 15% for riparian and zero to 80% for upland slopes. The vegetation communities at the west end are fir, spruce and pine, with willows, grass and sedges dominating the eastern portion.

The first site, close to the confluence, is west of an area with moist soils and many wetland plants. The actual site has a dirt road to the south, separated from the stream by trees. Many willows and grasses line the banks of the stream. The second site flows through a meadow, again with grasses and willows on the banks. The third, the reach furthest upstream, have dead trees and grass on the south bank that protrude into the stream, and upland species such as cinqfoil (a shrub) on the northern bank.

Palomas Creek or the Rito de las Palomas reach extends about 3 miles south of Forest Road 70. The elevation ranges from 9200 to 8200 feet. We estimated our sites occurred only as low as 8600 feet, as we walked in about 2 of the 3 miles, due to steep terrain alternating with extremely soggy soils with dense vegetation and roots. Riparian slopes are zero to 10%. Upland slopes are 15 to 80%, with moderate to severe risk of erosion. The upland vegetation communities include spruce, fir, pine and oak. The riparian soil is a deep and very stony to sandy loam. Upland soils are deep, cobbly loam and sandy loam, with high erosion risk.

The first stream site contained many uprooted trees. Adjacent soil was very moist. Plants noted were water hemlock, equisetum, yarrow, fleabane and grasses. The second stream section flowed through a meadow. It contained an eroded pointbar, and evidence of bank trampling by cattle. Mixed conifers occurred in the upland region. A dirt road lies northeast of the stream. The third site was immediately south of Forest Road 70. The ground was saturated. Moss grew on rocks in the stream, on fallen logs and the soil. Filamentous algae occurred in the stream. Again, equisetum and water hemlock were noted.

American Creek flows north to south and lies west of Forest Road 69. Its elevation starts at about 8600 feet and ends at 8100 feet, where it flows into Palomas Creek, on private land. The stream bottom soils range from gravelly, sandy loam to bouldery loam in the north, with clay loam and silty clay loam in the middle, to cobbly and sandy loam, just above the private land, where the assessment site ends. Riparian slopes are zero to 15% and upland slopes are 15 to 80%. Erosion is of moderate risk in the streambed material and of moderate to severe risk in the adjacent upland area. Spruce, fir, pine and oak communities are present.

The southernmost site contains a beaver dam that flooded a large meadow area some time ago, as evidenced by numerous dead trees. There is an active beaver dam at the end of the site, with evidence of beaver cut trees in the area. This stream site contains mid-channel bars vegetated with grass. The riparian area supports a mixture of wetland and upland plants, such as rushes and cinqfoil (shrubs). The second site is on moderately hilly ground, with large rocks and a small amount of woody debris in the stream. The dominant plants are grasses. The soil is very wet. The third site is a sinuous stretch, through a meadow, south of a dirt access road (no name). There are grasses, sedges, and rushes. Two small lateral cuts exist where water entered the stream from the east meadow.

The **Rio de las Vacas** also includes 2 survey areas. The first begins south of State highway 126 and also south of the Las Vacas campground. It ends where this portion of the stream again crosses Highway 126. The elevation ranges between 8200 and 8100 feet. The soils are loam, clay loam, and silty clay loam. Plant communities are willow, grasses and sedges. Riparian area occurs on zero to 15% slopes with moderate risk of erosion, and upland slopes are zero to 40% slopes with severe risk. This portion of the stream is very braided and contains many active beaver dams.

The first site has flattened willows along the banks, a beaver dam, and adjacent meadows for a short distance, rising up to the mixed conifer forest. The second site supports a riparian community of alders and grasses. The third is a very rocky stream section immediately south of State Highway 126, with much woody debris, a sand bar to the east, and little riparian vegetation. A spruce fir forest is west of this site.

The second reach of the Las Vacas is south of a Girl Scout camp, west of Forest Road 20. Elevation is about 7800 feet. The soils are loam, clay loam and silty clay loam at the north end of the site, and cindery sandy loam, very cobbly sandy loam, cobbly sandy loam, sandy loam and loam. The vegetation communities contain Kentucky bluegrass, sedge, and willow in the riparian area, and ponderosa pine, and oak in the uplands. Riparian slopes are zero to 15% with moderate erosion risk. Upland slopes are 15 to 120% with moderate to severe erosion risk.

The riparian vegetation noted on the first site are browsed willows (one height), short grass, rosehips, mullein, cinqfoil, and yarrow. The banks have many undercuts. Here we saw a large fish (about 8 inches). The second site contains a very rocky point bar with a small amount of vegetation. There is filamentous algae in the main channel. The immediate riparian community is comprised of willows and grasses. The south bank is eroding. North of the main channel is a dry channel, thick with willows and grasses. The third site is the most degraded. The lower banks are rocky. Tree roots are exposed. A sidecut is advancing into the southern meadow. There are tires in the stream channel. The northern upland bank is steep and eroding.

The **Rito Penas Negras** reach lies south of Forest Road 264 and east of State Highway 126. Elevation ranges from 8120 to 8160 feet. Soil types are cobbly, sandy loam, clay loam, silty, clay loam, and sandy loam, with moderate to severe risk of erosion. Riparian slopes range from zero to 15%, while upland slopes are zero to 40%. Vegetation communities are fir, pine, and oak, and sedge, willow and bluegrass.

The first site is shallow and sinuous, winding past eroding mounds. The lower banks are often bare and eroding with many lateral cuts. Grasses are the dominant vegetation. The second site is a meander that lies south and at the bottom of an eroding bank. South of the meander, but just north of an upland slope, is a small meadow area containing woody debris, grasses and wetland plants. Site 3 is similar to site 2.

The **Rock Creek** reach is situated immediately south of Forest Road 103 and east of the junction of F.R. 103 and State Highway 126. Elevation is 8240 feet to 8400 feet. Soils are clay loam and silty, clay loam. Vegetation communities are sedges, willow, and bluegrass. Erosion risk is moderate. Riparian slopes are zero to 15%. Upland slopes are zero to 40% with moderate to severe risk of erosion. The first site has a rock and wire gabion on the northern bank. A small wetland area lies west of the gabion. The south bank grows shrubs and grasses. The second stream site is at the bottom of 2 slopes. The stream is narrow with a small amount of woody debris. Short grasses and upland forbs comprise the riparian vegetation. The third site is north of a cowpath. A patch of small spruces occupies the bank, along with yarrow, red clover, grasses and shrubs. The stream is narrow and shallow.

Bureau of Land Management Sites

The **Rito Leche** reach is southeast of Cuba, New Mexico, and crosses State Highway 126. Elevation is 6900 to 7100 feet. The soil is a Hickman clay loam (Scheffe, 2000). Hazard of water erosion is slight. Riparian slopes are 1 to 3% and upland slopes are 1 to 15% with moderate risk of erosion.

Two sites assessed on the Rito Leche are within a livestock exclosure. The first site was adjacent to the exclosure fence. Vegetation includes cattails, equisetum, rushes and grasses. The rushes are pressed flat. The stream is narrow with a high sediment content. An upland bank is eroded, but it is evident that vegetation is spreading upward. The second site has an old cottonwood tree on the bank, large woody debris in the stream, an eroded southeastern bank, and riparian vegetation on the northwest floodplain area. The vegetation includes willows and equisetum. The third site, outside of the exclosure is east of a beaver dam. The south bank is steep and the north bank crumbles into the stream at the edge. A beaver had cut down the last remaining large cottonwood on the south bank. There are a few young ones remaining. The dominant vegetation is sparse stands of grass. This area was not evaluated by the BLM.

Senorito Canyon contains one of the few perennial streams that flows into the Rio Puerco. The confluence with the Puerco is approximately 5 miles south of Cuba. The assessed reach extends for a length of 2 miles northeast of State Highway 44. The soils along the streambank are sandy clay loam and clay loam. The soil contains much salt and vertical cracks are common (BLM, 1998). The dominant vegetation cover is black greasewood, shadscale and big sagebrush. The understory is dominated by alkali sacaton (BLM, 1998). Riparian slopes are zero to 3% and upland slopes are zero to 25%.

Two sites were assessed within the eastern exclosure. The first site is upstream from an active beaver dam. The south floodplain area contains a mixture of wetland and upland plants. The north upper bank supports willows and sedges. The second site is located south of a degraded area with eroding banks and little vegetation. McKinley-Ben Miller (the BLM riparian specialist) explained that this area had been a watering corridor for livestock. The study area occurs in a section where the stream diverges into an area of slackwater and a southern flowing channel. The slackwater ends where there is a large slump from the vertical northern wall of the canyon. Close to the channel are willows and rushes. Several feet back there is mixture of riparian (salt cedar) and upland shrubs (chamisa). The third site was noted but not assessed as there is no water. The dry channel passes through a densely vegetated area of dry equisetum, willows and grasses. There is evidence that beaver chewed through PVC pipe that was installed to protect small cottonwoods.

The soil descriptions for the Coal Creek, Wilson Creek, and Lost Valley portions of the Rio Puerco, along with the Senorito, are taken from the *Soil Survey, Cabezon Area, New Mexico*, (USDA,1968). Vegetation community descriptions from this manual are very general, such as "native grasses", and so site specific vegetation is provided when available from field notes.

Coal Creek is a 3 mile reach of the Puerco River, south of Cuba, N.M. and immediately north of Ventana. Elevation ranges approximately from 6500 to 6600 feet. Soil descriptions include clay loam, clay, silty clay loam with much lime and gypsum, and soil material that is saline and alkaline. Riparian slopes are zero to 3% and upland slopes are 3 to 25%.

A high, vertical bank borders the north side of the first site. Salt cedar and Russian olive are the dominant vegetation at the top of the bank. The southern upper bank, which supports some willow plants and other shrubs, is eroding. The lower bank is essentially a mudflat with a shallow stand of water on the north side. The flood plain is inaccessible. The second site has access to the flood plain, which is very sandy. Riparian plants are present on the south bank and can be seen in the slide taken, but were not identified in the field notes. There is an area which has slumped from the vertical cliff on the north side. Only 2 sites were assessed on this reach, due to little variation in sites.

Wilson Canyon is located approximately 1 mile south of the confluence of Senorito Creek and the Rio Puerco along the west side of State Highway 44. It extends 1.5 miles in length. Elevation is around 6600 feet. Soils are clay and silty clay with high risk of water erosion. Riparian slopes are zero to 3%. Upland slopes are 1 to 25%. The 1968 survey stated that the lower end of this reach contained upland soils that supported blue grama, sacaton and galleta. The first site has a sandy floodplain, sparsley vegetated with burdock, equisetum, salt cedar and juncas. The streambed contains mid-channel sandbars. The northern side at the south end is bordered by steep, vertical cliffs. The second site has a small burn area amidst the salt - cedar on the south bank. Willow, equisetum, and asters also grow on the flood plain. The channel portion that contains water is adjacent to the north bank, below a stand of saltcedar, Russian olive, and chamisa. Again, only 2 sites were assessed.

Lost Valley is a reach on the Rio Puerco that lies about 3 quarters of a mile south of San Luis and about a half mile north of Cabezon peak. Elevation ranges from 6160 to 6100 feet. Soils are clay to silty clay, saline and alkaline. Danger of water erosion is high. Riparian slopes are zero to 3%. Upland slopes are zero to 25%. Because the entire reach is approximately 3 and a half miles, 2 reaches were assessed.

The first site of reach 1 (north end) has a dense stand of saltcedar and Russian olive on either upper bank. A PVC fence was strung across the stream to contain cattle. The lower banks are eroding. The stream channel is a mud flat with a small, shallow pool of water. The stream contains numerous cow hoofprints and manure. Extreme areas of "piping" (vertical crevices in saline soils) are present on the upland areas. The second site of the first reach has the usual wide stream channel with a narrow, shallow flow of water below the southern bank, which is eroding. The northern bank is a series of terraced mud flats with no vegetation, until the third level.

Russian olive, saltcedar, and a few cottonwoods are on the upper terrace. The vegetation for the southern bank wasn't described in the field notes.

Only one site was assessed at the southern end due to lack of water further south. This area reveals a steep cliff on the north end with a shorter vertical bank at the south end. These banks support Russian olive and saltcedar. The southern bank slopes down to the streambank, where a narrow area of water flows. On this portion, willows grow.

The southernmost reach assessed was the **Rio Salado**, extending about a mile west of the bridge at San Ysidro. Soil type is called "riverwash", consisting of sandy or silty clay or gravelly sediment. Elevation is about 1,720 feet. Riparian slopes are zero to 3%, while upland slopes are only slightly steeper at zero to 5% with slight risk of erosion.

Adjacent to New Mexico State Highway 44 is a man-made wetland, supplied with water from the return flow of an irrigation ditch. This comprises the northern bank of our first site. The streambed is flat and wide and consists of mudflats interwoven with rivulets of flow. The dominant vegetation on the southern bank is saltcedar. The second site is similar to the first in that an eroding sandy southern bank supports saltcedar. The northern bank contains salt cedar, Russian olive, sedges, and grass. The streambed is comparable.

Appendix B-Data Sheets

Santa Fe National Forest Sites Proper Functioning Condition	Sites and Data Collection Date Clear Creek 1-1 9-24	Clear Creek 1-2 9-24	Clear Creek 1-3 9-24	Clear Creek 2-1 9-25	Clear Creek 2-1 9-25
Hydrology					
Floodplain above bankfull is inundated in relatively frequent events	Y	Y	Y	Y	Y
Beaver dams active and stable	Y	N	N	N	N
Sinuosity, width/depth ratio and gradient in balance with landscape	Y	Y	Y	Y	Y
Riparian-wetland area is widening or has achieved potential extent	Y	Y	N	Y	N
Upland watershed is not contributing to riparian wetland degradation	No-grazing	No-grazing	N-grazing	N-grazing	N-grazing
Vegetation					
Diverse age-class distribution of riparian-wetland veg	Y	Y	N	Y	Y
Diverse composition of riparian-wetland veg	Y	Y	Y	Y	Y
Species present indicate maintenance of riparian-wetland soil moisture characteristics	Y	Y	N	Y	Y
Streambank veg is comprised of those plants or plant communities that have root masses capable of withstanding high streamflow events	Y	Y	N	Y	Y
Riparian-wetland plants exhibit high vigor	Y	Y	N	Y	Y
Adequate riparian-wetland veg. cover present to protect banks and dissipate energy during high flows	Y	Y	N	Y	Y
Plant communities are an adequate source of coarse and/or large woody material	Y	Y	N	Y	Y
Erosion Deposition					
Floodplain and channel characteristics adequate to dissipate energy	Y	Y	N	Y	Y
Point bars are revegetating with riparian –wetland vegetation	Y	Y	N/A	Y	Y
Lateral stream movement is associated with natural sinuosity	Y	Y	N	Y	Y
System is vertically stable	Y	Y	N	L-Y,R-N	N
Stream is in balance with the water and sediment being supplied by the watershed	Y	Y	N	Y	Y
Functional Rating /Trend	PFC	PFC	NF	F-at risk	F-at risk

N.M. Watershed Riparian Survey

Parameter	Optimal	Sub-optimal	Fair	Poor	Rating	Rating	Rating	Rating	Rating
Riparian Veg Structural Diversity	>3 height classes grasses/ shrubs/tree	2 height classes mostly trees	1 height class grass/forb	1 height class sparse veg.	L/R 4/4	L/R 4/4	L/R 2/2	L/R 4/4	L/R 4/ 4
Lower Bank Stability	Stable, no erosion	Some erosion	Unstable/ erosion	Unstable/ Eroding	4/4	¾	1/ 2	4/4	3/ 3
Bank Cover	90% cover	70-89% cover	50-69% cover	< 50% cover	1/1	3/2	3/3	3/3	3/ 3
Veg.Buffer Width (meters or feet)	>18 meters (60 ft) on least buffered side	12-18 meters (40-60 ft)	6-12 meters (20-40 ft)	< 6 meters (20 ft)	4	4	4	1 road	4
Veg Diversity	> 20 plant species	15-19 plant species	5-14 plant species	0-5 plant species	4/2	4/2	2/2	2/ 2	2/ 2
Embedded-ness	Substrate surrounded by <25% fine sediment	25-50%	50-75%	>75%	3	3	1	3	3
Flow m3/sec (cfs) *COLD* *WARM*	>0.05 (2cfs) >0.15 (5 cfs)	0.03-0.05 (1-2) 0.05-15 (2-5)	0.01-0.03 (0.5-1) 0.03-0.05	<0.01 <0.03	4	4	4	2	1
Canopy Shading the Water	Mixed sun and shade	Sparse canopy Filtered light	Nearly complete Sun or shade	No shade Complete sun	4	4	2/2	4/4	4
Width to Depth Ratio of Lower Bank	Ratio<7	8-15	15-25 over bank flow	>25 not contained	4	3	3	4	3
Pools and Riffles	Ratio=5 to 7	7-15	15-25	>25	4	4	1	4	4
Streambed Geology	>50% boulders, cobbles, gravel or logs	25-50	10-25	<10%	1	4	1	3	3
Total/11					L 3.4 R3.18,A3.3	L3.6 R3.7.A3.7	L2.18 R2.3,A2.2	L3.1 R3.1	L3.1 R3.1
Benthic invertebrate in order of dominance (not counted in rating)					s-M-c-m	s-sn=b-c	s	c-M-b	c-M-b-s
s=stoneflies, c=caddisflies, b=beetles, M=mayflies, m=midges, sn=snails									

Santa Fe National Forest Sites Proper Functioning Condition					Sites and Data Collection Dates Clear Creek 2-3 9-25	Palomas 1-1 9-28	Palomas 1-2 9-28	Palomas 1-3 9-28	American Creek 1-1 9-28
Hydrology									
Floodplain above bankfull is inundated in relatively frequent events					Y	Y	Can't tell	Y	Y
Beaver dams active and stable					N/A	N/A	N/A	N/A	N(present)
Sinuosity, width/depth ratio and gradient in balance with landscape					Y	Y	Y	Y	Y
Riparian-wetland area is widening or has achieved potential extent					N	Y	Y	Y	Y
Upland watershed is not contributing to riparian wetland degradation					N-grazing	N-grazing	N-grazing	N-road	N-grazing
Vegetation									
Diverse age-class distribution of riparian-wetland veg					Y	Y	Y	Y	Y
Diverse composition of riparian-wetland veg					Y	Y	Y	Y	Y
Species present indicate maintenance of riparian-wetland soil moisture characteristics					N	Y	Y	Y	Y
Streambank veg is comprised of those plants or plant communities that have root masses capable of withstanding high streamflow events					Y	N	N	N	Y
Riparian-wetland plants exhibit high vigor					Y	Y	Y	Y	Y
Adequate riparian-wetland veg. cover present to protect banks and dissipate energy during high flows					Y	Y	N	N	Y
Plant communities are an adequate source of coarse and/or large woody material					Y	Y	Y	Y	Y
Erosion Deposition									
Floodplain and channel characteristics adequate to dissipate energy					Y	Y	N	Y	Y
Point bars are revegetating with riparian –wetland vegetation					Y	Y	N	N	Y
Lateral stream movement is associated with natural sinuosity					Y	Y	Y	Y	Y
System is vertically stable					Y	N	N-cows	N-cows	Y
Stream is in balance with the water and sediment being supplied by the watershed					Y	Y	Y	Y	Y
Functional Rating					F-at risk	PFC	F-at risk	F- at risk	F-at risk
N.M. Watershed Riparian Survey									
Parameter	Optimal	Sub-optimal	Fair	Poor	Rating	Rating	Rating	Rating	Rating
Riparian Veg Structural Diversity	>3 height classes grasses/ shrubs/tree	2 height classes mostly trees	1 height class grass/forb	1 height class sparse veg.	L/R 4/3	L/R 4/4	L/R 2/2	L/R 3/3	L/R 2/2
Lower Bank Stability	Stable, no erosion	Some erosion	Unstable/ erosion	Unstable/ Eroding	4/4	3/3	3/3	4/2	3/3
Bank Cover	90% cover	70-89% cover	50-69% cover	< 50% cover	4/4	2/3	4/4	2/1	4/4
Veg.Buffer Width (meters or feet)	>18 meters (60 ft) on least buffered side	12-18 meters (40-60 ft)	6-12 meters (20-40 ft)	< 6 meters (20 ft)	4	4	4	4	4
Veg Diversity	> 20 plant species	15-19 plant species	5-14 plant species	0-5 plant species	2/2	3/3	2/2	2/2	3
Embedded-ness	Substrate surrounded by <25% fine sediment	25-50%	50-75%	>75%	3	3	3	3	3
Flow m2/sec (cfs) COLD / *WARM*	>.05 (2cfs) >.15 (5 cfs)	0.03-0.05 (1-2) 0.05-15 (2-5)	0.01-0.03 (.5-1) 0.03-0.05	<0.01 <0.03	3	3	3	4	4
Canopy Shading the Water	Mixed sun and shade	Sparse canopy Filtered light	Nearly complete Sun or shade	No shade Complete sun	2	4	2/2	3	3/2
Width to Depth Ratio of Lower Bank	Ratio<7	8-15	15-25 over bank flow	>25 not contained	3	2	3	3	4
Pools to Riffles Ratio	Ratio=5 to 7	7-15	15-25	>25	1	4	2	4	4
Streambed Geology	>50% boulders, cobbles, gravel or logs	25-50	10-25	<10%	2	3	2	3	3
Total/11					L 2.9 R2.8,A2.9	L3.2 R3.3,A3.3	L2.7 R2.7	L3.2 R2.9,A3.1	L3.4 R3.3,A3.4
Benthic invertebrates in order of dominance (= means equal no. of)					c=l=w	s,c, M=b	s,c,M,sn=m	c,s,d	c,s=M,m,f
s=stoneflies, c=caddisflies, b=beetles, M=mayflies, m=midge fly larva, sn=snails, l=leeches, w=aquatic worms, d=dragonflies, f=flatworms									

Santa Fe National Forest Sites Proper Functioning Condition					Sites and Data Collection Dates				
					American Creek 1-2 9-28	American Creek 1-3 9-28	Las Vacas 1-1 10-2	Las Vacas 1-2 10-2	Las Vacas 1-3 10-2
Hydrology									
Floodplain above bankfull is inundated in relatively frequent events					Y	Y	Y	Y	Y
Beaver dams active and stable					N/A	N/A	Y	N/A	N/A
Sinuosity, width/depth ratio and gradient in balance with landscape					Y	Y	Y	Y	Y
Riparian-wetland area is widening or has achieved potential extent					Y	Y	Y	Y	N
Upland watershed is not contributing to riparian wetland degradation					N-grazing	N-grazing	N-grazing	N-grazing	N-grazing and road
Vegetation									
Diverse age-class distribution of riparian-wetland veg					Y	N	Y	Y	Y
Diverse composition of riparian-wetland veg					Y	Y	Y	Y	Y
Species present indicate maintenance of riparian-wetland soil moisture characteristics					Y	Y	Y	Y	N
Streambank veg is comprised of those plants or plant communities that have root masses capable of withstanding high streamflow events					Y	Y	Y	Y	N
Riparian-wetland plants exhibit high vigor					Y	Y	Y	Y	N
Adequate riparian-wetland veg. cover present to protect banks and dissipate energy during high flows					Y	Y	N	N	N
Plant communities are an adequate source of coarse and/or large woody material					N	N	Y	Y	Y
Erosion Deposition									
Floodplain and channel characteristics adequate to dissipate energy					Y	N	N	Y	N
Point bars are revegetating with riparian –wetland vegetation					Y	Y	N	N/A	N
Lateral stream movement is associated with natural sinuosity					Y	N	Y	Y	N
System is vertically stable					N	Y	N	N	N
Stream is in balance with the water and sediment being supplied by the watershed					Y	N	N	N	N
Functional Rating					F-at risk	F-at risk	F-at risk	F-at risk	NF-road
N.M. Watershed Riparian Survey									
Parameter	Optimal	Sub-optimal	Fair	Poor	Rating	Rating	Rating	Rating	Rating
Riparian Veg Structural Diversity	>3 height classes grasses/ shrubs/tree	2 height classes mostly trees	1 height class grass/forb	1 height class sparse veg.	2/2	2/2	3/3	2/2	3/3
Lower Bank Stability	Stable, no erosion	Some erosion	Unstable/ erosion	Unstable/ Eroding	3/3	4/4	2/2	2/2	1/1
Bank Cover	90% cover	70-89% cover	50-69% cover	< 50% cover	4/4	4/2	1/1	1/1	1/1
Veg.Buffer Width (meters or feet)	>18 meters (60 ft) on least buffered side	12-18 meters (40-60 ft)	6-12 meters (20-40 ft)	< 6 meters (20 ft)	4	4	4/4	4	1
Veg Diversity	> 20 plant species	15-19 plant species	5-14 plant species	0-5 plant species	2/2	3	3/2	3/3	2/2
Embedded-ness	Substrate surrounded by <25% fine sediment	25-50%	50-75%	>75%	3	2	3	3	3
Flow m2/sec (cfs) *COLD* *WARM*	>0.05 (2cfs) >0.15 (5 cfs)	0.03-0.05 (1-2) 0.05-15 (2-5)	0.01-0.03 (0.5-1) 0.03-0.05	<0.01 <0.03	4	3	4	4	4
Canopy Shading the Water	Mixed sun and shade	Sparse canopy Filtered light	Nearly complete Sun or shade	No shade Complete sun	2/2	2/3	4/4	4	2/2
Width to Depth Ratio of Lower Bank	Ratio<7	8-15	15-25 over bank flow	>25 not contained	3	4	2	2	2
Pools to Riffles Ratio	Ratio=5 to 7	7-15	15-25	>25	2	4	4	4	4
Streambed Geology	>50% boulders, cobbles, gravel or logs	25-50	10-25	<10%	2	3	3	3	3
Total/11 **Benthic invertebrates in order of dominance (= means equal no. of)**					L2.8 R2.8 b,M=c,m	L3.2 R3.1,A3.2 M=c,s	L3 R2.9,A3.0 M,s,c,m	L2.9 R2.9 M,s=c	L2.4 R2.4 s,M,c,b
s=stoneflies, c=caddisflies, b=beetles, M=mayflies, m=midge fly larva, sn=snails, l=leeches, w=aquatic worms, d=dragonfly									

Santa Fe National Forest Sites Proper Functioning Condition					Sites and Data Collection Dates Las Vacas 2-1 10-6	Las Vacas 2-2 10-6	Las Vacas 2-3 10-6	Penas Negras 1-1 10-8	Penas Negras 1-2 10-8
Hydrology									
Floodplain above bankfull is inundated in relatively frequent events					Y	Y	N	N	Y/N
Beaver dams active and stable					N/A	N/A	N/A	N/A	N/A
Sinuosity, width/depth ratio and gradient in balance with landscape					N	N	N	N	N
Riparian-wetland area is widening or has achieved potential extent					N	N	N	N	N
Upland watershed is not contributing to riparian wetland degradation					N-grazing	N-grazing	N-grazing	N	N
Vegetation									
Diverse age-class distribution of riparian-wetland veg					N	Y	N	N	N
Diverse composition of riparian-wetland veg					N	N	Y	Y	Y
Species present indicate maintenance of riparian-wetland soil moisture characteristics					N	Y	N	N	Y/N
Streambank veg is comprised of those plants or plant communities that have root masses capable of withstanding high streamflow events					N	N	N	N	N
Riparian-wetland plants exhibit high vigor					Y	Y	N	N	N
Adequate riparian-wetland veg. cover present to protect banks and dissipate energy during high flows					N	N	N	N	N
Plant communities are an adequate source of coarse and/or large woody material					N	N	N	N	N
Erosion Deposition									
Floodplain and channel characteristics adequate to dissipate energy					N	N	N	N	N
Point bars are revegetating with riparian –wetland vegetation					N	N	N	N	N
Lateral stream movement is associated with natural sinuosity					Y	N	N	N	N
System is vertically stable					N	N	N	N	N
Stream is in balance with the water and sediment being supplied by the watershed					N	N	N	N	N
Functional Rating					NF,yet fish	NF	NF	NF	NF
N.M. Watershed Riparian Survey									
Parameter	Optimal	Sub-optimal	Fair	Poor	Rating	Rating	Rating	Rating	Rating
Riparian Veg Structural Diversity	>3 height classes grasses/ shrubs/tree	2 height classes mostly trees	1 height class grass/forb	1 height class sparse veg.	L/R 2/3	L/R 3/2	L/R 2/1	L/R 2/2	L/R 1/ 2
Bank Stability	Stable, no erosion	Some erosion	Unstable/ erosion	Unstable/ Eroding	2/1	2/2	1/1	1/1	1/1
Bank Cover	90% cover	70-89% cover	50-69% cover	< 50% cover	1/1	1/1	1/1	1/1	1/1
Veg.Buffer Width (meters or feet)	>18 meters (60 ft) on least buffered side	12-18 meters (40-60 ft)	6-12 meters (20-40 ft)	< 6 meters (20 ft)	4	4	1	1	1
Veg Diversity	> 20 plant species	15-19 plant species	5-14 plant species	0-5 plant species	2/2	2/2	2/2	2	1/ 2
Embedded-ness	Substrate surrounded by <25% fine sediment	25-50%	50-75%	>75%	2	3	3	1	2
Flow m2/sec (cfs) COLD	>0.05 (2cfs)	0.03-0.05 (1-2)	0.01-0.03 (0.5-1)	<0.01	4	4	4	4	4
WARM	>0.15 (5 cfs)	0.05-15 (2-5)	0.03-0.05	<0.03					
Canopy Shading the Water	Mixed sun and shade	Sparse canopy Filtered light	Nearly complete Sun or shade	No shade Complete sun	2/2	1/1	1/1	1/1	1/1
Width to Depth Ratio of Lower Bank	Ratio<7	8-15	15-25 over bank flow	>25 not contained	3	2	2	3	4
Pools to Riffles Ratio	Ratio=5 to 7	7-15	15-25	>25	4	4	4	4	2
Streambed Geology	>50% boulders, cobbles, gravel or logs	25-50	10-25	<10%	4	4	4	2	1
Total/11					L2.7 R2.7	L2.7 R2.6,A2.7	L2.5 R2.2,A2.4	L2.0 R2.0	L1.7 R1.9.A1.8
Benthic invertebrates in order of dominance (= means equal no. of)					sn,cc,M, s=m	sn,M,s,c,b	M=c,s,sn b=m	c,sn,s,b,M, m	sn,s,c=M m,b
s=stoneflies, c=caddisflies, b=beetles, M=mayflies, m=midge fly larva, sn=snails, l=leeches, w=aquatic worms, d=dragonfly									

Santa Fe National Forest Sites Proper Functioning Condition	Sites and Data Collection Dates			
	Penas Negras 1-3 10-8	Rock Creek 1-1 10-8	Rock Creek 1-2 10-8	Rock Creek 1-3 10-8
Hydrology				
Floodplain above bankfull is inundated in relatively frequent events	Y	N-road	N-road	N-road
Beaver dams active and stable	N/A	N/A	N/A	N/A
Sinuosity, width/depth ratio and gradient in balance with landscape	N	N	N	N
Riparian-wetland area is widening or has achieved potential extent	N	L-Y/N-road	N	N
Upland watershed is not contributing to riparian wetland degradation	N-grazing	N-grazing	N-grazing	N-grazing
Vegetation				
Diverse age-class distribution of riparian-wetland veg	Y	N	N	N
Diverse composition of riparian-wetland veg	Y	Y	Y	Y
Species present indicate maintenance of riparian-wetland soil moisture characteristics	N	Y	N	N
Streambank veg is comprised of those plants or plant communities that have root masses capable of withstanding high streamflow events	N	N	N	N
Riparian-wetland plants exhibit high vigor	Y	Y	Y	Y
Adequate riparian-wetland veg. cover present to protect banks and dissipate energy during high flows	N	N	N	N
Plant communities are an adequate source of coarse and/or large woody material	N	N	Y	N
Erosion Deposition				
Floodplain and channel characteristics adequate to dissipate energy	N	Y	N	N
Point bars are revegetating with riparian –wetland vegetation	N	Y	Y	N/A
Lateral stream movement is associated with natural sinuosity	N	N	N	N
System is vertically stable	N	N	N	N
Stream is in balance with the water and sediment being supplied by the watershed	N	Y	N	N
Functional Rating /Trend	NF	NF	NF	NF

N.M. Watershed Riparian Survey								
Parameter	Optimal	Sub-optimal	Fair	Poor	Rating	Rating	Rating	Rating
Riparian Veg Structural Diversity	>3 height classes grasses/ shrubs/tree	2 height classes, mostly trees	1 height class grass/forb	1 height class sparse veg.	L/R 2/2	L/R 2/2	L/R 2/2	L/R 2/2
Bank Stability	Stable, no erosion	Some erosion	Unstable/ erosion	Unstable/ Eroding	1/1	2/3	2/1	2/1
Bank Cover	90% cover	70-89% cover	50-69% cover	< 50% cover	1/1	2/2	2/1	3/3
Veg.Buffer Width (meters or feet)	>18 meters (60 ft) on least buffered side	12-18 meters (40-60 ft)	6-12 meters (20-40 ft)	< 6 meters (20 ft)	3	1	2	2
Veg Diversity	> 20 plant species	15-19 plant species	5-14 plant species	0-5 plant species	2/2	2/2	2/2	2/2
Embeddedness	Substrate surrounded by <25% fine sediment	25-50%	50-75%	>75%	2	3	2	2
Flow m2/sec (cfs) COLD / WARM	>0.05 (2cfs) >0.15 (5 cfs)	0.03-0.05 (1-2) 0.05-15 (2-5)	0.01-0.03 (.5-1) 0.03-0.05	<0.01 <0.03	4	2	2	2
Canopy Shading the Water	Mixed sun and shade	Sparse canopy Filtered light	Nearly complete Sun or shade	No shade Complete sun	1/1	1/1	1/1	2/2
Width to Depth Ratio of Bank	Ratio<7	8-15	15-25 over bank flow	>25 not contained	3	3	3	3
Pools to Riffles Ratio	Ratio=5 to 7	7-15	15-25	>25	3	4	4	1
Streambed Geology	>50% boulders, cobbles, gravel or logs	25-50	10-25	<10%	2	3	4	1
Total/11					L2.2 R2.2	L2.3 R2.4,A2.4	L2.4 R2.2,A2.3	L2 R1.9,A2.0
Benthic invertebrate in order of dominance (not counted in rating)					s,M,c,b	s,M,c,b,f	M,b,sn	s,M,m
s=stoneflies, c=caddisflies, b=beetles, M=mayflies, m=midges, sn=snails, f=flatworms								

Bureau of Land Management Sites Proper Functioning Condition	Sites and Data Collection Dates: Rito Leche 1-1 10-12	Rito Leche 1-2 10-12	Rito Leche 1-3 10-12	Coal Creek 1-1 10-12	Coal Creek 1-2 10-12
Hydrology					
Floodplain above bankfull is inundated in relatively frequent events	Y	Y	N	R-Y, L-N	R-N,L-Y
Beaver dams active and stable	N/A	N/A	Y	N/A	N/A
Sinuosity, width/depth ratio and gradient in balance with landscape	N	N	N	N	N
Riparian-wetland area is widening or has achieved potential extent	Y	N	N	N	N
Upland watershed is not contributing to riparian wetland degradation	N-grazing	N-grazing	N-grazing	N-grazing	N-grazing
Vegetation					
Diverse age-class distribution of riparian-wetland veg	Y	Y	Y	Y	Y
Diverse composition of riparian-wetland veg	Y	Y	Y	Y	Y
Species present indicate maintenance of riparian-wetland soil moisture characteristics	Y	Y	N	Y	Y
Streambank veg is comprised of those plants or plant communities that have root masses capable of withstanding high streamflow events	Y	N	N	N	N
Riparian-wetland plants exhibit high vigor	Y	N	N	Y	Y
Adequate riparian-wetland veg. cover present to protect banks and dissipate energy during high flows	N	N	N	N	N
Plant communities are an adequate source of coarse and/or large woody material	N	Y	Y	N	N
Erosion Deposition					
Floodplain and channel characteristics adequate to dissipate energy	N	N	N	N	N
Point bars are revegetating with riparian –wetland vegetation	Y	N	N/A	N	N
Lateral stream movement is associated with natural sinuosity	N	N	N	N	N
System is vertically stable	N	N	N	N	N
Stream is in balance with the water and sediment being supplied by the watershed	N	N	N	N	N
Functional Rating /Trend	NF/U Exclosure	NF/U Exclosure	N/F	N/F	N/F

N.M. Watershed Riparian Survey

Parameter	Optimal	Sub-optimal	Fair	Poor	Rating	Rating	Rating	Rating	Rating
Riparian Veg Structural Diversity	>3 height classes grasses/ shrubs/tree	2 height classes mostly trees	1 height class grass/forb	1 height class sparse veg.	L/R 4/3	L/R 4/4	L/R 4/2	L/R 4/4	L/R 3/3
Lower Bank Stability	Stable, no erosion	Some erosion	Unstable/ erosion	Unstable/ Eroding	1/1	1/1	1/1	1/1	1/1
Bank Cover	90% cover	70-89% cover	50-69% cover	< 50% cover	2/1	1/1	1/1	1/1	1/1
Veg.Buffer Width (meters or feet)	>18 meters (60 ft) on least buffered side	12-18 meters (40-60 ft)	6-12 meters (20-40 ft)	< 6 meters (20 ft)	4	4	4	4	4
Veg Diversity	> 20 plant species	15-19 plant species	5-14 plant species	0-5 plant species	2/2	2/2	2/2	2/2	2/1
Embedded-ness	Substrate surrounded by <25% fine sediment	25-50%	50-75%	>75%	1	1	1	1	1
Flow m2/sec (cfs) COLD WARM	>0.05 (2cfs) >0.15 (5 cfs)	0.03-0.05 (1-2) 0.05-15 (2-5)	0.01-0.03 (.5-1) 0.03-0.05	<0.01 <0.03	1	1	1	1	2
Canopy Shading the Water	Mixed sun and shade	Sparse canopy Filtered light	Nearly complete Sun or shade	No shade Complete sun	3/2	4/1	4/1	1/1	1/1
Width to Depth Ratio of Lower Bank	Ratio<7	8-15	15-25 over bank flow	>25 not contained	1	1	1	1	1
Pools to Riffles Ratio	Ratio=5 to 7	7-15	15-25	>25	1	1	1	1	1
Streambed Geology	>50% boulders, cobbles, gravel or logs	25-50	10-25	<10%	1	1	1	1	1
Total/11					L1.9 R1.6,A1.8	L1.9 R1.6 Av1.8	L2 R1.5 Av1.8	L1.6 R1.6	L1.6 R1.5,A1.6
Benthic invertebrate in order of dominance (not counted in rating)					w	None	none	M	M,m=f

s=stoneflies, c=caddisflies, b=beetles, M=mayflies, m=midges, sn=snails, w=aquatic worms, f=flatworm

Bureau of Land Management Sites Proper Functioning Condition	Sites and Data Collection Dates				
	Wilson Canyon 1-1 10-16	Wilson Canyon 1-2 10-16	Lost Valley 1-1 10-20	Lost Valley 1-2 10-20	Lost Valley 2-1 10-20
Hydrology					
Floodplain above bankfull is inundated in relatively frequent events	Y	Y	Y	Y	Y
Beaver dams active and stable	N/A	N/A	N/A	N/A	N/A
Sinuosity, width/depth ratio and gradient in balance with landscape	N	N	N	N	N
Riparian-wetland area is widening or has achieved potential extent	N	N	N	N	Y
Upland watershed is not contributing to riparian wetland degradation	N-grazing	N-grazing	N-grazing	N-grazing	N-grazing
Vegetation					
Diverse age-class distribution of riparian-wetland veg	Y	Y	Y	Y	Y
Diverse composition of riparian-wetland veg	Y	Y	Y	Y	Y
Species present indicate maintenance of riparian-wetland soil moisture characteristics	Y	Y	N	N	Y/N
Streambank veg is comprised of those plants or plant communities that have root masses capable of withstanding high streamflow events	N	N	N	N	N
Riparian-wetland plants exhibit high vigor	Y	Y	Y	Y	Y
Adequate riparian-wetland veg. cover present to protect banks and dissipate energy during high flows	N	N	N	N	N
Plant communities are an adequate source of coarse and/or large woody material	N	N	N	N	N
Erosion Deposition					
Floodplain and channel characteristics adequate to dissipate energy	N	N	N	N	N
Point bars are revegetating with riparian –wetland vegetation	N	N	N	N	N
Lateral stream movement is associated with natural sinuosity	N	N	N	N	N
System is vertically stable	N	N	N	N	N
Stream is in balance with the water and sediment being supplied by the watershed	N	N	N	N	N
Functional Rating /Trend	NF	NF	NF	NF	NF

N.M. Watershed Riparian Survey

Parameter	Optimal	Sub-optimal	Fair	Poor	Rating	Rating	Rating	Rating	Rating
Riparian Veg Structural Diversity	>3 height classes grasses/ shrubs/tree	2 height classes mostly trees	1 height class grass/forb	1 height class sparse veg.	L/R 3/3	L/R 3/3	L/R 3/3	L/R 3/1	L/R 3/3
Lower Bank Stability	Stable, no erosion	Some erosion	Unstable/ erosion	Unstable/ Eroding	1/1	1/1	1/1	1/1	1/1
Bank Cover	90% cover	70-89% cover	50-69% cover	< 50% cover	1/1	1/1	1/1	1/1	1/1
Veg.Buffer Width (meters or feet)	>18 meters (60 ft) on least buffered side	12-18 meters (40-60 ft)	6-12 meters (20-40 ft)	< 6 meters (20 ft)	4	3	4	4	4
Veg Diversity	> 20 plant species	15-19 plant species	5-14 plant species	0-5 plant species	2/2	2/2	2/2	2/1	2/2
Embedded-ness	Substrate surrounded by <25% fine sediment	25-50%	50-75%	>75%	1/1	1/1	No rocks	1	1
Flow m2/sec (cfs) *COLD* *WARM*	>0.05 (2cfs) >0.15 (5 cfs)	0.03-0.05 (1-2) 0.05-15 (2-5)	0.01-0.03 (.5-1) 0.03-0.05	<0.01 <0.03	1	2	1	1	1
Canopy Shading the Water	Mixed sun and shade	Sparse canopy Filtered light	Nearly complete Sun or shade	No shade Complete sun	1/1	1/1	1/1	1	1
Width to Depth Ratio of Lower Bank	Ratio<7	8-15	15-25 over bank flow	>25 not contained	1	1	1	1	1
Pools to Riffles Ratio	Ratio=5 to 7	7-15	15-25	>25	1	1	1	1	1
Streambed Geology	>50% boulders, cobbles, gravel or logs	25-50	10-25	<10%	1	1	1	1	1
Total/11					L1.5 R1.5	L1.5 R1.5	L1.6 R1.6	L1.5 R1.3 Av1.4	L1.5 R1.5
Benthic invertebrate in order of dominance (not counted in rating) s=stoneflies, M=mayflies, b=beetles					none	None	no rocks	s=m=b	none

Bureau of Land Management Sites Proper Functioning Condition	Sites and Data Collection Dates				
	Rio Senorito 1-1 10-22	Rio Senorito 1-2 10-22	Rio Salado 1-1 10-22	Rio Salado 1-2 10-22	
Hydrology					
Floodplain above bankfull is inundated in relatively frequent events	Y	Y	N	N	
Beaver dams active and stable	Y	Y	N/A	N/A	
Sinuosity, width/depth ratio and gradient in balance with landscape	Y	Y	Y	Y	
Riparian-wetland area is widening or has achieved potential extent	Y/N	Y/N	Y(west)/N	N	
Upland watershed is not contributing to riparian wetland degradation	N-grazing	N-grazing	N-grazing	N	
Vegetation					
Diverse age-class distribution of riparian-wetland veg	Y	Y	Y	Y	
Diverse composition of riparian-wetland veg	Y	Y	Y	Y	
Species present indicate maintenance of riparian-wetland soil moisture characteristics	Y/N	Y/N	Y/N Constructed wetland	Y/N	
Streambank veg is comprised of those plants or plant communities that have root masses capable of withstanding high streamflow events	Y/N	N	N	N	
Riparian-wetland plants exhibit high vigor	Y	Y	Y	Y	
Adequate riparian-wetland veg. cover present to protect banks and dissipate energy during high flows	N	N	N	N	
Plant communities are an adequate source of coarse and/or large woody material	N	N	N	N	
Erosion Deposition					
Floodplain and channel characteristics adequate to dissipate energy	N	N	N	N	
Point bars are revegetating with riparian –wetland vegetation	Y/N	Y/N	N	N	
Lateral stream movement is associated with natural sinuosity	Y	Y	Y	Y	
System is vertically stable	N	N	N	N	
Stream is in balance with the water and sediment being supplied by the watershed	N	N	N	N	
Functional Rating /Trend	NF/U	NF/U	NF	NF	

N.M. Watershed Riparian Survey

Parameter	Optimal	Sub-optimal	Fair	Poor	Rating	Rating	Rating	Rating	
Riparian Veg Structural Diversity	>3 height classes grasses/ shrubs/tree	2 height classes mostly trees	1 height class grass/forb	1 height class sparse veg.	L/R 3/3	L/R 3/3	L/R 3/3	L/R 3/2	
Lower Bank Stability	Stable, no erosion	Some erosion	Unstable/ erosion	Unstable/ Eroding	1/1	1/1	1/1	1/1	
Bank Cover	90% cover	70-89% cover	50-69% cover	< 50% cover	1.5/1.5	1/1	1/1	1/1	
Veg. Buffer Width (meters or feet)	>18 meters (60 ft) on least buffered side	12-18 meters (40-60 ft)	6-12 meters (20-40 ft)	< 6 meters (20 ft)	4	4	4	4	
Veg Diversity	> 20 plant species	15-19 plant species	5-14 plant species	0-5 plant species	2/2	2/2	2/2	2/1	
Embedded-ness	Substrate surrounded by <25% fine sediment	25-50%	50-75%	>75%	1	1	1	1	
Flow m2/sec (cfs) COLD	>0.05 (2cfs)	0.03-0.05 (1-2)	0.01-0.03 (.5-1)	<0.01	1	1	2	1	
WARM	>0.15 (5 cfs)	0.05-15 (2-5)	0.03-0.05	<0.03					
Canopy Shading the Water	Mixed sun and shade	Sparse canopy Filtered light	Nearly complete Sun or shade	No shade Complete sun	1	1	1	1	
Width to Depth Ratio of Lower Bank	Ratio<7	8-15	15-25 over bank flow	>25 not contained	2	2	1	1	
Pools to Riffles Ratio	Ratio=5 to 7	7-15	15-25	>25	1	1	1	1	
Streambed Geology	>50% boulders, cobbles, gravel or logs	25-50	10-25	<10%	1	1	1	1	
Total/11					L1.7 R1.7	L1.6 R1.6	L1.5 R1.5	L1.5 R1.4,A1.5	
Benthic invertebrate in order of dominance (not counted in rating)					b=sn	None	none	M	

s=stoneflies, c=caddisflies, b=beetles, M=mayflies, m=midges, sn=snails, w=aquatic worms, f=flatworm

Santa Fe National Forest Sites Proper Functioning Condition (Jim Eaton,Cuba Ranger District)	Sites and Data Collection Date			
	Palomas 10-13-00	Las Vacas Reach 1 9-9-99	Las Vacas Reach 2 9-9-99	Rock Creek 9-9-99
Hydrology				
Floodplain above bankfull is inundated in relatively frequent events	Y	Y	Y	Y
Beaver dams active and stable	Y	Y	N	N
Sinuosity, width/depth ratio and gradient in balance with landscape	Y	Y	Y	Y
Riparian-wetland area is widening or has achieved potential extent	Y	Y	N	Y
Upland watershed is not contributing to riparian wetland degradation	N	N	N	N
Vegetation				
Diverse age-class distribution of riparian-wetland veg	Y	Y	N	N
Diverse composition of riparian-wetland veg	Y	Y	N	N
Species present indicate maintenance of riparian-wetland soil moisture characteristics	Y	Y	Y	Y
Streambank veg is comprised of those plants or plant communities that have root masses capable of withstanding high streamflow events	Y	Y	N	Y
Riparian-wetland plants exhibit high vigor	Y	Y	N	Y
Adequate riparian-wetland veg. cover present to protect banks and dissipate energy during high flows	Y	Y	N	Y
Plant communities are an adequate source of coarse and/or large woody material	Y	Y	N	N
Erosion Deposition				
Floodplain and channel characteristics adequate to dissipate energy	Y	Y	N	N
Point bars are revegetating with riparian –wetland vegetation	Y	Y	Y	Y
Lateral stream movement is associated with natural sinuosity	Y	Y	Y	N
System is vertically stable	Y	Y	N	N
Stream is in balance with the water and sediment being supplied by the watershed	N	Y	N	N
Functional Rating /Trend	PFC	PFC	F-at risk	F-at risk

Bureau of Land Management Sites Proper Functioning Condition (McKinley-Ben Miller, Andy Iskra)	Sites and Data Collection Dates, Additional ID Team Members				
	Rito Leche 7/16/98	Coal Creek 7/1/98 O'Haver Silva	Wilson Canyon 7/1/98	Lost Valley (north) 7/7/98 Silva	Lost Valley (south) 7/798 Silva
Hydrology					
Floodplain above bankfull is inundated in relatively frequent events	Y	Y	Y	Y	Y
Beaver dams active and stable	Y	N/A	N/A	N/A	N/A
Sinuosity, width/depth ratio and gradient in balance with landscape	Y	N	N	N+	N+
Riparian-wetland area is widening or has achieved potential extent	Y	Y	Y	Y	Y
Upland watershed is not contributing to riparian wetland degradation	Y	N	N	Y-	N
Vegetation					
Diverse age-class distribution of riparian-wetland veg	Y	N	N	Y-	N
Diverse composition of riparian-wetland veg	Y	N	N	Y	Y-
Species present indicate maintenance of riparian-wetland soil moisture characteristics	Y	Y	Y	Y	Y
Streambank veg is comprised of those plants or plant communities that have root masses capable of withstanding high streamflow events	Y	N+	Y	Y	Y-
Riparian-wetland plants exhibit high vigor	Y	Y	Y	Y	Y-
Adequate riparian-wetland veg. cover present to protect banks and dissipate energy during high flows	Y	N	N	N+	N
Plant communities are an adequate source of coarse and/or large woody material	Y	N/A	N/A	Y-	N
Erosion Deposition					
Floodplain and channel characteristics adequate to dissipate energy	Y	N	N	N+	N
Point bars are revegetating with riparian –wetland vegetation	Y	Y	Y	Y	Y
Lateral stream movement is associated with natural sinuosity	Y	N	N	N	N
System is vertically stable	Y	Y	Y	Y	Y
Stream is in balance with the water and sediment being supplied by the watershed	Y	N	N	Y	N
Functional Rating /Trend	PFC	F-at-risk,U	F-at risk,U Livestock	F-at-risk	F-at risk-U

Bureau of Land Management Sites Proper Functioning Condition (McKinley-Ben Miller, Andy Iskra, James Silva)	Sites and Data Collection Dates, Additional ID Team Members		
	Senorito (East) 7/1/98	Senorito (West) 7/1/98	Rio Salado
Hydrology			
Floodplain above bankfull is inundated in relatively frequent events	Y	Y	Y
Beaver dams active and stable	Y	N/A	N/A
Sinuosity, width/depth ratio and gradient in balance with landscape	Y	Y	N
Riparian-wetland area is widening or has achieved potential extent	Y	Y	Y
Upland watershed is not contributing to riparian wetland degradation	Y	Y	Y
Vegetation			
Diverse age-class distribution of riparian-wetland veg	Y	Y	Y
Diverse composition of riparian-wetland veg	Y	Y	N
Species present indicate maintenance of riparian-wetland soil moisture characteristics	Y	Y	N
Streambank veg is comprised of those plants or plant communities that have root masses capable of withstanding high streamflow events	Y	Y	N
Riparian-wetland plants exhibit high vigor	Y	Y	N
Adequate riparian-wetland veg. cover present to protect banks and dissipate energy during high flows	Y	Y	N
Plant communities are an adequate source of coarse and/or large woody material	N/A	N/A	N/A
Erosion Deposition			
Floodplain and channel characteristics adequate to dissipate energy	Y	Y	N
Point bars are revegetating with riparian –wetland vegetation	Y	Y	N
Lateral stream movement is associated with natural sinuosity	Y	Y	N
System is vertically stable	Y	Y	Y
Stream is in balance with the water and sediment being supplied by the watershed	Y	Y	Y
Functional Rating /Trend	PFC	PFC	NF

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