University of Nevada, Reno

The Training, Use, and Water Quality Effects of Riparian Proper Functioning Condition Assessment in Nevada

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Hydrology

by

Robert J. Gibson

Dr. Sherman Swanson, Thesis Advisor

August 2012

THE GRADUATE SCHOOL

We recommend that the thesis
prepared under our supervision by

ROBERT J. GIBSON

entitled

The Training, Use, And Water Quality Effects Of Riparian Proper Functioning Condition Assessment In Nevada

be accepted in partial fulfillment of the
requirements for the degree of

MASTER OF SCIENCE

Sherman Swanson, Ph.D., Advisor

Mark Walker, Ph.D, Committee Member

William Evans, Ph. D., Graduate School Representative

Marsha H. Read, Ph. D., Dean, Graduate School

August, 2012

Abstract

The limited spatial extent of riparian systems in Nevada belies their importance to the production of ecosystem services by the landscape as a whole. Management of these systems is complicated by legacy effects of historic management, contrasting and often conflicting perspectives among stakeholders, and differing philosophies and mandates among the various land management agencies charged with their care. Recently, there has been interest in increased collaboration in the management of riparian areas to mitigate these challenges. In widespread use in Nevada for up to 15 years, Proper Functioning Condition (PFC) assessment is a qualitative method for rapid riparian assessment. We investigated the effectiveness of the teaching of PFC, its utility in the field, and current use in management through a survey of class participants, field users, and land managers. The results indicate that PFC is widely supported by those who use it. The technical aspects of performing PFC seem to be slightly better understood than its more nuanced use in building cooperation and trust among stakeholders and developing appropriate, adaptive, and collaborative management for riparian areas and their adjoining uplands. High quality water is understood to be a product of functional ecosystems. If PFC is helping managers steer riparian areas toward higher functionality, there should be improvements in physical, chemical, and biological water quality. Through statistical analysis of a variety of available data, we looked for evidence of such a relationship. While we were not able to show a connection between PFC-driven management and water quality, the attempt to do so provided insight into some challenges of using water quality standards and monitoring as a basis for riparian management and suggested some appropriate directions for future study.

Acknowledgements

I would like to thank the following for their assistance and support in completing this project:

- Sherman Swanson, Ph.D.
- Mark Walker, Ph.D.
- William Evans, Ph.D.
- Peter Weisberg, Ph.D.
- Carol Evans, Patrick Coffin, and others at the Elko BLM District office
- Nevada Division of Environmental Protection
- BLM State Office
- Survey Respondents
- Dawn King
- Kelly Sieg
- Faculty and Fellow Students

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1 Introduction

1.1 Overview

Riparian areas, "transitional semiterrestrial areas regularly influenced by fresh water," (Naiman et al. 2005) make up only a small percentage of the arid and semi-arid Nevada landscape (Patten 1998), yet they hold importance disproportionate to their physical extent. The functions and attributes of riparian systems provide a variety of ecosystem services including improved water quality, increased groundwater recharge, greater biodiversity and primary production (Daniels and Gilliam 1996; Dosskey et al. 2010). These characteristics support multiple human uses, including recreation, agriculture and livestock grazing, as well as supplying water for various uses (Naiman et al. 2005; Patten 1998; Prichard et al. 1998). The extensive usage of riparian areas, along with inappropriate management strategies, has led to their widespread degradation (Belsky et al. 1999).

Increasing understanding of the importance of riparian systems over the last half century has led land managers to develop strategies for their protection. One approach, used by the US Environmental Protection Agency (EPA) and the Nevada Department of Environmental Protection (NDEP), relies on water quality standards based on beneficial uses. To meet standards, waste loads are allocated among pollution sources to achieve regulatory control of point source pollution and enforcement against polluters. On the other hand, the nonpoint source pollution remediation approaches of NDEP/EPA and multiple use agencies such as the Bureau of Land Management (BLM) and the US Forest Service (USFS) often emphasize collaborative and adaptive management strategies to balance the interests of the various stakeholders in a system. Yet even when managing nonpoint pollution sources, Federal agencies have become committed by policy to meet State water-quality standards, using this to guide management and permitting of multiple uses. This situation results in the possibility of conflicting or duplicated efforts between various agencies charged with wisely using, maintaining, or restoring Nevada's riparian systems and the water (and other ecosystem services) they produce.

The objectives of this study are addressed in the upcoming chapters. The balance of this chapter includes an introduction to the state of knowledge about riparian ecosystem implications for water quality management. In Chapter 2, we use surveys and management documentation to investigate the curriculum, teaching and use of Proper Functioning Condition (PFC) assessment, a centerpiece of the land management strategy used by the BLM. This study will help the Nevada Creeks and Communities Team (Nevada Team) and others who teach PFC to provide high quality instruction in the philosophy and use of PFC. Also, this study provides land managers who use PFC an estimate of the extent to which they have successfully used the information and collaborative processes provided by the PFC assessment process. Chapter 3 uses available monitoring data, PFC assessments, and other information to seek a connection between the use of PFC-driven management and improved outcomes in riparian function and water quality. The difficulties encountered provide valuable perspective on the strengths and weaknesses of the assessment and monitoring practices currently used by the BLM and NDEP. Chapter 4 briefly synthesizes the preceding two chapters, along with an analysis of possibilities for future research.

1.2 Current Knowledge

The functions of riparian areas for improved water quality are manifold and well supported. Riparian plants intercept sediment and nutrients from overland runoff and overbank flood flows (Daniels and Gilliam 1996; Olde Venterink et al. 2006; Patten 1998). Uptake of nutrients by plants retains them onsite and slows their migration downstream. Anaerobic conditions maintained in saturated soils allow removal of nitrogen through denitrification (Olde Venterink et al. 2006). Coarse woody debris (CWD) contributed by trees and large shrubs stabilize streambanks, increase deposition, and provide new colonization substrates by dissipating energy and slowing water flow (Naiman et al. 2005; Tabacchi et al. 2000). Canopy cover and streambank vegetation shade the water surface, reducing evaporation and water temperature, and improving fish habitat (Patten 1998). Dissipation of energy during peak flows reduces erosion and downcutting (Kauffman and Krueger 1984), maintaining access to the floodplain. Increased roughness and wide, shallow flows slow movement of water, sediments, and nutrients; increase infiltration, groundwater storage, and water table elevation; and extend stream baseflow supply of clean, cool water to riparian ecosystems between peak flow events (Prichard et al. 1998).

Riparian areas are important to the biodiversity and production of the landscape. In arid regions, riparian areas provide important resources for a disproportionate percentage of animal species (Patten 1998). Kondolf et al. (1987) found that while riparian areas only accounted for 0.4% of their study area, 75% of the local vertebrate species require them some point in their life cycle. Many migratory birds are either obligate or facultative users of riparian habitats in the arid regions of western North

America (Rich 2002). Loss of riparian habitat negatively affects salmonid fish populations (Jones et al 1999; Platts 1991) and has serious implications for amphibians and invertebrates, which may be wholly restricted to riparian corridors in arid environments (Patten 1998). Spatial heterogeneity of riparian systems and interaction with upland species help drive productivity and biodiversity (Naiman et al. 1993).

Riparian areas often dominate land-use decisions in arid regions. Recreational, fishing, and hunting opportunities tend to be clustered around water sources. The high soil quality of level floodplains supports agriculture, while access to water and green forage is critical to success for grazing operations in arid lands. Transportation routes and urbanization tend to concentrate around stream corridors, due to the gentle gradient, access to water, and milder microclimate (Patten 1998). Because of the importance of water in arid and semi-arid regions, many western rivers have been dammed, fundamentally altering their hydrologic and sedimentation regimes (Patten 1998).

Perhaps the most extensive anthropogenic influence to riparia of the western US over the last one to two hundred years is livestock grazing (Kauffman and Krueger 1984). Even with their limited spatial extent, riparian areas provide a large part of the forage for cattle in western rangelands (Kauffman and Krueger 1984). If cattle are allowed to concentrate in riparian areas for long periods they can remove ground cover and destabilize streambanks, increasing the sediment load to the stream (Patten 1998) and putting the riparian and aquatic habitats at risk (Myers and Swanson 1992). Belsky et al. (1999) assert that approximately 80% of riparia in this region have been damaged by livestock grazing. Since the late 1960’s, increasing awareness has led rangeland managers to examine livestock-management practices to reduce riparian impacts on both public and private lands (Wyman et al. 2006).

Proliferating literature in this field testifies to the permanence and importance of the issue. Increasingly, recreationists, ranchers, managers, and others seek ways to accommodate human use of riparian areas while preserving or restoring the functionality that makes them such attractive, useful, and important elements of the western landscape.

1.3 Proper Functioning Condition (PFC)

Beginning in 1988, the Bureau of Land Management (BLM), Fish and Wildlife Service (FWS), and Natural Resources Conservation Service (NRCS) worked together to develop a method for assessing the condition of riparian-wetland areas (Prichard et al. 1998). Starting with a review of riparian classification procedures (TR 1737-5) and a modification of BLM's ecological site description method (intended for upland systems), the National Riparian Service Team (NRST) developed Ecological Site Inventory (ESI, TR 1737-7). ESI is a rigorous quantitative method of site classification, from which the qualitative assessment method of Proper Functioning Conditioning (PFC) was developed to help field offices efficiently assess the condition of riparian areas (Prichard et al. 1998). The PFC method uses "attributes and processes that are common and important, and that can be judged visually to assess the condition of a riparian-wetland area." (Prichard et al. 1998) These attributes and processes were used to create standard checklists for assessing the condition of lentic and lotic riparian areas.

"PFC" names the assessment process and describes an on-the-ground condition of the system being assessed. Prichard et. al. (1998) provides a definition of PFC:

> *A riparian-wetland area is considered to be in proper functioning condition 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 floodplain development;*
> - *improve flood-water retention and ground-water recharge;*
> - *develop root masses that stabilize streambanks against cutting action;*
> - *develop diverse ponding and channel characteristics to provide the habitat and the water depth, duration, and temperature necessary for fish production, waterfowl breeding, and other uses;*
> - *support greater biodiversity.*

An interdisciplinary (ID) team employs visual assessment to determine the functionality of each of the hydrologic, vegetation, and erosion/deposition attributes and processes listed on the PFC checklists, considering the ecological potential and capability (in the presence of social, political, or economic constraints) of the reach in question (Prichard et al. 1998). The yes-and-no checklist answers and comments about relevant observations help classify the system as either PFC: functioning properly; Functional-At Risk (FAR): Presently functioning, but susceptible to degradation due to one or more attributes or processes; Nonfunctional (NF): vegetation, landform, and CWD clearly not adequate to support physical functions; or Unknown (UNK): when information is insufficient to make an accurate assessment. On FAR reaches trend (whether conditions on that stream are improving, degrading, or not apparent) helps inform management decisions.

PFC allows classification of the overall functionality of individual stream reaches as well as identification of specific processes or attributes that may be impaired. This makes it a powerful management tool in 2 ways: it provides a triage system, allowing managers to choose where to best allocate limited resources; and it indicates what kinds of system changes will restore functions by identifying the specific impaired attributes. In most cases, the bulk of management resources should be spent on FAR reaches. While NF streams appear to need help more urgently, they respond more slowly where form and missing functions impede revegetation (NRST 2008; Prichard et al. 1998). With limited time and money for management, it is often more effective to use those resources to prevent a FAR reach from becoming NF, or to assist one to regain PFC. The specifics of which attributes and processes are present or lacking allows managers to use function-based actions, considering management alternatives against the needs of the system to bring about recovery. This can result in more efficient resource use, less conflict and more collaboration with land users who understand the rationale for management changes, and more adaptive and effective management focused on specific objectives.

Until a stream is functioning properly, it is counterproductive to attempt to manage it for the production of resource values (Prichard et al. 1998). By focusing on the functionality that is the basis for the production of those values, managers can more effectively and efficiently support stream systems to provide a variety of resources according to their own potential. For this reason, management objectives for non-PFC reaches or areas need to be based on maintaining and/or improving functionality first, rather than production of resources. A properly functioning stream can provide high-quality recreation, forage, and water simultaneously and over the long term, while a nonfunctional one will be able to provide none of these until management is changed and functionality is restored.

Riparia represent continuous systems that connect diverse landscapes across ownership and management boundaries. Recognizing this, in 1996 the BLM, the USDA Forest Service (FS), and the NRCS initiated a program aimed at increasing cooperative riparian management and restoration (NRST 2008). The initial strategy was founded on the idea that to improve riparian conditions in the West, the top-down approach needed to be abandoned in favor of a more collaborative method. The new approach integrates ecological, social, and economic factors across jurisdictional boundaries and uses a large, well-trained group of experts able to "influence change in land manager and landowner behavior." (NRST 2008) Training a large interdisciplinary cadre of scientists in the use of PFC assessment was a primary focus of this effort. After a review of the first 5 years of implementing the program (Van Riper 2003), a major revision of the original strategy resulted in the development of the Creeks and Communities strategy (C&C) (NRST 2008). While it still relies on the use of PFC as a primary assessment tool, the C&C strategy focuses on the need for more emphasis on the human and social dimensions rather than relying solely on information and technology transfer in the restoration of riparian habitats. Science alone is not enough; only through informing, educating and actively engaging the various stakeholders in a riparian system can a truly collaborative, adaptive, and effective management prescription be developed. The NRST is currently engaged in a new assessment of the C&C strategy to help define the future directions and emphases for the strategy (Van Riper, L. pers. comm. 2012).

While NRST has recently focused more on the human and social aspects of the C&C strategy, state riparian service teams have continued to focus on PFC assessment trainings, though with increasing participation in the C&C process (NRST 2008). In particular, the Nevada Creeks and Communities Team (Nevada Team, formerly the NV Riparian PFC Training Cadre) has begun using the C&C strategy in their outreach and education.

This study aims to determine the effectiveness of the Nevada C&C Team and the PFC assessment process in influencing on-the-ground management changes and in improving functionality and water quality in Nevada stream systems. This effectiveness depends on a series of inputs, outputs, and outcomes, as described in the PFC Program Development logic model developed by the NV C&C Team (Appendix A).

The NV C&C Team utilizes its time and resources to teach PFC Assessment, riparian functionality, adaptive management, and cooperative problem solving concepts. A primary goal of this teaching is to develop a common vocabulary and effective communication among agency staff, scientists, ranchers, farmers, recreationists, community leaders, and other stakeholders. This communication will build a greater understanding of and respect for these concepts as a basis for the collaborative development of effective riparian management. In turn, stakeholders with differing interests can build mutual trust, allowing the formation of successful working relationships and mutually agreed-upon resource objectives, management changes, and monitoring plans. Ultimately, the successful implementation of this program should lead to a reduction in community and societal conflict, an improvement in riparian area functionality, an increase in stability and in ecosystem services including biodiversity, sustainable livestock forage, fish and wildlife habitat, and a longer seasonal release of high quality water.

1.4 Study Area

The class participant population for this study includes as many past attendees of NV C&C Team PFC Assessment Training and/or C&C events over the period from 1997 to the present as could be identified and contacted from event rosters and sign-in sheets. The agency employee population includes the employees of NV state and regional offices for BLM, FS, and NRCS identified from current employment directories and personal nomination, and others who may have had an opportunity to learn and/or use PFC assessment as part of their professional duties.

Lotic (running water) riparian systems throughout the Elko BLM District (Elko County, NV) were included in the comparative study of functionality and water quality. Elko BLM District manages over 1200 miles of streams, and incorporates widespread use of PFC, riparian monitoring, and to a lesser extent water quality monitoring (Coffin 2011).

2 The Teaching and Use of Riparian Proper Functioning Condition Assessment in Nevada

2.1 Abstract

Proper Functioning Condition (PFC) was developed in the early 1990's as a tool for rapid assessment of the condition, trend, and needs of riparian systems (Prichard et al. 1998). In Nevada, PFC has been taught for 15 years by the Nevada Creeks and Communities Team (Nevada Team) and is in widespread use by various land management agencies, including the Bureau of Land Management (BLM) and the USDA Forest Service (USFS). A survey of Nevada Team classes' participants, field users, and land managers investigated the effectiveness of the teaching of PFC, its utility in the field, and its current use in management. The content and presentation of PFC classes were rated highly, as was PFC's utility and importance to management. In all sections, questions regarding the basic concepts of performing riparian assessment scored higher than those involving the finer points of addressing riparian needs and building cooperative, adaptive management. However, an examination of documents prepared by the Elko District BLM indicates that this office has incorporated many of these ideas in their management practices. The Nevada Team may wish to make minor adjustments to their curriculum or presentation at PFC classes to build greater understanding and use of the insights available from the PFC assessment process. In concert with such changes, the Nevada Team should continue to seek avenues outside of the PFC classes to teach effective management through cooperative and adaptive strategies.

2.2 Introduction

2.2.1 Importance of riparian areas

Although riparian areas make up only a small percentage of the arid and semi-arid Nevada landscape (Patten 1998), the attributes and functions of these systems make them critical to the overall health of the landscape (Prichard et al. 1998). Functional riparian systems improve water quality, increase groundwater recharge, support greater biodiversity and ecosystem health (Daniels and Gilliam 1996; Dosskey et al. 2010), and provide for multiple human uses, including recreation, agriculture and livestock grazing, fish and wildlife habitat, as well as supplying clean water for various uses.

The continuing proliferation of literature in this field is testament to the long-term importance of riparian functionality. Increasingly, recreationists, ranchers, managers, and other interested parties seek ways to accommodate human use of riparian areas while preserving or restoring the functionality that makes them such attractive, useful, and important elements of the desert landscape.

2.2.2 Proper Functioning Condition (PFC)

A variety of techniques for assessing, monitoring, and managing riparian areas have been developed and refined in an attempt to reduce the stress these areas experience due to human activities. Proper Functioning Conditioning (PFC) assessment was developed by the Bureau of Land Management (BLM), in concert with other agencies, academia, and interested publics, to give field offices an efficient tool to assess the condition of riparian areas (Pritchard et al. 1998). PFC is used both as the name of the assessment process and as a description of the on the ground condition of the system being assessed. The methodologies and supporting science of the PFC process are described in TR 1737-15 (Prichard et al. 1998) for lotic systems and in TR 1737-16 (Prichard et al. 1999) for lentic areas.

Over the almost 2 decades since PFC was introduced, users and developers of the process have expanded their ideas regarding the uses of PFC for better management of riparian areas. From its inception, PFC was meant to be an effective tool for rapid assessment of the condition, trend, and needs of riparian systems (Prichard, et al. 1998). By the time Prichard et al. (1998) was published, it was understood that using the “No” answers and associated notes from PFC checklists would provide detailed information to help guide management decisions. Around this time, the National Riparian Service Team (NRST) began promoting the use of the framework and language of PFC to provide a basis for effective collaboration among stakeholders in riparian systems (NRST 2008).

The effectiveness of PFC assessment in helping to maintain and improve riparian functionality relies upon several factors. The ID teams that use PFC assessment must understand and apply the tool correctly and consistently, managers using the results of PFC assessment must be able to trust and interpret the results while they decide on appropriate management, and all stakeholders involved in developing management must at least understand the language and underlying reasoning behind the PFC process, allowing participants to build mutual trust and cooperation.

We created and administered an online survey to investigate whether participants of PFC classes given by the Nevada Team were learning important aspects of PFC theory and practice, whether people who have used PFC assessment in the field or as part of the management process find it useful and effective, and whether they are taking advantage of the full range of PFC's utility. Participants of Nevada Team PFC classes, land management professionals, tribal officers, and others who may have had experience with PFC were invited to complete the survey. In addition, we performed further investigation into the use of PFC by obtaining and analyzing the contents of documents produced by the Elko District BLM in managing the land under their care. The null hypotheses we tested were that PFC class participants have not been learning the important features of PFC, that PFC and the results of assessment have not been used to full advantage, and that PFC has not been useful for field assessment or management decisions.

2.3 Methods

We prepared a questionnaire (Appendix B) for administration as an internet-based survey to be answered by three target populations: attendees of PFC Assessment classes given by the Nevada Team, agency employees and others who may have performed PFC assessments in the field, and individuals who may have used results from PFC assessments to help develop management for riparian areas in Nevada. The goals of the survey were to determine: (1) how well the presentation and curriculum of PFC classes taught by the Nevada Team are imparting the information and skills necessary for application of the PFC assessment process; (2) how useful, convenient, and cost-effective field users find the PFC assessment process; (3) how the results from PFC assessment are being used by managers as they implement management of riparian areas; and (4) which areas may warrant improvement as the Nevada Team moves forward.

Prior to launching the survey, we obtained approval for the study protocol from the Social Behavioral Institutional Review Board at UNR. This approval is necessary to ensure compliance with institutional standards and to minimize risks to human subjects, including the inconvenience of completing the survey and the risk of loss of privacy and/or confidentiality.

2.3.1 Survey Design

Though each survey respondent was only presented with questions relevant to their situation, the experience of each member was made as similar as possible. The length, layout, question phrasing, visual design, questionnaire delivery method, and contact strategy were held as constant as practical to reduce the potential for the introduction of nonresponse and/or measurement errors (Dillman et al. 2009). Due to the limited size of the survey population and the likelihood of low response rates, the possibility for sampling error necessitated that the sample size include the entire population. In addition to reducing the likelihood of introducing sampling error, this method is also expected to reduce the chance for coverage error (Dillman et al. 2009).

A dual-mode (web-based and telephone) implementation strategy was originally considered, but due to strong response to the web-based survey, the phone-based strategy was not used. The questionnaire was posted on the survey hosting website Checkbox, which is administered by the Instructional Design Team at UNR. Members were invited to participate via a 3-contact series of emails: an initial email providing an introduction, explanation and invitation; a follow-up thank you and reminder; and a final reminder focusing on the limited time available for, and importance of responding. Each email provided a link to the web survey and explained the other options for completing the questionnaire. All emails included a link to the survey website, used friendly and courteous language, and were personalized to the recipient. Before administering the survey to the entire population, a small pilot group consisting of the members of the Nevada Team, was surveyed to identify potentially confusing or misleading wording, formatting, or other issues. No such issues were found, and there were no changes made to the survey before the full launch. The responses from the pilot group were pooled with the other responses for analysis of results.

2.3.2 Survey Population

To include the three categories of participants (class attendees, field users, and land managers), two population groups were targeted:

1. Participants in Nevada Team sponsored PFC assessment training courses and other events. These people may or may not use PFC assessment as a part of their personal or professional duties, but have received training by the Nevada Team. Their responses to the survey provide important feedback regarding the quality of the instruction, as well as its continuing utility and relevance over time. This population was identified from rosters and sign in sheets for PFC assessment classes between 1997 and 2010. However, rosters were no longer available from 1998 through 2003.

2. State and federal agency employees and others throughout Nevada who may have used PFC assessment in carrying out their professional responsibilities. These people may or may not have received training from the Nevada Team,

> but were included because they may have experience using the PFC assessment protocol or the information thus collected. Their views on the utility and effectiveness of the PFC assessment process should help the Nevada Team and other state teams to focus their curricula and teaching methods to improve the accuracy and consistency of interdisciplinary PFC assessment teams. They may also provide useful information for agencies reconsidering their approach to riparian assessment, management, and monitoring. This population was identified from published employee directories on the websites of BLM, USFS, NRCS, and the Nevada Department of Environmental Protection; from the list of Nevada Creeks and Communities Team members; and from specific nominations provided by Nevada Team members.

The two population bases are not mutually exclusive. The PFC classes have often been attended by agency employees, and some non-agency participants in classes may have used the PFC assessment as part of their work, volunteer, or business duties. Through the branching logic of the survey, each respondent was only presented with questions relevant to their situation.

2.3.3 Survey Structure

The survey contained five parts, each focusing on a different question of interest for the study. This allowed more efficient partitioning of data and created exit points through which participants were able to avoid answering questions that didn’t pertain to their situation.

- Part A: Contained general questions about PFC and the degree of participation in assessment and/or training by the study member. It was intended to develop initial categories of respondents, as well as provide an early exit point for those who were incorrectly targeted.

- Part B: Intended for class participants, focused on questions about the quality of the curriculum and effectiveness of the instructors.

- Part C: Directed at respondents who have participated in PFC assessments in the field, investigated the utility of PFC assessment as a tool for determining functionality and users' understanding of the theory and practice of PFC.

- Part D: Targeting respondents who have used the results from PFC assessment while developing and implementing riparian management, focused on the relative importance of PFC results and other considerations during the management process; how well the information acquired through PFC assessment is being incorporated into riparian management objectives and/or techniques; and whether objectives chosen by managers are based on functionality as recommended by PFC.

- Part E: Closed the survey with a few demographic questions, allowing us to check for differences in responses across demographic groups.

2.3.4 Analysis of Responses

The Instructional Design Team supplied response data in spreadsheet format after each of the survey periods (pilot and main). As the survey was identical during each period, we assigned a unique series of ID numbers to each dataset and merged the data from both. We then translated all Likert scale responses from their original categorical values to integer values (0 – 4). This allowed us to treat them as either continuous or categorical variables. Question 15 asked respondents to select the checkboxes for all appropriate responses. We coded a selected checkbox as “1” and an unselected one as “0.” Finally, we formatted the resulting table to ease location and interpretation of the data (Appendix C).

We calculated frequencies in both total number (n) and percentage (%) forms for all responses to each question. For each question presented in matrix form (5, 7, 8, 12, 16, and 17), we created a scale variable representing the mean frequency (both n and %) for each response category over all sub-questions in the matrix. In Question 5 we excluded the final statement (“Overall, the training met my expectations and needs.”) from the calculation of the mean response, permitting comparison between the scores for these two measures. All values are reported in Appendix D in tabular form.

To investigate possible variance in response frequencies among sex, age, and education level demographic groups, we calculated separate means and 95% confidence intervals for each class over 19 factors, including questionnaire responses and scale variables. We inspected the results and selected 10 cases with minimal overlap of confidence intervals to cross-tabulate demographic class against response frequency. We tested cross-tabulation results for independence of variables using Chi-squared tests.

2.3.5 Management Documents

In August of 2010, we visited the Elko BLM District office, interviewed each range conservationist in the Tuscarora and Wells Field offices, and obtained all management documents for Allotments containing riparian areas under their supervision produced from the Mid-1990's to the present. We specifically asked for all documents that might mention results from riparian proper functioning condition assessments. Typical management documents obtained include environmental assessments, biological opinions, proposed and final grazing decisions, and fire closure and reopening memoranda. We collected a total of 46 documents during this process (Appendix E).

If the finer points of PFC use discussed above have been adopted by the Elko District, there should be clues within the management documents we collected. To search for these clues, we developed 5 statements (Table 2-1.) about the documents which, if true, would indicate the incorporation of the ideas into the management process of the BLM Elko District. The documents were categorized based on their overall purpose: Memoranda, Assessment, Proposed Decision, or Final Decision. For each document, we recorded whether or not each statement was true, and compiled the results to seek out any evidence of trends.

2.4 Results

2.4.1 Response Overview

Invitations for the pilot portion of the online survey were sent to 39 individuals. Of these, 16 (41%) completed the survey. Of 420 invitations sent for the main survey, we received 131 (31%) responses. Eighty-seven invitees were never successfully contacted, so between the pilot and main studies, a total of 372 people received invitations and 40% (n=147) completed the survey. Due to branching logic, respondents had the opportunity to answer only questions that corresponded with their exposure to PFC assessment. Of the total of 147 responses to the survey, 137 contained answers to at least one of the three main sections. Missing data on the main sections ranged from 0 to 6%, while non-responses for the demographic section varied from 6 to 7%. Both missing data and "Don't know" answers (except Questions 18, 20, and 22) were excluded from further analysis.

2.4.2 Demographics and Main Categories

There were 122 responses to Part B regarding PFC trainings; Part C, using PFC in the field, received 103 responses, and Part D, covering PFC and management, had 57 respondents. One hundred twenty two respondents had taken the riparian PFC assessment training at least once and 53 had attended at least one riparian grazing management and monitoring class.

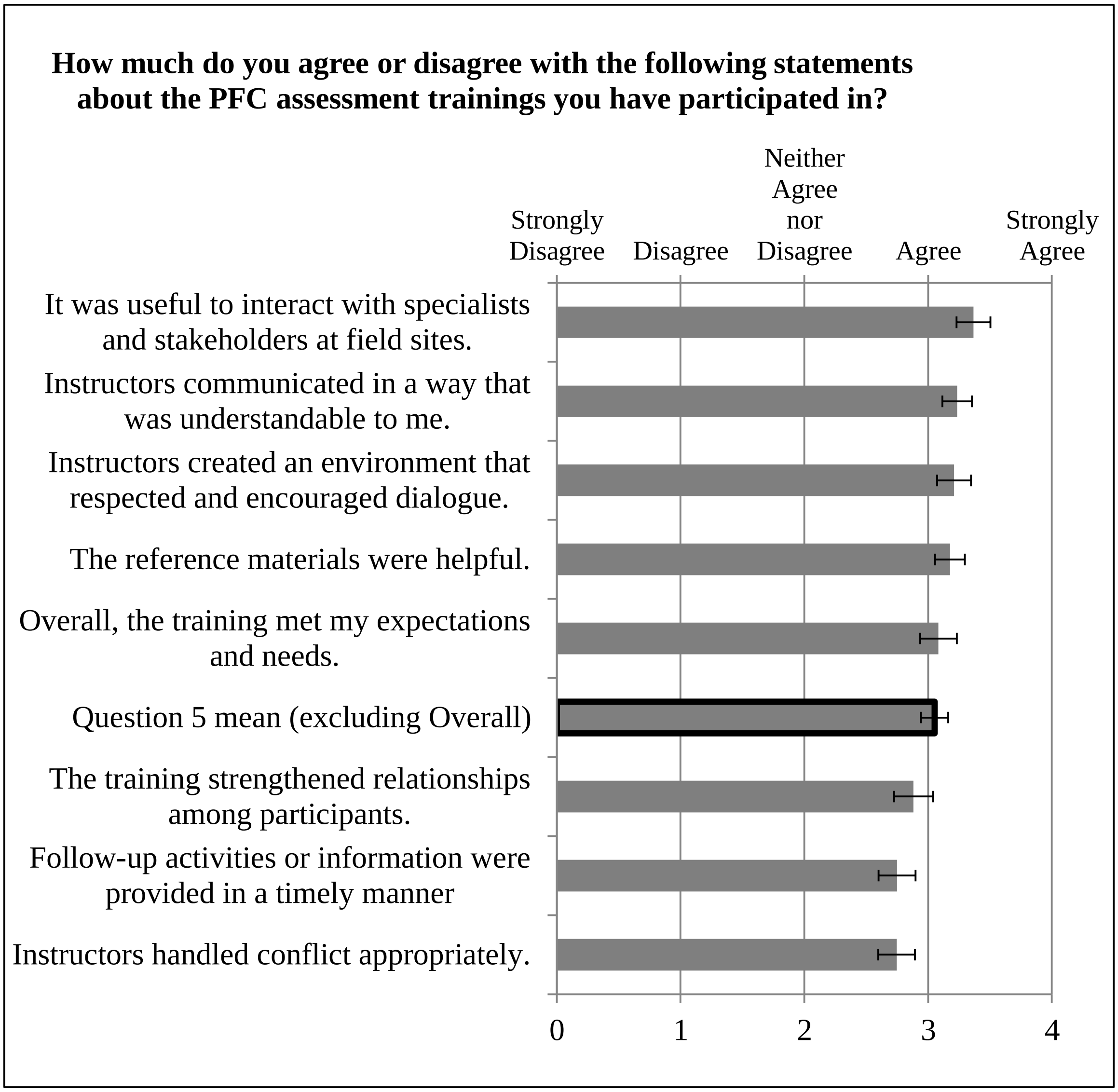
Eighty five (58%) of the 147 respondents were men, 53 (36%) were women, and 9 (6%) did not answer this question. The largest age class of respondents was between 26 and 35 years old (n = 40, 27%), while those younger than 26 (n = 13, 9%) comprised the smallest group. All respondents had attended some college, with 73 (50%) holding undergraduate degrees, and 55 (37%) having attained graduate degrees (Nine respondents left this question blank).

2.4.3 PFC Classes

We calculated the mean response for Question 5 by converting to a numeric scale, with zero (0) representing "Strongly Disagree and four (4) equal to "Strongly Agree." Respondents agreed with all statements (Figure 2-1) and agreed most strongly that "It was useful to interact with specialists and stakeholders at field sites." The statements with lowest agreement were "Instructors handled conflict appropriately," and "Follow-up activities or information were provided in a timely manner." Lower scores represented higher numbers of respondents scoring the question "Neither agree nor disagree." Responses of "Disagree" and "Strongly Disagree" were 5% or less for all statements. The score for "Overall, the training met my expectations and needs" (mean score = 3.14) is similar to the mean score for all of the other statements in Question 5 (3.22). Of those who had attended training events, 83% were at least somewhat likely to attend another or recommend training to a colleague, while 10% were either very or somewhat unlikely to do so.

Questions 7 and 8 rating educational outcomes of PFC training were treated similarly to question 5, with 0 representing "Don't Know" and 1-4 corresponding to increasingly positive responses. The most positive responses among these statements were for "How to determine a functionality rating for a riparian area using the PFC

Figure 2-1. Mean responses for Question 5, error bars represent 95% confidence level. Mean response for question 5 outlined in black for emphasis.

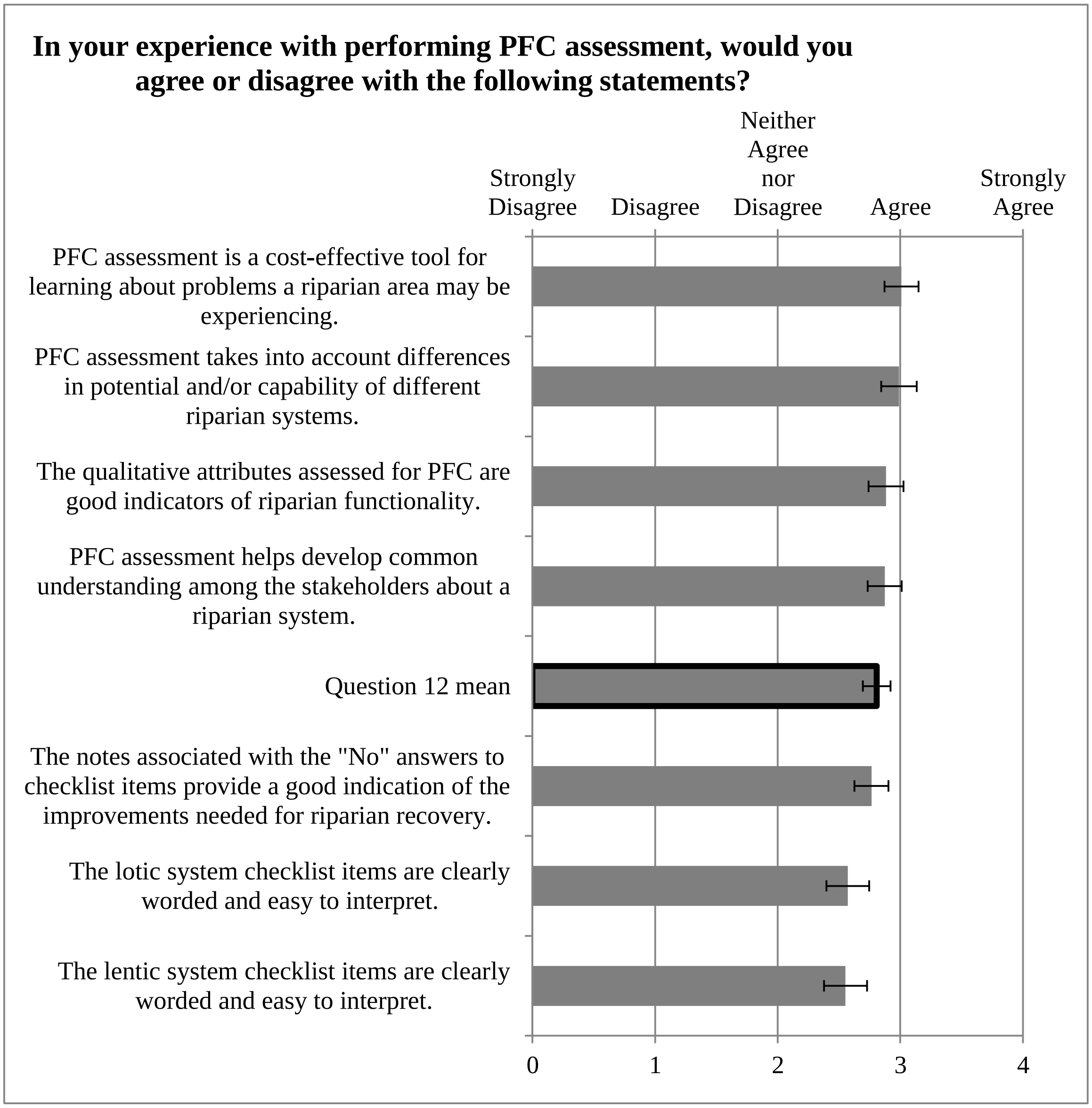


checklist," (3.42) and "Why an experienced interdisciplinary team is needed to perform a PFC assessment" (3.41). The least positive responses were for "Whether to use monitoring data to adapt management strategies to achieve riparian objectives" (2.77) and "How to use PFC assessment data to help design monitoring strategies" (2.81).

2.4.4 Utility of PFC Assessment

Of the 103 respondents to Part C, 62% had participated in an ID team performing PFC assessments, 29% had performed PFC assessments as an individual; and 11% had done PFC assessments only individually, and never as a part of an ID team.

Figure 2-2. Question 12 responses show tendency for technical aspects of PFC to outscore the finer points of application.

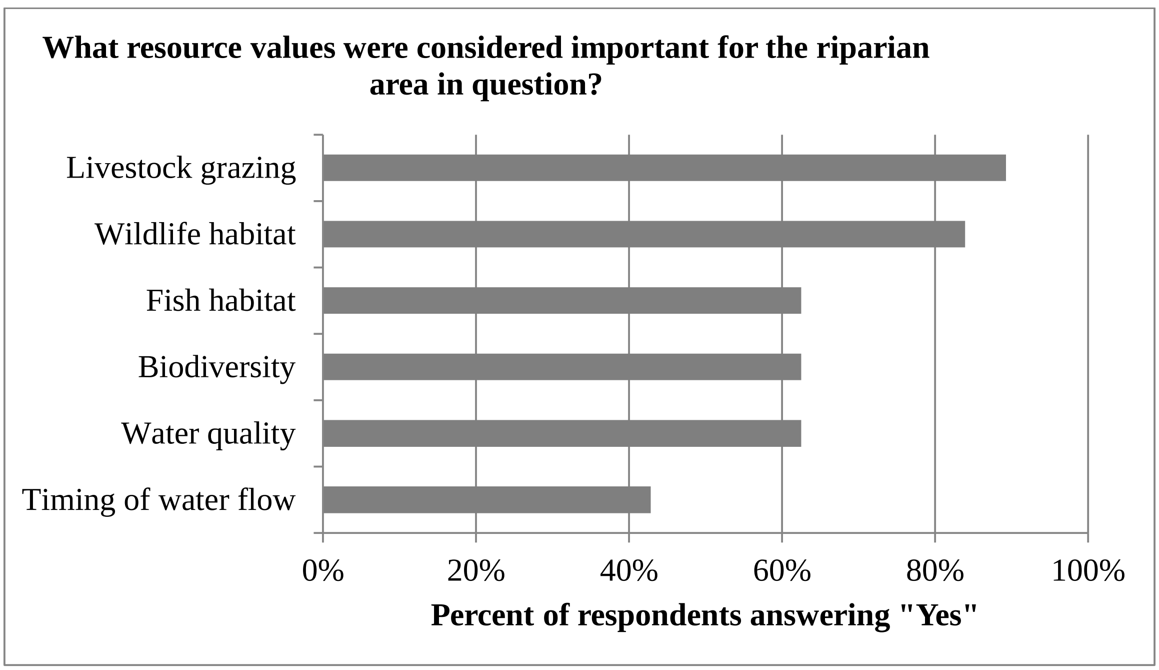


Responses for Question 12 (Figure 2-2) were coded similarly to Question 5. The highest levels of agreement were for “PFC assessment is a cost-effective tool for learning about problems a riparian area may be experiencing” (3.01) and “PFC assessment takes into account differences in potential and/or capability of different riparian systems.” Two statements regarding the clarity of the questions on the lotic and lentic checklists had the lowest level of agreement.

2.4.5 PFC as a Management Tool

Forty percent (n = 57) of respondents had participated in implementation of management using PFC assessment. Livestock grazing and wildlife habitat were most often considered important resource values for those riparian areas (Question 15), while the timing of water flow was less often considered important (Figure 2-3).

Figure 2-3. Livestock grazing and wildlife habitat are very likely to be important goals when implementing management in arid and semi-arid Nevada rangelands.



The most influential considerations on management decisions (Question 16) were reported to be PFC assessment results (3.51) and cooperation from the permit holder or land user (3.50), while the least important factor was preventing or withstanding litigation (2.77). Respondents also reported (Question 17) that the type of vegetation capable of growing and needed by the riparian area (3.54), production of resource values (3.45) and readiness of the riparian area to improve or decline (3.44) were very important factors in the management decision making process, while using the "No" answers on the PFC checklist to diagnose the needs of the riparian area was marked lower (2.94).

Long-term (3 years or more) resource objectives were developed in two thirds of the cases, and two thirds have been monitored. Functionality appears to be improving in 50% of the areas, and declining in only 15%. No trend was observed in the other sites.

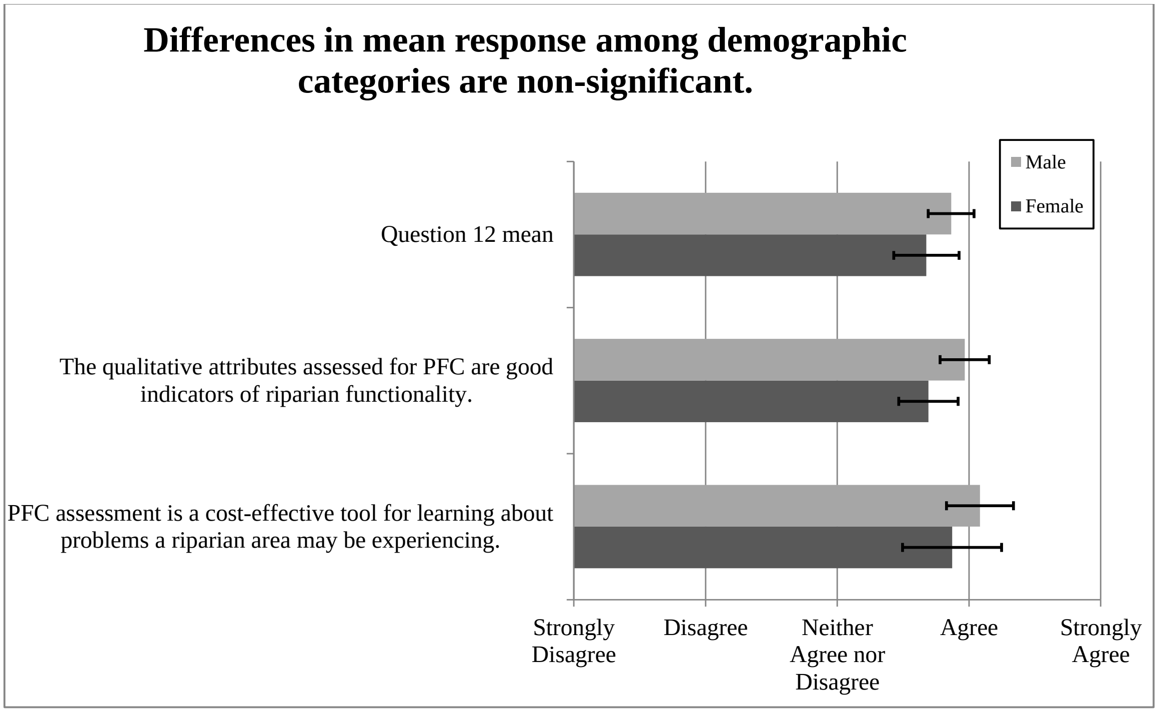
2.4.6 Cross-Tabulation Results

Cross-tabulation failed to show significant differences (at $p < .05$) in response across the tested demographic factors (age, sex, and education level). This is demonstrated in Figure 2-4 by the overlapping 95% confidence intervals.

2.4.7 Management Documents

The search of management documents confirmed that the Elko District BLM considers more than just the overall rating from PFC assessment results (Table 2-1). In proposed decision and assessment type documents that include management recommendations, nearly all include reference to specific attributes from the PFC checklist. The other document types are less likely to include these references. In addition, each of the document types had one occurrence of reference to a cooperative

Figure 2-4. Example cross-tabulation results showing no significant difference in response between genders.



mixed-stakeholder group working toward management of the riparian area in question, although none of the references included specific mention of the use of PFC assessment in their cooperative management efforts.

2.5 Discussion

2.5.1 General

Outside of the cross-tabulation results, there was no need to perform detailed data analysis and statistical testing to meet the study objectives. Calculation and visual representation of response frequencies were sufficient to show the relative strengths and weaknesses of PFC classes, perceptions of PFC's utility in the field, and how PFC results are being used for management. Cross-tabulation allowed us to search for but not find a different response to several selected questions by demographic indicators. Overall, several interesting trends emerged from the data and the study questions were satisfactorily addressed.

Table 2-1. Test statements for document analysis.

	Final Decision	Proposed Decision	Memo	Assessment	Total
The document uses results of PFC assessment to recommend management.	10	3	16	11	40
The document specifically refers to the attributes and functions highlighted by PFC assessment (especially "No" answers and comments).	2	3	7	10	22
The document recommends management based (at least partially) on problems highlighted by PFC assessment ("No" answers and comments)	2	3	4	3	12
The document mentions cooperative groups involved in the management process.	1	1	1	1	4
The document records stakeholder cooperation with specific reference to PFC concepts	0	0	0	0	0
Number of documents	12	3	19	14	48

2.5.2 Demographics

Response differences among demographic groups were non-significant, so the age, sex, and educational level of respondents had little or no effect on their perception of PFC assessment. These results indicate that the presentation and curriculum of the PFC classes is generally appropriate for all attendees, and the field protocol is accessible and understandable by all users.

2.5.3 PFC Classes

For all questions relating to the PFC assessment classes, the response was strongly positive. For example, in no case did the statements for Question 5 receive more than 5% of total responses in the “Strongly Disagree” and “Disagree” categories, and the statements with the lowest mean scores did so not because of higher numbers of negative responses, but due to higher non-committal ones (“Neither Agree nor Disagree”). The statements in these cases referenced situations that likely don't arise in every class, so a non-committal response could represent "not applicable" as well as a neutral (neither good nor bad) experience. The various parts of this question relate to the learning environment created by the instructors, and the high marks indicate that the classes have generally occurred in an atmosphere of trust and comfort.

Interpretation of the responses for Question 6 is hampered by the "double-barreled" (having two clauses) nature of the question, and also because there are multiple possible motivations for positive vs. negative responses. A person may be unlikely to "attend another or recommend this training to a colleague" for many reasons. For example, a person may not expect to have a need to use PFC assessment, may not see a need for additional training, or may have not agreed with the principles and/or practice of PFC. While these reasons could have been explored with further questions, the small sample size of negative responses (n=12, 10%) makes such analysis unreliable. Similarly, since the two criteria for positive responses (attend another or recommend to colleague) overlap to an unknown degree, we cannot say which criterion triggered the response in individual cases. However, the strongly positive (83% "Agree" and "Strongly Agree") response indicates that the program is very well received and that there should be a strong demand for future training classes.

Respondents generally reported strong improvements in their understanding of the topics covered in PFC classes, resulting in a mean score of 3.05 for Question 7. Statements exploring the relationship between PFC assessment, management, and monitoring strategies scored lower than the mean for this question. The mean response for “Whether to use monitoring data to adapt management strategies to achieve riparian objectives” was the lowest (2.77) in this section, and scores for “How to use PFC assessment data to help design monitoring strategies” (2.81), “How to consider riparian objectives in selecting management strategies” (2.88), and “How to work with stakeholders to assess, manage, and monitor riparian areas” (2.88) were only slightly higher. These topics showcase the aspects of PFC that allow it to transcend strict riparian assessment and become a guide for successful, responsive, and adaptive management. All of them were covered during the second day’s classroom session (they were moved to earlier in the course after the survey data were collected), so there may have been some problem in the materials for this section or the timing of its presentation. This tendency for questions about the more technical aspects of PFC assessment to score higher than those addressing PFC’s role in the broader issues of riparian management appears throughout the survey and will be discussed further below.

The other statements in Question 7 with below average scores were those exploring improved understanding of the relationship between riparian function and various resource values (fish and wildlife habitat, 2.86; livestock forage, 2.96; biodiversity, 2.97; and timing of water flow, 2.97). An understanding of these relationships helps stakeholders recognize the importance of functionality for sustainable resource production in riparian areas. Because most of the respondents are public land managers, lower scores on these topics could simply reflect higher levels of understanding prior to beginning the training. Still, a strong majority (64-74%) of respondents answered either “A fair amount” or “A great deal,” so while the mean score of these questions is lower than that of other questions, participants do seem to be receiving good education in these areas and adjustments to the curriculum are probably unnecessary.

Question 8 addresses how well the PFC classes are improving knowledge about cooperation between various stakeholders when addressing riparian issues. Mean for this question was 3.09. Among the 3 statements, the weakest score (2.88) is for "How to work with stakeholders to assess, manage, and monitor riparian areas." While participants seem to understand the importance of working with stakeholders, they are less sure that they are receiving the tools they need to carry out such cooperation. If the Nevada Team's vision of cooperative, adaptive, community supported management is to be fully realized, these techniques will need to be well understood by all of the various stakeholders.

2.5.4 Utility of PFC Assessment

Of 104 respondents who had performed at least one PFC assessment in the field, 16 had performed them only individually, not as a part of an interdisciplinary team. Proper utilization of PFC assessment requires the interaction of two or more people with expertise in the appropriate disciplines. Even broadly knowledgeable individuals would not be expected to produce the same high quality assessments as an ID team, because the interactions and sharing of opinions between members tend to build a strong consensus and more nuanced understanding about the observed conditions and their meanings. From these results it appears that most PFC assessments are indeed being performed by ID teams, but in the interest of obtaining high quality assessments it may be prudent to redouble efforts to impart this message.

Of the topics in Question 12, regarding the performance and utility of PFC assessment in the field, strong majorities answered the statements favorably ("Agree" or "Strongly agree"). The only statements with greater than 10% unfavorable response addressed the clarity and understandability of the lotic and lentic checklist items ("Disagree" and "Strongly Disagree" totaled 15% for each of these statements). The checklist items are written so that a "Yes" answer indicates a favorable state for the attribute or process in question, while a "No" answer indicates an unfavorable state. While this simplifies interpretation of finished PFC assessments and helps to focus management and monitoring efforts, the wording on some questions is complex and somewhat tricky. To minimize confusion, it might be worthwhile to reword some of the questions. On the other hand, as users gain experience with the checklists they are likely to become comfortable with the questions as written. Careful explanation of each of the checklist questions in the classroom and supervised practice during the field portion of PFC classes is crucial for the success of users new to PFC assessment. A revision to TR-1737-15 is underway and may address this issue, especially if the Nevada Team uses that opportunity to clarify concepts presented in their trainings.

One interesting result in Question 12 concerns the statement "The notes associated with the "No" answers to checklist items provide a good indication of the improvements needed for riparian recovery." The average response (2.76) to this topic is slightly lower than the scale for the question (2.81), but the concept of using the notes associated with "No" answers to identify challenges and opportunities for management is central to both the theory and practice of PFC assessment. The Nevada Team may wish to seek ways to emphasize this aspect of PFC to help managers focus their management on the most efficient and effective strategies for each particular riparian system.

2.5.5 PFC as a Management Tool

Forty percent of respondents indicated that they had participated in management “based on or influenced by” PFC. These participants were asked to answer questions about the most recent instance of management they had taken part in. The resource values most commonly considered important among these responses (Figure 3, above) were livestock grazing (89%) and wildlife habitat (84%). This is not surprising as these are two of the most widespread and important factors for public land managers in Nevada, who made up the bulk of the survey respondents.

Timing of water flows was considered important least often (43%), even though reduction of peak flows and maintenance of baseflow through the dry season are foundational factors to the maintenance of riparian areas for production of good livestock forage and wildlife habitat. The characteristics of the stream systems being managed could be influencing these results. In some watersheds, managers may have little ability to affect stream flow timing due to the hydrology and geomorphology of the system. In others, timing of flows may be unimpaired, so other considerations take precedence. Still, the results indicate that PFC users often fail to emphasize this aspect of functionality.

When deciding on management actions (Question 16), respondents indicated that the results from PFC assessment (3.51) and attaining the cooperation of the land user or permit holder (3.50) were the most important factors (Scale = 3.23). These are generally encouraging results, indicating that PFC is a trusted method and that cooperation between stakeholders is taken seriously.

Interestingly, respondents indicated that preventing or withstanding litigation was less important (2.77). Even though a majority (61%) of the responses indicated this factor was either “Important” or “Very Important,” the number of “Not Important” responses (n=12) was more than twice of any other factor investigated. Within Elko BLM District, litigation of environmental and planning documents is considered a virtual certainty and a serious challenge to management efforts (e.g. Carol Evans, pers. comm 9/10/11). Although there is a contrast between this anecdotal experience and the survey results, the threat of litigation is clearly influencing the development of management prescriptions. PFC’s focus on cooperation among all stakeholders in a riparian system could reduce the prevalence of litigation if the process is trusted and accepted by all of the various stakeholder groups involved. In practice, one stakeholder can disrupt management by opting out of the cooperative process in favor of seeking satisfaction in court.

Question 17 asks about the role of several factors strongly emphasized in PFC teaching and their importance in the management process. Mean scores for all of the factors were high (scale: 3.30), but the lowest scoring factor was “Using the ‘No’ answers to diagnose the needs of the riparian area” (2.94). When managers reference the notes associated with the “No” answers on the PFC checklists when recommending management, the link between problems faced by the riparian system and the proposed management actions is clarified and documented. This might provide a management document with a greater resistance to litigation, as it would explicitly state the connection between the conditions on the ground and the proposed management solution.

Two other factors that scored below scale in this question were the importance of working with diverse stakeholders (3.11) and developing a common vision (3.21). Again, the factors relating directly to the science and process of riparian function outscored those related to the broader goal of cooperation and community involvement. This may reflect the backgrounds of the respondents. Although the majority of respondents were public land managers, among the qualifications required for many of these positions is a scientific degree. This may lead to a tendency to value scientific methods over interpersonal communication when approaching management. The scores for the cooperative factors were quite high in absolute terms; they could be considered low only in relation to the other questions. The relative positions, however, do indicate that perhaps public land managers would profit from further instruction in the more advanced cooperative and social aspects of the PFC model.

2.5.6 Management Documents

The widespread inclusion of specific PFC related attributes in assessment and proposed decision type documents indicates that Elko District BLM has embraced the idea of using the “No” answers and associated notes from PFC assessment to help guide their management proposals and decisions. The relatively lower inclusion rate into final decisions and memoranda does not necessarily reduce confidence in this conclusion, as the nature of these documents may lead their authors to include less detail about assessment results. Final decisions are built upon the foundation of a series of documents, including environmental assessment and proposed decision documents. In the interest of brevity, there may be a tendency to summarize results that have been reported in greater detail elsewhere. In the case of memoranda, these documents are less formal and often much less detailed than other types. Again, the interests of brevity and efficient implementation of management may lead to less detail being included in these documents.

Reference to cooperative watershed management groups in all types of documents studied indicates these groups influence the management process. The methods of this study do not allow inference about the prevalence of these groups, their influence, or their use of PFC concepts in their management efforts. Evidence to support these concepts would not be expected to be preserved in documents focused on meeting policy guidelines and laying out management prescriptions. However, the widespread use of PFC by the Elko District BLM and references to cooperative groups in management documents indicate that the Creeks and Communities process used by the NRST and the Nevada Team may yield greater coordination of stakeholder management objectives.

2.5.7 Implications for PFC teachers

The PFC assessment classes presented by the Nevada Team received high marks for both content and presentation. Participant reports indicate good learning environments, improved understanding of the concepts underlying PFC, and most would either take the training again or recommend it to a colleague. Due to lower scores relative to the scale, it may be useful to make a further effort to help participants understand the connections between riparian functionality and the production of resource values, as well as the importance of using objectives based on functionality rather than production.

Although PFC seems to be generally well received, the survey results indicate that understanding and use of PFC may be somewhat limited in scope. Questions about the science and techniques of PFC assessment consistently outscored questions about how to use the information once it has been gathered. Some areas the Nevada Team might consider improving are: (1) using the common language provided by PFC to build cooperation among ID team members and other stakeholders throughout the management process, (2) teaching participants how to use the results of PFC assessment (especially the "No" checklist answers and their comments) to help identify trouble spots and develop functionality-based riparian objectives, and (3) connecting PFC assessment, riparian objectives, management strategies, and monitoring schedules in an adaptive management structure that allows the riparian system to build functionality.

2.5.8 Management Implications

Those who have used PFC assessment in the field find it to be an efficient and effective tool for assessing the functionality of riparian systems. There may be some confusion due to the complex wording of the questions on both the Lotic and Lentic Checklists. This confusion will probably be minimized through experience and careful attention to detail during training. A period of "apprenticeship" where less experienced ID team members receive mentoring from more experienced users may be appropriate.

PFC assessment teams may not always realize the importance and value of the "No" answers and their associated notes for those who will be using their findings for management. The allocation of scarce management dollars can be optimized by focusing on the trouble points and implications of the management situation indicated by these “No” answers. The Nevada Team should emphasize the value of this information to managers when training potential ID team members. In addition, agencies should foster a culture of attention to detail in the performance of PFC assessments. Greater reliance on PFC will help efforts to develop successful management.

PFC assessment is seen as a useful and valuable tool by public land managers. Managers may not be currently utilizing the full range of tools provided by the PFC assessment process due to a tendency to focus their attentions on the final rating of the PFC assessment at the expense of the nuanced cooperative process that it is intended to facilitate. Managers face many obstacles in their attempts to develop management. A major challenge is to bring people with differing viewpoints and opinions together to reach agreement on a plan that best meets the needs of stakeholders and the environment. While PFC can help in this process, it is also susceptible to disruption by groups who choose not to participate cooperatively, but to seek solutions through litigation. To address this difficulty, the Nevada Team may wish to seek out ways to either encourage cooperation by those who currently choose to disrupt the process or to limit their ability to derail it. At the same time, they can continue to build their focus on the broader problem of building cooperative approaches to riparian management.

2.6 Literature Cited

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Prichard, D., F. Berg, S. Leonard, W. Hagenbuck, M. Manning, R. Krapf, C. Noble, R. Leinard, and J. Staats. 1999. Riparian area management: A user guide to assessing proper functioning condition and the supporting science for lentic areas. U.S. Department of the Interior, Bureau of Land Management. National Business Center, Denver, CO.

3 The Effect of Proper Functioning Condition Driven Management on Water Quality in Elko County, NV

3.1 Abstract

The role of riparian systems in sustaining healthy aquatic and terrestrial ecosystems is well recognized, as are the benefits of riparian attributes and processes to biological, chemical, and physical water quality. Because of widespread degradation throughout the western US a variety of state and federal agencies, tribes, ranchers, recreationists, and others are attempting to improve management of these critical systems. The Bureau of Land Management (BLM) has adopted Proper Functioning Condition (PFC) assessment to assess the problems and challenges riparian systems might be facing, prioritize areas for management, and inform choices among management options. This approach contrasts with the nonpoint pollution strategy of the US Environmental Protection Agency (USEPA) and Nevada Department of Environmental Protection (NDEP), where water quality standards are developed based on beneficial uses, Total Maximum Daily Loads (TMDLs) are allocated to meet those standards, and widespread water quality sampling is carried out to identify areas where TMDLs are being exceeded. We examined a variety of available water quality and riparian monitoring data to see if the use of PFC-driven practices has improved water quality of streams within the Elko BLM District. Several riparian and water quality indicators showed trends over time, and one, riparian zone width, showed a difference in trend for reaches receiving PFC-driven management. Our conclusions are tempered by challenges with the available data and appropriate study design. The currently available

water quality and riparian data may not provide the information needed to effectively manage nonpoint pollution and riparian ecosystem function.

3.2 Introduction

Because of their importance to human activities, many riparian systems in the arid and semi-arid West have been heavily impacted. In an extensive review, (Belsky et al. 1999) assert that approximately 80% of riparia in the arid and semi-arid West have been damaged by livestock grazing. However, over the last 40 years, the importance of riparian areas and their role in landscapes has become a centerpiece of rangeland management. A variety of techniques for assessing, monitoring, and managing uses of riparian areas have been developed and refined to reduce stress and facilitate natural recovery. Management is based on the idea that riparian systems self-heal when well managed (Wyman et al. 2006) and that when functioning properly these ecosystems produce the resources we value (Prichard et al. 1998). Assessment and monitoring techniques indicate the health of riparian systems by focusing on the attributes and processes that characterize functional riparian systems. For example, the stream survey monitoring protocol utilized by the Elko District BLM includes a measurement of “Bank Stability,” a measure of streambank vulnerability to erosion and sloughing (BLM 2002). Because bank erosion affects fisheries habitat, sediment load, and chemical water quality, changes in bank erosion can indicate the trend in riparian functionality and ecosystem health (Prichard et al. 1998). While quantitative monitoring approaches such as water quality sampling and BLM’s stream survey help managers document trend and changes in resource values, they are based on the habitat needs of cold-water fish, not the varying potential of riparian areas in different geomorphic and climatic settings. Assessment of the system's potential (Prichard et al. 1998) and current risk or readiness to recover is better achieved through an approach that recognizes both the underlying commonalities and the inherent differences among streams.

Beginning in 1988, the Bureau of Land Management (BLM), working with other agencies, academia, and interested publics, developed Proper Functioning Conditioning (PFC) assessment to provide field offices an efficient tool to assess the condition of riparian areas (Pritchard et al. 1998). The PFC method uses an interdisciplinary team of journey-level professionals to assess "attributes and processes that are common and important, and that can be judged visually to assess the condition of a riparian-wetland area" (Prichard et al. 1998). PFC is both as the name of the assessment process and as a description of the on the ground condition of the system being assessed. The qualitative PFC assessment locates priority (at-risk) reaches for focused management. Combining this with quantitative monitoring methods such as Stream Survey enables managers to effectively improve riparian areas, evaluate their strategies, and modify them as necessary.

While the importance of riparian functions for the production of high quality water has been extensively studied and verified (Daniels and Gilliam 1996; Hubbard et al. 2004; Olde Venterink et al. 2006), less is known about the effectiveness of management based on the results of PFC assessment. The Elko District BLM manages over 1,200 miles of streams, and has PFC assessment for over 230 perennial and intermittent streams within their district (Coffin 2011). Since development of PFC, Elko

BLM has documented management efforts due to periodic renewal of grazing permits or disturbance, primarily by fire. The BLM also collects stream monitoring data through their stream survey and water quality sampling efforts. In addition, Nevada Department of Environmental Protection (NDEP) routinely monitors water quality at approximately 49 stations within Elko County (Walker 2012). These databases may contain evidence that use of PFC assessment has led to improved outcomes in riparian functionality and water quality. We collected and analyzed Stream Survey (BLM 2002) data, a variety of management documents prepared by Elko District BLM, PFC assessment checklists, and water quality data provided by NDEP and BLM to address the following questions:

- How have water quality and riparian conditions of Elko's streams changed?
- Have strategies using PFC assessment improved functionality and habitat condition of the managed riparian systems?

The null hypotheses are no trends, with or without management, in these measurements of stream and riparian health.

3.3 Methods

3.3.1 Data Collection and Reduction

3.3.1.1 Management Documents

Formal land management efforts carried out by the Elko District BLM are documented in a variety of documents, including memoranda describing prescribed actions after fire and other events, NEPA documents such as Environmental Impact Statements (EIS), Environmental Assessments, and Final Multiple Use Decisions laying out important management actions (livestock stocking rates and rotation schedules, fencing and watering improvements, riparian conservation/restoration measures, etc.) for one or more grazing allotments or other defined areas. We requested copies of all such documents which were produced by the Elko District BLM between 1993 and 2010 which, due to the presence of riparian systems, would be likely to contain reference to the results of PFC assessment. The riparian systems and locations mentioned in these documents are considered to be receiving "formal" management based in part on the PFC process.

3.3.1.2 Stream Survey

The BLM State office in Reno provided a database containing stream survey (BLM 2002) results for all survey stations in the Elko BLM District from 5/26/1977 to 10/29/2010. We reduced this dataset to the measurements described below.

- Bankfull width: The channel width during a bankfull event, defined as a momentary maximum flow that, on the average, has a recurrence interval of 1.5 years. As defined in BLM (2002), this estimates the flow that will fill the channel to the top of its banks and begin to access its floodplain.
- Riparian width category B: The width (to the nearest 0.5 ft.) of riparian vegetation on each transect where total riparian canopy cover (woody and herbaceous) is greater than 50% (BLM 2002). This approximates the riparian zone, defined by Naiman and Decamps (1997) as the area influenced by high water tables or periodic flooding, and by the soils ability to hold water.

- Embeddedness: The covering of streambed materials with fine sediment. This is reported on a 5 point scale, with 1 representing over 75% fine sediment cover, and 5 indicating less than 5% cover.
- Bank Cover: Riparian vegetation living on the active floodplain or streambanks (for systems without floodplain), rated on a four point scale: 0.5 is “exposed;” 1.0 equals “grass;” 1.5 is “brush;” and 2.0 is “forested.” These ratings are further explained in BLM (2002) as general categories of covers, not exact definitions.
- Bank Stability: Another four level rating that indicates the amount of active erosion occurring in the vicinity of the transect. A rating of 2.0 indicates a totally stable bank with no erosion at any flow, while a rating of 0.5 indicates heavy erosion and sloughing.

Riparian vegetation and streambank measurements were reported for both left and right bank for an area 50 feet above and 50 feet below 5 transects spaced 100 feet apart. Detailed descriptions of measurement protocols are available in BLM (2002) and elsewhere.

The Elko BLM District uses a composite measurement of Bank Stability and Cover Type called Riparian Condition Class (RCC). While management documents report RCC, the BLM database contained the raw data for stability and cover type, so we converted to RCC using the BLM’s method, which averages all these scores for a station and converts the mean to a percentage of the highest possible rating (2.0). We summed the columns for left and right bank riparian category B to get total riparian width.

Bankfull channel width and embeddedness were left unchanged. The bankfull channel of a stream may narrow as riparian plants grow into the channel and capture sediment .It may also narrow if it incises into a deep and initially narrow gully, so interpreting changes in bankfull width may be difficult. To account for this, we added two new variables; total width (riparian width plus bankfull width) and width ratio (total width/bankfull width).

We created one composite average value for each variable over all transects for each survey. We eliminated one survey because it was dated to the year 2206. We also eliminated stations with only one survey over the time period because our interest was in change over time.

To account for possible seasonal changes in measurements, we converted sample date to month, season, and year. Spring is March through May, and other seasons follow. We added a column indicating whether each site was mentioned in the management documents described above. Finally, we merged water year total annual precipitation values from the Elko Airport weather gage (DRI 2012). Most precipitation in this area falls in the winter as snow, so we used the prior year precipitation for the months of September through March to reflect the effect of the most recent spring runoff.

3.3.1.3 Water Quality

We obtained separate datasets of water quality measurements from the BLM and NDEP. The dates of measurements in the NDEP dataset are between 7/22/1966 and 11/04/2010, while the BLM samples date from 6/16/1993 to 6/17/2011. Sampling times varied from 6:11 AM to 10:00 PM. Several samples in the BLM file included only the year of collection, not the specific date, so they were eliminated. As in the Stream Survey dataset, sites with only one record of sampling were removed.

We reduced these databases to merge them into one file. Water quality indicators that were not common to both databases were eliminated. Since fewer samples were analyzed in the lab, and differences in handling, lag time, and laboratory methods would make comparisons difficult, only field measurements were retained. After reduction, 8 measured variables were retained: Temperature, pH, Dissolved Oxygen, Total Phosphorus, Ortho-Phosphate, Turbidity, Total Suspended Solids, and Electrical Conductivity. In addition to the response variable columns, the merged dataset contains columns for Station ID, Agency (data source), UTM NAD 83 coordinates, Year, Month, Season, Day (number of days since 7/22/1966), and Time of Day. We merged the water year annual precipitation data from the Elko Airport to the dataset. The resulting water quality data table contains 3148 records for 194 locations.

NDEP water quality sampling stations are not co-located with BLM stream survey sites and BLM's water quality sites are identified differently than their corresponding stream survey sites (UTM coordinates were recorded differently as well), making it inappropriate to attempt to merge the has management variable to this dataset. While these records all come from within the Elko District BLM, the sites are not necessarily co-located with sites from the Stream Survey dataset. Therefore, we abandoned attempts to make comparisons between individual records from the two datasets.

3.3.1.4 Proper Functioning Condition

At the Elko District BLM office, we collected images of all available PFC checklists from assessments performed on stream reaches that were mentioned in the management documents described above. The reaches used for PFC roughly correspond to Stream Survey stations, but they are often longer. The checklist responses, notes, and overall ratings were transferred to a spreadsheet (Appendix E). A total of 117 PFC assessments were collected on 25 streams. Of these, stream surveys were conducted at the same location in the same month 73 times (64 of these occurred on the same day). To test how well PFC assessment ratings predict RCC scores, the data from these cases were combined and reduced for analysis. PFC assessment ratings were converted to integers in two ways: the Rating variable identifies Nonfunctional (NF) ratings as 1, FAR as 3, and PFC as 5; the Trend variable adds FAR-down at 2 and FAR-up at 4, while FAR NA and “trend not specified” remain coded as 3. These variables represent ordinal categories rather than true integers, but we coded them as integers for ease of analysis. The resulting dataset contains 73 records, with columns for Month, Season, Year, Precipitation, Rating, Trend, Embeddedness and RCC.

3.3.2 Statistical Analysis

3.3.2.1 Exploratory Data Analysis

All predictor variables were inspected for outliers that may have applied excessive leverage to the finished models. Two channel width measurements were removed, as they were much larger than any other measurement. One was much different from other measurements at the same site, while the other was the only value recorded for that site. Thirteen RCC measurements were removed because they were below .25, which is the lower limit of scores possible for this indicator. One riparian width measurement was much larger than all others, and was the only record for that variable at that site, so it was removed. All other measurements were retained, as any further attempt to remove possible outliers would rely on arbitrary thresholds, and would not necessarily improve the reliability of the data.

To check for normal distribution, we developed histograms of all response variables. Several variables (Channel Width, Riparian Width, Total Width, Width Ratio, Electrical Conductivity, Ortho-Phosphate, Total Phosphate, Total Suspended Solids, and Turbidity) had distributions which were strongly non-normal, with high frequencies close to zero, and only a few larger values. These variables were log-transformed to create a more normal distribution.

3.3.2.2 Statistical Modeling

The Stream Survey and Water Quality datasets represent repeated measurements with both random (Site) and fixed variables of interest. This situation was represented in S+ (TIBCO 2010) by building linear mixed-effects models for each of the response variables, allowing us to account for random variation among sites while examining the variables for trends over time. For each response variable, we built the models sequentially, starting with the intercept-only (null) model, and adding variables in a specific order. The predictor variables were slightly different between the Stream Survey and Water Quality datasets. For the Stream Survey data, variables were added in the order: “year”, ”precipitation”, “season”, “month”, “has management”, and the interaction “year: has management”. When both season and month significantly improved the model, only the better performing variable was retained, and if there was no significant difference between their effects, season was retained as it added fewer parameters. As explained above, models built from the water quality dataset omitted the “has management” and interaction terms. We added the agency variable to account for differences in collection and analysis techniques, and time of day, as chemical water quality may vary on a diurnal time scale (Scholefield et al. 2005).

We tested each more complex model by Chi-squared comparison of likelihoods, only retaining a new predictor if the test returned a p-value less than .05. S-Plus uses restricted maximum likelihood (REML) fits for linear mixed effects models, but comparisons between REML fits are not valid, so we refit the models using maximum likelihood (ML) before performing the Chi-squared test. This confirmed that the improvement in the model’s accuracy more than compensated for the increased complexity. We tested model fit using McFadden’s R^2, which is the ratio of the log-likelihood of the full model to that of the intercept-only model, subtracted from one ($1 - \text{log-lik}_f/\text{log-lik}_0$).

If PFC assessment is capturing changes in riparian attributes and/or processes, there should be significant covariance with quantitative measurements of those processes. To test this hypothesis, the PFC checklist dataset was analyzed for correlation between “rating” (3 classes) or “trend” (5 classes), “RCC”, and “embeddedness”. We then built a simple linear regression model using trend as the response variable, and precipitation, RCC, and embeddedness as potential parameters. Each model was again built through sequential addition of variables, and only variables that significantly improved the model at the $p < .05$ level (F-test) were retained.

3.4 Results

3.4.1 Stream Survey Data

All of the models exhibited low McFadden's R^2 values, in no case exceeding 0.2, but they all performed significantly better than their respective null models (Table 3-1).

Table 3-1. Model performance versus null model.

Model	log-Likelihood Ratio	p-value	McFadden's R^2
Riparian Condition Class	393.59	<.0001	0.17
Embeddedness	66.12	<.0001	0.02
Channel Width	587.03	<.0001	0.13
Riparian Width	21.25	<.0001	0.004
Total Width	48.15	<.0001	0.03
Width Ratio	45.48	<.0001	0.01

Two response variables show a decrease over time, embeddedness and bankfull channel width. Riparian width, riparian condition class (RCC), and width ratio increased, while there was no support for yearly trend in total width (Table 3-2).

Support for rejecting the second null hypothesis, that there was no effect of management over time, came only with the riparian width, $t(274) = 2.4$, $p < 0.05$), and total width, $t(231) = 2.5$, $p < 0.05$, models. These performed significantly better than the same models without the interaction term (riparian width: $L(2) = 9.06$, $p < 0.05$, total width: $L(2) = 8.66$, $p < 0.05$) and the 95% confidence interval for the coefficient of the interaction term did not include zero. This suggests there may be a difference in the trend of these variables over time between "managed" and "unmanaged" sites.

Table 3-2. Trend of riparian indicators over time. Trend in total width is non-significant. Trend in width ratio is significant at $p > 0.05$ but 95% confidence interval includes zero.

Parameter	Value	95% Confidence Interval			Degrees of Freedom	t-value	p-value
Riparian Condition Class	0.005	0.005	to	0.006	2053	18.15	<0.0001
Embeddedness	-0.018	-0.029	to	-0.006	399	-3.11	0.002
Channel Width	-0.032	-0.034	to	-0.029	1108	-24.36	<.0001
Riparian Width	0.025	-0.023	to	-0.005	274	2.52	0.012
Width Ratio	0.010	-0.00004	to	0.020	233	1.99	0.047
Total Width	0.0042	-0.0077	to	0.0161	231	0.71	0.48

3.4.2 Water Quality Data

These models also exhibited generally poor fit, although the McFadden's R^2 of the electrical conductivity model was greater than 0.2, and all models performed significantly better than the null (Table 3-3). Among the water quality measurements tested, dissolved oxygen (DO), turbidity, and pH increased over time, while ortho-phosphate decreased (Table 3-4). While the trend in water temperature was significant at the $p < 0.05$ level, the 95% confidence interval included zero. There was no support for trend over time for electrical conductivity, total phosphate, or total suspended solids.

Table 3-3. Model parameters attained mostly poor McFadden's R^2 scores, suggesting that other factors are important drivers of water quality.

Model	log-Likelihood Ratio	p-value	McFadden's R^2
Dissolved Oxygen	592.52	<.0001	0.05
Orthophosphate	234.51	<.0001	0.05
pH	74.77	<.0001	0.02
Turbidity	869.37	<.0001	0.11
Electrical Conductivity	740.20	<.0001	0.32
Water Temperature	3536.07	<.0001	0.18
Total Phosphate	164.35	<.0001	0.03
Total Suspended Solids	621.29	<.0001	0.08

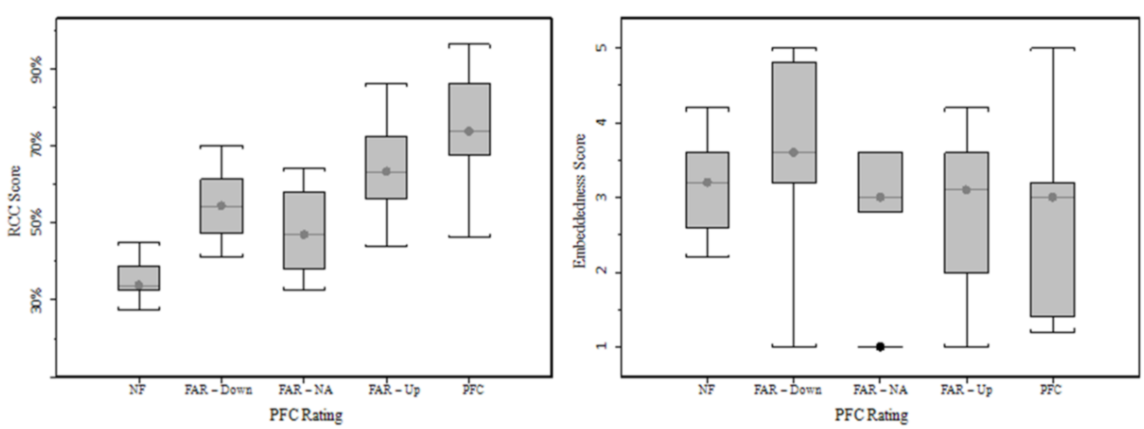
Table 3-4. Trends in water quality variables. Electrical conductivity, total phosphate, and total suspended solids had no significant trend.

Parameter	Value	95% Confidence Interval			Degrees of Freedom	t-value	p-value
Dissolved Oxygen	0.01835	0.00955	to	0.0272	2543	4.17	<.0001
Orthophosphate	-0.00073	-0.0011	to	-0.0003	2503	-3.66	0.0003
pH	0.01525	0.00952	to	0.021	2087	5.34	<.0001
Turbidity	0.019	0.01514	to	0.0229	2630	9.86	<.0001
Water Temperature	0.0153	-0.0002	to	0.0308	2835	1.98	0.0479
Electrical Conductivity	-	-	to	-			-
Total Phosphate	-	-	to	-			-
Total Suspended Solids	-	-	to	-			-

3.4.3 PFC Assessment Data

Pearson's correlation coefficients show that PFC ratings were highly correlated with RCC scores, $r(71) = 0.77$, $p < 0.001$, but not with Embeddedness values, $r(45) = -0.21$, $p > 0.05$. Simple box plots (Figure 3-1) show these relationships. RCC score and annual precipitation together explained a significant proportion of the variance in PFC scores, $R^2 = .65$, $F(2, 70) = 64.63$, $p < .0001$, while predictions of PFC based on embeddedness only achieved an R^2 of .05, $F(1, 47) = 2.22$, $p > 0.05$. The effect of current water year annual precipitation on embeddedness was not significant.

Figure 3-1. PFC Rating is correlated with RCC score, but not embeddedness.



3.5 Discussion and Conclusions

With the exception of width ratio, each of the riparian indicators derived from the Stream Survey dataset show significant trends over time. The change in RCC and riparian width values indicate an improvement in conditions, while increased embeddedness (lower score) indicates deterioration. The reduction in Channel Width over time is more difficult to interpret without other evidence, as we expect channels to narrow as conditions improve, but channel width might also decrease if the stream incises and is confined in a gully. Avoiding channel incision is fundamental to maintaining riparian functionality, yet there is no direct measure of it in Stream Survey. If channel width is decreasing due to recovery of the riparian system, we would expect the total width (channel plus riparian) to remain constant or increase. Since we found no trend in total width, the trend toward narrowing channels may be a result of riparian recovery. The other measurement intended to clarify changes in channel width, width ratio (total width divided by channel width), would also be expected to increase with riparian recovery. In this case, however, the weak support for a trend in width ratio provides little confidence that decreased channel widths represent improved conditions.

The positive value of the interaction terms found in the riparian width and total width models indicate that those streams receiving documented management may be experiencing greater gain of riparian zone width than other streams. However, the association was somewhat weak and didn’t show up in the other variables. This, along with other factors discussed below, limits our confidence in this conclusion.

Of the eight water quality measures tested, five showed significant trends over time: dissolved oxygen, ortho-phosphate, pH, water temperature, and turbidity. We have low confidence in the trend in water temperature because the 95% confidence interval included zero. Dissolved oxygen increased, which could be interpreted as improvement, as could the reduction in ortho-phosphate. Turbidity increased, which would generally be considered a negative development. The drop in acidity (higher pH) could be considered an improvement, although other factors would need to be known before making such a conclusion. For example, the change may represent disturbance in the upland watershed (Dow and Zampella 2000) rather than any change in riparian function.

In all models, the majority of variance in the response variable was unexplained. This is to be expected, as we didn’t specifically set out to model parameter variability, but to seek out trends in parameter values while accounting for random variation among sites. However, our ability to make inferences regarding the trends was hampered by the large residual variance of the models. These data and analyses indicate that for the Elko District locations studied many of the stream/riparian indicators do seem to be changing over time. However, they do not allow us to say that the formal management process represented in official documents has had an effect on these trends.

3.5.1 Discussion

Although we found some trends, a number of factors limited our ability to satisfactorily address the research questions we set out to answer in this study. These factors include limitations in the available data, data collection and recording methods, and consequent limitations to the study design. Of particular concern are the water quality dataset and its relationship to the other sources of data. NDEP uses different sampling sites than the BLM, and the BLM uses a different method of naming and locating their water quality sampling sites than they do for their stream survey and PFC sites. In addition, water quality sampling is not performed over appropriate time and distance scales to relate them to the conditions or management of a particular reach. This precludes any attempt to directly compare the results of PFC assessment with water quality data.

Due to the realities of managing public land for the benefit of multiple users, one assumption in our study design may be problematic. By assuming that inclusion in formal management documents indicated management using PFC, we ignored all informal management efforts that may be occurring in the region. However, the Elko District BLM's widespread adoption of PFC means that all streams under their jurisdiction are being managed using PFC, not just the ones going through formal processes such as fire closure and grazing permit renewal. Furthermore, there may be confounding factors for inclusion in formal documents; including the possibility that streams having more disturbance or in greater need of management changes may be more (or less) likely to be included. Furthermore, due to the virtual certainty of challenges to legal documents such as Environmental Assessments and Grazing Decisions, much of the actual grazing management progress is occurring by using the flexibility written into existing management plans (Carol Evans, pers. comm., 9/10/11). These factors mean that our division of sites into control and experimental groups was not likely to be entirely accurate or useful.

The available data were collected with the intention of monitoring changing conditions at one site over time. The types of measurements needed for such monitoring are not necessarily the same as those needed to make region-wide inferences regarding management effects, as many parameters are strongly influenced by elevation, aspect, local geology and other factors. To truly get an insight into these research questions, a more intensive look at specific sites, with careful data collection and proper controls, is needed.

The effectiveness of the current management environment for maintenance and recovery of riparian systems could be investigated by intensively monitoring over the long term a variety of sites under different management circumstances. A researcher may be able to uncover factors that are important for successful management of riparian systems (e.g. studies in Wyman et al 2006), through: A.) careful selection of sites, B.) Thorough examination of the historic land use, management, socio-political, climatic, and geologic factors each site has experienced, and C.) Detailed analysis of current, historic, and prehistoric (where possible) conditions and trends of the study sites.

A study more likely to determine if the use of PFC-driven management leads to changes in water quality would require substantial investment of time and monetary resources. In fact, simply finding a way to separate sites into treatment versus control groups would present a difficult challenge. The concepts of PFC are integrated into all aspects of the management process, so separation into “PFC vs. not PFC” driven management would invariably introduce confounding factors. Even if one was able to make that distinction properly, the variation in time scales would provide another difficult (and expensive) challenge. Water quality has been shown to vary on diurnal and seasonal time scales (Scholefield et al. 2005), as well as over the course of annual and event hydrographs (e.g. Walling and Foster 1975; Dahlgren et al 1999). Changes due to PFC-driven management would be expected to occur over annual to decadal scales. This means that water quality sampling would need to be carried out on a short time-step and over long periods of time, perhaps every 2 hours for several days, several times a year, for 5-10 years. Finally, water quality sampling reflects the conditions of the entire upstream watershed, with varying rates and processes of distance decay. Sampling stations would need to be established at the top and bottom of the study reach, and the protocol would need to account for the contributions of any tributaries within the reach. Such a study would be prohibitively expensive.

Fortunately, there may not be a need to pursue this line of questioning. The question of whether using PFC results in improvements in water quality may not address the core of the issue. USEPA and NDEP use water quality measurements to determine if beneficial uses are impaired. In wildland systems those beneficial uses, e.g. fishable, swimmable waters, are generally the same ecosystem services that the BLM values on its land. As both methods of assessment aim for the same goal, a more direct inquiry may be whether one approach better enables A.) Understanding the locations and causes of problems from management that affects fish habitat, recreation, water for livestock, and other water uses; B.) Selection of management changes to address those problems; C.) Monitoring the effects of management changes soon enough to make timely adjustments as needed; and D.) Communication with stakeholders about rationale for management strategies. Properly answering this question would require consideration of ecological, social, economic, and political factors, and could provide substantial support for managers facing the challenge of balancing diverse and sometimes competing interests.

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4 Conclusions

The results from Chapter 2 show that PFC assessment is highly regarded as a field assessment technique and aid in management. The Nevada Team can be confident that their students receive proper education in the techniques and use of PFC assessment, and that the emphasis on collaborative management techniques is consistent with, and may be influencing, the management philosophy of public agency employees. Among the minor changes they may consider are further clarification of the wording of checklist questions and increased emphasis on the value of PFC for developing trust among stakeholders and adapting management techniques to the challenges specific to each riparian system.

Although we found no explicit link between PFC-driven management and improvements in physical, chemical and biological water quality, our efforts to do so brought to light some drawbacks of using water quality standards and TMDLs as a guide for management. The characteristics of a water sample taken at a point on a watercourse are the result of all of the upstream influences on the water, along with the effect of time and distance lags of varying magnitudes. Knowing the constituents of a sample of water tells us little about those influences, or what management actions are indicated to obtain improvement. In addition the practice of setting water quality standards based on pollution levels that “ought not to impair beneficial use of the water” (Walker 2012) ignores geological, topographic, and hydrological variations that cause the potential of even very similar streams to differ significantly. Management based on these standards runs the risk of attempting to force a stream to produce levels of water quality which are unsuitable for its physical and biological setting or setting standards at a low level that provides little inducement for reaching optimum conditions of habitats and water quality.

Management to promote the riparian attributes and functions that are expected to naturally develop within a riparian system is likely to produce high quality water (relative to the potential of that stream) with optimum investment of resources and a lower risk of failure.

4.1 Recommendations

Overall response rate to the survey in Chapter 2 was quite high, but two factors limited our ability to perform detailed analysis on the data. Since a large majority of the respondents described themselves as land managers and no other category represented more than 10% of the total respondents, responses could not be compared by relationship to riparian areas at the time of training. In addition, two of the questions (Questions 6 & 13) were “double-barreled,” having two clauses, either of which could have prompted the response. This reduced the scope and precision of the conclusions drawn from the responses. Though these factors somewhat limited the range of appropriate analysis methods, the survey results provided good insight into the study questions. Future efforts to study this topic would be strengthened by careful targeting of underrepresented stakeholder groups when building the population list and by carefully rewording the troublesome questions.

Researchers at Oregon State University are conducting a similar study which includes land managers and PFC users throughout the western United States. Many of the questions are similar to those in this study, and it could be possible to obtain useful information by comparing the results of both studies. As the NRST and Nevada Team continue to develop inclusive and cooperative management strategies, they will want to observe how understanding of PFC is changing among class participants and stakeholders. Regular post-class administration of a questionnaire similar to the one used here could provide the basis for an investigation of these trends.

While previous studies have shown the connections between attributes and processes of properly functioning riparian areas and the water quality of streams (Daniels and Gilliam 1996; Tabacchi et al. 2000; Olde Venterink et al. 2006), more work would be needed to clearly identify the links between PFC-driven management and the chemical, biological and physical quality of the water produced. Work to bring these connections to light would be difficult and prohibitively expensive, and may not be the most productive direction for investigation.

Water quality monitoring has been an important tool for land and water body managers combatting point source pollution (Smith et al. 1987). But widespread use of water quality monitoring in wildland stream systems may be less efficient and effective than other assessment and monitoring methods. This raises the question “Under what circumstances and conditions are TMDL’s, water quality standards and chemical monitoring the most appropriate approach, and when would another method, such as PFC assessment coupled with riparian monitoring, be more appropriate?”

In seeking an answer to this question, we might borrow the concept of leading and lagging indicators from the field of Economics. A leading indicator will change before a corresponding change in the property of interest, while a lagging indicator will change after. Land managers will find leading indicators more valuable than lagging ones, as they use indicators to predict and avoid negative outcomes by taking preventative action and empowering adaptive management. A thorough investigation into the circumstances where water quality becomes a leading or lagging indicator would help managers focus their use of limited resources more effectively.

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6 Appendices

6.1 Appendix A

Creeks & Communities Strategy
Logic Model
DRAFT 4 – NRST EDITS – 8.1.09

Inputs[1]	Immediate Outcomes	Intermediate Outcomes		Program Goal/ Long-Term Outcome
	Learning	Behavior Change		
	Individual Learns:	Individual:	Groups of Individuals:	
1. PFC Assessment Training 2. Grazing Management Training 3. Service Trips	Scientific & Technical Information/Tools • PFC (what it is & how to assess it) • Function of rivers and riparian areas • Function before values • Link between riparian and uplands • Joint fact-finding approach • Management and monitoring strategies • Connection of grazing and riparian function	Use Scientific & Technical Information/Tools • Uses PFC tool and joint fact-finding approach to assess own area • Monitors riparian areas • Uses various management strategies • Considers function as a basis for creating riparian values when assessing riparian areas	• Together use concepts associated with functionality to regularly assess watershed condition and influence management strategies • Together use PFC as a bridging communication tool that places function ahead of values to manage conflict	The successful management and restoration of riparian areas, throughout the service area.
	Collaborative Tools/ Information • Importance of working with diverse and appropriate group of people • Importance of working across the landscape • Ties to larger watershed (importance of landscape scale perspectives) • How to develop common vision/plan at any scale • Conflict management	Use Collaborative Tools/ Information • Collaborates across ownerships to resolve own issues • Develops vision/plan for own area • Recognizes and manages own riparian area conflict effectively	• Together coordinate collaborative management • Collaborate together across boundaries to resolve riparian issue • Share a vision/plan • Work together to resolve community riparian conflicts effectively	
	How to effect 'on-the-ground' change • Management strategies • Plans that are economically feasible • Understand adaptive management	Effect 'on-the-ground' change • Applies management strategies to aim for desired or designed riparian goals and objectives • Develops plans that are economically feasible	• Work together to develop and implement a management plan based on goals and objectives that are economically feasible	

[1] The darkness of arrows in the logic model indicates the level of influence the Strategy has on the outcome. The Creeks & Communities Strategy has the most direct influence over the inputs it invests and the learning outcomes of individuals. Many additional factors influence immediate and intermediate outcomes, including participants' backgrounds and community conditions. Many factors influence the achievement of long-term and overall program goals; examples include state and federal policies, economic and market conditions, social and population conditions, and some environmental conditions.

The above model should incorporate the various components of the adaptive management cycles: awareness, understanding/acceptance, agreement, actions, monitoring and adaptation around a common purpose.

6.2 Appendix B

Web Survey Questionnaire and Branching Logic

Part A: General Information

1. If you would prefer to schedule an appointment to complete this survey over the phone, select the box below.

   ☐ Make an appointment for a phone survey.

   ➢ <u>If checked, go to question 30</u>

2. How many times have you participated in a Proper Functioning Condition (PFC) assessment training offered by the Nevada Creeks and Communities Team (Formerly known as the Nevada Riparian PFC Cadre)?

   a. Never
   b. Once
   c. Twice
   d. Three times or more

3. Have you participated in any Riparian Grazing Management and Monitoring trainings offered by the Nevada Creeks and Communities Team or the National Riparian Service Team (NRST)?

   a. Yes
   b. No

➢ <u>If Question 1 = a, then go to Question 10</u>

4. Which of these categories best describes your relationship to wetland-riparian areas <u>at the time</u> of the trainings? (Select the <u>one</u> best answer)

   a. Public land manager - tribal, state, federal, county
   b. Private land owner
   c. Public land recreationist (e.g. for hiking, hunting, fishing)
   d. Public land grazing permittee
   e. Other: ____

Part B: Curriculum and Presentation

5. How much do you agree or disagree with the following statements about the Nevada Creeks and Communities Team PFC assessment trainings you have participated in? (Choose the <u>most accurate</u> response)

   Strongly Disagree – Disagree – Neither Agree nor Disagree – Agree – Strongly Agree

   a. Instructors communicated in a way that was understandable to me.
   b. It was useful to interact with specialists and stakeholders at field sites.
   c. The reference materials were helpful.
   d. The training strengthened relationships among participants.

e. Instructors created an environment that respected and encouraged dialogue.
f. Instructors handled conflict appropriately.
g. Follow-up activities or information were provided in a timely manner.
h. Overall, the training met my expectations and needs.

6. After participating in one Nevada Creeks and Communities Team training event how likely are you to attend another?

Very Unlikely – Somewhat Unlikely – Neither Likely nor Unlikely – Somewhat Likely – Very Likely

7. How much have the Nevada Creeks and Communities Team PFC assessment trainings you have participated in improved your understanding about each of the following subjects? (Choose the <u>most accurate</u> response)

Not at all – A little – A fair amount – A great deal – Don't Know

a. The relationship between riparian function and fish and wildlife habitat.
b. The relationship between riparian function and livestock forage.
c. The relationship between riparian function and biodiversity.
d. The relationship between riparian function and water quality.
e. The connection between riparian areas and the timing of water flow.
f. Why an experienced interdisciplinary team is needed to perform a PFC assessment.
g. The importance of studying existing records or information about the riparian area prior to PFC assessment.
h. How to determine a functionality rating for a riparian area using the PFC checklist.
i. Riparian attributes and processes (i.e., the interaction of water, vegetation, and soil/landform).
j. Riparian area potential and capability as they relate to function)
k. How to support PFC assessment with notes, photos and a plant list.
l. How to use PFC assessment data to focus riparian objectives.
m. How to consider riparian objectives in selecting management strategies.
n. How to use PFC assessment data to help design monitoring strategies.
o. Whether to use monitoring data to adapt management strategies to achieve riparian objectives.

8. How much have the Nevada Creeks and Communities Team PFC assessment trainings you have participated in improved your understanding about: (Choose the <u>most accurate</u> response)

Not at all – A little – A fair amount – A great deal – Don't Know

a. The importance of working with diverse stakeholders when dealing with riparian issues.
b. The importance of riparian functions for developing a common vision or plan with stakeholders.
c. How to work with stakeholders to assess, manage, and monitor riparian areas.

9. Please add any additional comments about your experience with the Nevada Creeks and Communities Team PFC assessment training: (Text box)

Part C: Utility of PFC

10. Have you participated as a member of an interdisciplinary team in the PFC assessment of one or more lotic (running water) or lentic (slow water) riparian systems? YES/NO

11. Have you performed a PFC assessment of one or more lotic or lentic riparian systems as an individual (i.e. NOT as part of an ID team)? YES/NO

- <u>No on questions 10 and 11, go to question 13</u>

12. In your experience with performing PFC assessment, would you agree or disagree with the following statements? (Please mark the most appropriate answer.)

    Strongly Disagree – Disagree – Neither Agree nor Disagree – Agree – Strongly Agree

    a. PFC assessment is a cost-effective tool for learning the problems a riparian area may be experiencing.
    b. PFC assessment takes into account differences in potential and/or capacity of different riparian systems.
    c. PFC assessment helps develop common understanding among the stakeholders in a riparian system.
    d. The lotic system checklist items are easy to understand and interpret.
    e. The lentic system checklist items are easy to understand and interpret.
    f. The qualitative attributes assessed for PFC are good indicators of riparian functionality.
    g. The notes associated with the "No" answers to checklist items provide a good indication of the improvements needed for riparian recovery.

13. Have you participated in the process of implementing management based on or influenced by the PFC assessment process? Yes/No

- <u>No on question 13, go to question 25</u>

14. What year was the new management put in place? _____

15. What resource values were considered important for the riparian area in question?

    a. Livestock grazing
    b. Fish habitat
    c. Wildlife habitat
    d. Biodiversity
    e. Timing of water flow
    f. Water quality
    g. Other_______________

16. How influential were each of the following considerations to the decision on management actions?

    Not Important – Not Very Important – Important – Very Important – Don't Know

    a. Results from stream survey
    b. Results from PFC assessment
    c. Cooperation from permit holder/land user
    d. Cooperation from management agency(ies)
    e. Preventing/withstanding litigation

17. How important was the role of each of the following factors in the management decision-making process?

    Not Important – Not Very Important – Important – Very Important – Don't Know

    a. Working with diverse or conflicting stakeholders to manage riparian areas.
    b. Developing a common vision or plan for a riparian area with relevant stakeholders.
    c. Using the "No" answers on the PFC checklist to diagnose the needs of the riparian area.
    d. The type of vegetation capable of growing and needed by the riparian area.

e. The interdependence of water, soil/landform, and riparian vegetation.
f. The production of water, forage, fisheries or other resource values.
g. The readiness of the riparian area to repair itself or to decline in functionality.

18. Were long-term (3 years or more) resource objectives developed for this riparian area? (Yes/No/Don't Know)

19. Briefly describe these objectives: (Text Box)

20. Has monitoring data or information been collected from this riparian area? (Yes/No/Don't Know)

21. Briefly describe your monitoring methods: (Text Box)

22. Are there indications that functionality is improving in the riparian area? (Yes/No/Don't Know)

23. What leads you to this conclusion? (Text Box)

24. Please add any other thoughts or observations about your experience in development and implementation of management changes using the PFC process: (Text Box)

Demographic Information (optional)

25. Sex: M/F

26. Age:

    a. 18-25
    b. 26-35
    c. 36-45
    d. 46-55
    e. 55 or better

27. Current level of education:

    a. High School
    b. Some College
    c. Undergraduate Degree
    d. Graduate Degree

28. Current Occupation: ________________

29. Feel free to leave comments regarding this questionnaire, the study, the PFC process, or riparian management and restoration: (Text Box)

Phone Interview Contact Information

30. Name ____________

31. Phone ____________

32. Extension _________

33. What are the best times to reach you (day of the week, time of day)? (Text Box)

34. Any special contact instructions? (Text Box)

6.3 Appendix C

Survey Raw Data Table

ID	Q2	Q3	Q4	Q5a	Q5b	Q5c
1	2	No	Public land recreationist (e.g. for hiking, hunting, fishing)	3	4	3
2	1	No	Public land manager - tribal, state, federal, county	3	4	3
3	3	No	Public land manager - tribal, state, federal, county	3	3	4
4	1	No	Public land manager - tribal, state, federal, county	4	4	4
5	1	No	Public land manager - tribal, state, federal, county	4	3	3
6	2	Yes	nonprofit director	3	2	3
7	0	No				
8	0	No				
9	0	No				
10	1	No	Public land manager - tribal, state, federal, county	3	3	3
11	1	No	Private land owner	4	4	4
12	2	Yes	ranch hand, public and private grazing	4	3	3
13	1	Yes	Public land grazing permittee	3	3	3
14	1	No	NRCS	3	3	3
15	1	No	Public land manager - tribal, state, federal, county	4	4	4
16	1	No	Public land manager - tribal, state, federal, county	2	3	2
17	1	No	Public land manager - tribal, state, federal, county	3	3	3
18	3	No	Public land manager - tribal, state, federal, county	3	4	3
19	1	Yes	Public land manager - tribal, state, federal, county	3	4	2
20	2	No	State regulatory	3	3	3
21	1	No	Public land manager - tribal, state, federal, county	3	3	3
22	0	No				
23	1	No	Public land manager - tribal, state, federal, county	4	4	4
24	1	Yes	Public land manager - tribal, state, federal, county	4	4	4
25	1	No	Public land manager - tribal, state, federal, county	3	3	3
26	1	No	Public land manager - tribal, state, federal, county	3	3	3
27	1	Yes	Public land manager - tribal, state, federal, county	3	3	3
28	1	No	Public land manager - tribal, state, federal, county	3	4	3
29	0	No				
30	1	Yes	Public land manager - tribal, state, federal, county	4	4	4
31	0	No				
32	0	Yes				
33	3	Yes	Public land manager - tribal, state, federal, county			
34	0	No				
35	0	No				
36	3		NRCS employee/consultant	3	4	2
37	1	No	flood irrigation	3	3	3
38	1	Yes	Private land owner	3	3	3
39	1	Yes	Public land manager - tribal, state, federal, county	3	4	3
40	2	No	assisting BLM in assessing w-r	3	3	3

Appendix C (Cont.)

ID	Q5d	Q5e	Q5f	Q5g	Q5h	Q6	Q7a	Q7b	Q7c	Q7d	Q7e	Q7f	Q7g
1	3	4	3	3	3	4	2	2	2	4	3	4	4
2	3	3	3	2	3	3	2	2	2	2	2	2	2
3	3	3	4	3	3	4	4	3	4	4	4	4	4
4	2	4	2	2	4	4	2	3	2	1	1	3	4
5	3	4	2	2	3	4	3	3	3	3	3	4	2
6	2	3	3	3	3	3	2	3	3	3	4	3	3
7													
8													
9													
10	2	3	2	2	2	0	1	1	1	1	1	2	2
11	4	4	2	2	3	4	4	3	4	4	3	4	3
12	3	4	3	3	4	4	3	4	4	4	3	3	4
13	2	3	2	1	3	2	3	2	2	3	3	2	2
14	3	3	3	3	3	4	3	3	3	3	3	3	3
15	4	4	4		4	4	2	2	4	3	4	3	2
16	3	2	2	2	2	0							
17	2	3	3	3	3	3	2	2	2	2	3	4	4
18	3	3	3	2	2	2	1	1	1	1	1	1	1
19	1	2	2	2	3	4	3	2	2	3	2	4	2
20	2	3	3	2	3	4	3	2	3	3	2	4	3
21	2	3	2	2	3	4	4	4		4	4	4	3
22													
23	4	4	4	4	4	3	3	3	3	3	3	3	3
24	4	4	4	4	4	4	2	3	3	3	2	3	2
25	2	3	2	2	3	4	3	3	3	3	2	4	4
26	2	3	3	3	3	3	4	4	3	4	3	4	3
27	3	3	2	3	3	4	3	3	3	4		3	2
28	3	3	3	3	3	3	2	3	3		1	4	4
29													
30	3	4	4	3	4	4	4	4	4	4	4	4	4
31													
32													
33						4							
34													
35													
36	3	3	2	3	3	4	3	4	4	4	3	0.001	4
37	4	4	3	3	3	3	3	3	4	2	1	3	3
38	2	3	2	2	2	1	3	3	3	3	2		1
39	3	3	2	3	3	3	3	3	2	3	3	3	3
40	2	3	2	2	2	3	2	0.001	2	3	3	1	3

Appendix C (Cont.)

ID	Q7h	Q7i	Q7j	Q7k	Q7l	Q7m	Q7n	Q7o	Q8a	Q8b	Q8c	Q10	Q11
1	4	2	3	4	4	4	4	3	3	3	2	Yes	Yes
2	3	3	3	3	3	2	2	3	2	2	2	Yes	No
3	4	4	4	4	4	4	4	4	4	4	4	Yes	Yes
4	4	2	3	3	4	3	2	2	3	3	2	Yes	No
5	4	3	4	3	4	2	2	2	2	2	2	No	No
6	4	4	4	4	4	3	3	3	4	4	4	No	No
7												Yes	No
8												Yes	No
9												No	No
10	2	1	2	2	2	1	2	1	2	2	2	Yes	No
11	4	4	4	4	4	2	2	2	1	1	1	Yes	Yes
12	4	3	3	2	3	3	3	3	4	4	4	Yes	Yes
13	4	2	2	2	2	3	2	2	1	4	2	No	Yes
14	3	3	3	3	3	3	3	3	4	4	4	No	Yes
15	4	3	3	2	2	1	1	2	2	2	2	Yes	No
16									3	3	2	Yes	No
17	4	4	4	4	4	4	4	3	2	2	2	No	No
18	3	1	1	3	2	1	1	1	3	3	2	No	Yes
19	4	3	4	4	3	1	1	1	1	2	1	Yes	Yes
20	4	3	3	3	3	3			2	2	2	No	No
21	4	4	3	4	4	4	3	4	4	4	4	Yes	No
22												Yes	Yes
23	0.001	4	0.001	0.001	0.001	4	0.001	4	3	3	3	No	No
24	4	2	4	3	2	2	2	2	4	4	4	No	No
25	4	3	4	3	4	3	3	3	3	3	3	Yes	Yes
26	4	3	3	4	3	4	4	3	3	3	3	Yes	Yes
27	3	4	2	3	2	2	2	3	3	3	2	Yes	No
28	4	4	3	4	2	2	2	2	4	3	3	Yes	No
29												No	No
30	3	4	4	4	4	4	4	4	4	4	4	Yes	Yes
31												No	Yes
32												Yes	No
33									4	4	3	Yes	No
34												Yes	No
35												No	No
36	4	4	4	4	3	4	3	3	4	4	4	Yes	Yes
37	4	3	3		3	3	3	3	3	3	3	No	No
38	2	2	2	3	2	3	2	3	3	3	2	No	Yes
39	4	3	2	3	2	3	3	2	4	3	3	Yes	No
40	2	2	3	2	2	1	1	1	2	2	1	Yes	No

Appendix C (Cont.)

ID	Q12a	Q12b	Q12c	Q12d	Q12e	Q12f	Q12g	Q13	Q14	Q15a	Q15b
1	3	3	3	3	3	3	2	No		0	0
2	3	4	3	3	3	3	2	No		0	0
3	3	3	3	3	3	3	2	Yes	2002	1	1
4	3	4	2	3	3	3	3	No		0	0
5								No		0	0
6								Yes	2010	1	0
7	3	2	3	3	3	4	4	No		0	0
8	2	1	3	1	2	3	3	No		0	0
9								No		0	0
10	0	1	3	2	2	1	2	No		0	0
11	4	3	3	3	3	3	4	Yes	2008	1	0
12	3	4	3	4	4	3	3	Yes	1995	1	1
13										0	0
14	3	3	3	3	3	3	3	No		0	0
15	3	4	2	3	3	3	2	Yes	2009	1	0
16	3	3	3	3	3	3	2	No		0	0
17								No		0	0
18	3	3	1	1	1	2	1	Yes	2010	1	0
19	3	3	2	3	3	4	2	Yes	2007	0	1
20								No		0	0
21	2	3	3	3	3	3	3	Yes	1993	1	0
22	3	3	3	2	2	3	2	Yes	2006	1	1
23								No		0	0
24								No		0	0
25	3	3	3	3	3	3	3	Yes		1	0
26	3	3	2	2	2	2	2	Yes	2007	1	0
27	3	3	2	2	1	3	3	Yes		1	1
28	3		3	2	2	3	3	No		0	0
29								No		0	0
30	4	4	3	3	3	4	4	Yes	2009	1	1
31	3	3	2	2	2	3	2	No		0	0
32	4	3	3	2	2	3	3	No		0	0
33	4	4	4	4	4	4	4	Yes	2007	0	0
34	3	3	3	3	3	3	2	No		0	0
35								No		0	0
36	3	2	3	3	3	3	3	Yes	2000	1	1
37								No		0	0
38	1	2	1	3	3	2	2	No		0	0
39	3	1	3	3	3	3	2	Yes	2009	1	1
40	2	3	1	3	3	3	2	No		0	0

Appendix C (Cont.)

ID	Q15c	Q15d	Q15e	Q15f	Q15g
1	0	0	0	0	
2	0	0	0	0	
3	1	1	1	1	
4	0	0	0	0	
5	0	0	0	0	
6	1	1	1	1	
7	0	0	0	0	
8	0	0	0	0	
9	0	0	0	0	
10	0	0	0	0	
11	1	1	0	1	water volume
12	1	1	1	1	
13	0	0	0	0	
14	0	0	0	0	
15	1	1	0	0	
16	0	0	0	0	
17	0	0	0	0	
18	1	1	0	0	
19	0	0	0	0	
20	0	0	0	0	
21	1	0	0	0	
22	1	1	1	1	
23	0	0	0	0	
24	0	0	0	0	
25	1	1	0	1	
26	1	1	1	1	wild horses
27	1	1	1	1	
28	0	0	0	0	
29	0	0	0	0	
30	0	0	0	1	
31	0	0	0	0	
32	0	0	0	0	
33	1	1	0	0	Recreational Use/Wild Horse and Burro Use
34	0	0	0	0	
35	0	0	0	0	
36	0	0	0	0	
37	0	0	0	0	
38	0	0	0	0	
39	0	0	0	0	
40	0	0	0	0	

Appendix C (Cont.)

ID	Q16a	Q16b	Q16c	Q16d	Q16e	Q17a	Q17b	Q17c	Q17d	Q17e	Q17f	Q17g
1												
2												
3	4	4	4	2	2	4	4	4	4	4	4	4
4												
5												
6	2	2	3	4	2	4	4	3	3	3	3	4
7												
8												
9												
10												
11	3	3	3	3	1	1	3	3	3	3	3	3
12	4	3	4	4	4	4	4	3	3	3	4	4
13												
14												
15		4	4	4	1	2	3	3	3	3	3	2
16												
17												
18	3	3	3	3	3	3	3	3	3	3	3	
19	3	4	0	0.001	2	3	3	2	4	4	4	4
20												
21	4	4	3	1	1	1	3	1	4	3	3	3
22	3	3	3	3	2	3	3	2	3	3	3	3
23												
24												
25	0	4	4	4	4	4	4	4	4	4	3	4
26	0	3	3	3	3	3	3	2	3	3	3	3
27	2	4	4	4	4	3	3	4	3	2	3	2
28												
29												
30	4	4	3	4	0	4	4	4	4	4	4	4
31												
32												
33	4	4	4	4	2	4	4	3	3	4	4	4
34												
35												
36	3	3	4	4	0	4	3	2	4	2	4	4
37												
38												
39	4	4	3	3	3	3	3	0	3	3	3	3
40												

Appendix C (Cont.)

ID	Q18	Q20	Q22	Q25	Q26	Q27
1				Female	26-35	Undergraduate Degree
2				Male	36-45	Graduate Degree
3	D/K	D/K	D/K	Male	46-55	Graduate Degree
4				Male	26-35	Graduate Degree
5				Male	46-55	Undergraduate Degree
6	No	No	No	Male	36-45	Some College
7						
8				Male	56 or better	Undergraduate Degree
9				Male	46-55	Undergraduate Degree
10				Male	46-55	Graduate Degree
11	Yes	No	Yes	Male	46-55	Some College
12	Yes	Yes	Yes	Male	18-25	Undergraduate Degree
13						
14				Male	46-55	Undergraduate Degree
15	No	No	D/K	Female	26-35	Undergraduate Degree
16				Female	26-35	Graduate Degree
17				Male	18-25	Undergraduate Degree
18	No	Yes	Yes	Male	46-55	Graduate Degree
19	Yes	Yes	Yes	Male	36-45	Undergraduate Degree
20				Male	56 or better	Graduate Degree
21	Yes	Yes	Yes	Female	36-45	Undergraduate Degree
22	D/K	Yes	D/K	Male	36-45	Undergraduate Degree
23				Male	26-35	Graduate Degree
24				Female	36-45	Undergraduate Degree
25	Yes	No	D/K	Male	46-55	Undergraduate Degree
26	D/K	Yes	No	Male	36-45	Undergraduate Degree
27	Yes	D/K	Yes	Male	18-25	Undergraduate Degree
28				Female	26-35	Graduate Degree
29				Male	46-55	Graduate Degree
30	Yes	Yes	Yes	Male	26-35	Undergraduate Degree
31				Male	36-45	Undergraduate Degree
32				Female	18-25	Undergraduate Degree
33	Yes	Yes	Yes			
34				Female	18-25	Undergraduate Degree
35				Male	56 or better	Graduate Degree
36	Yes	Yes	D/K	Male	46-55	Graduate Degree
37				Male	56 or better	Undergraduate Degree
38				Female	56 or better	Graduate Degree
39	Yes	Yes	No	Male	36-45	Graduate Degree
40				Female	46-55	Graduate Degree

Appendix C (Cont.)

ID	Q2	Q3	Q4	Q5a	Q5b	Q5c
41	1	Yes	graduate student	3	4	3
42	0	Yes				
43	2	No	Public land manager - tribal, state, federal, county	3	2	3
44	1	No	Public land manager - tribal, state, federal, county	4	4	3
45	2	No	Public land manager - tribal, state, federal, county	3	4	3
46	3	Yes	Public land manager - tribal, state, federal, county	4	3	3
47	0	No				
48	0	No				
49	1	No	Private land owner	4	4	4
50	1	No	Public land manager - tribal, state, federal, county	3		2
51	1	No	Private land management (Land Trust)	3	4	3
52	1	Yes	Public land manager - tribal, state, federal, county	3	3	2
53	0	No				
54	1	No	Public land manager - tribal, state, federal, county	3	3	3
55	2	Yes	Not stated	3	4	3
56	1	No	Public land manager - tribal, state, federal, county	3	4	4
57	1	No	Public land manager - tribal, state, federal, county	4	4	4
58	1	No	Public land manager - tribal, state, federal, county	4	4	4
59	3	No	Public land manager - tribal, state, federal, county	4	4	4
60	2	No	Public land manager - tribal, state, federal, county	3	3	3
61	3	Yes	Public land manager - tribal, state, federal, county	3	4	3
62	0	No				
63	1	Yes	Public land manager - tribal, state, federal, county	2	1	3
64	2	Yes	Private land owner	3	3	4
65	1	Yes	NRCS	3	3	3
66	1	No	Private land owner	4	4	4
67	1	Yes	Public land manager - tribal, state, federal, county	3	3	3
68	1	No	consultant	4	4	4
69	0	No				
70	2	No	Public land manager - tribal, state, federal, county	3	3	3
71	1	No	college teacher	3	3	3
72	1	No	Public land manager - tribal, state, federal, county	3	3	3
73	3	Yes	Public land manager - tribal, state, federal, county	4	4	4
74	2	No	Public land manager - tribal, state, federal, county	3	3	3
75	1	No	Public land manager - tribal, state, federal, county	3	3	3
76	1	No	Public land manager - tribal, state, federal, county	3	3	2
77	1	No	Public land manager - tribal, state, federal, county	3	2	3
78	1	Yes	Public land manager - tribal, state, federal, county	3	4	3
79	1	No		4	4	4
80	1	No	Research Assistant	3	3	3

Appendix C (Cont.)

ID	Q5d	Q5e	Q5f	Q5g	Q5h	Q6	Q7a	Q7b	Q7c	Q7d	Q7e	Q7f	Q7g
41	2	3	3	3	3	4	3	4	3	3	3	4	2
42													
43	2	3	3	3	3	3	3	4	4	3	3	4	3
44	3	4	2	2	3	4	3	3	4	4	4	4	4
45	3	3	3	2	3	4	4	4	4	4	3	4	4
46	3	3	4	3	3	3	3	3	3	2	3	4	4
47													
48													
49	4	4	4	4	4	4	3	3	3	3	2	4	4
50	3	3	2	2	3	2	3	4	4	3	4	4	4
51	2	3	3	2	3	3	3	3	3	3	3	4	3
52	4	2	2	1	3	3	1	1	2	2	3	2	3
53													
54	3	3	2	2	2	3							
55	2	3	2	1	3	2	3	4	3	3	3	4	3
56	4	4	2	3	4	4	3		2	2	2	1	1
57	3	4	4	4	4	4	4	4	4	4	4	4	4
58	4	4	4	4	4	4	2	4	2	3	4	4	3
59	4	4	2	4	4	4	3	4	4	4	4	4	4
60	3	3	3	3	3	3	4	4	4	4	4	4	4
61	4	3	3	2	3	4	4	4	4	4	4	4	4
62													
63	2	2	2	2	2	0	1	1	1	1	1	1	1
64	2	3	2	3	3	3	4	3	4	4	3	3	4
65	2	3	2	3	3	4	4	3	3	4	4	4	4
66	4	4	2	4	4	2	4	4	3	3	4	3	3
67	2	3	2	3	3	3	2	3	3	3	2	4	2
68	3	4	2	2	4	4	4	3	4	4	4	4	4
69													
70	3	3	3	3	3	4	3	3	3	3	3	4	4
71	2	3	3	2	3	2	4	3	4	4	4	4	3
72	3	3	3	3	3	3	3	2	3	3	3	4	3
73	4	4	4	4	4	4	4	4	4	4	4	4	4
74	3	4	3	2	3	4	2	3	3	3	2	4	3
75	3	3	2	2	3	3	3	3	3	3	3	4	4
76	2	3	2	2	2	3	3	3	3	3	3	2	4
77	1	4	2	2	3	0	1	2	1	3	4	1	4
78	3	3	3	3	3	4	3	3	3	3	3	3	3
79	3	4	2	4	4	4	2	2	3	3	2	4	3
80	3	3	3	3	3	2	2	2	2	2	2	2	2

Appendix C (Cont.)

ID	Q7h	Q7i	Q7j	Q7k	Q7l	Q7m	Q7n	Q7o	Q8a	Q8b	Q8c	Q10	Q11
41	3	4	3	2	3	3	3	2	4	3	2	Yes	No
42												Yes	No
43	4	4	4	3	3	4	3	4	3	3	3	Yes	No
44	3	4	3	3	2	2	2	2	3	4	3	Yes	Yes
45	4	4	4	4	4	3	4	4	4	4	4	Yes	No
46	4	3	4	3	4	4	4	3	3	4	3	Yes	No
47												Yes	No
48												Yes	No
49	4	3	3	3	3	3	3	3	4	4	3	No	No
50	3	3	3	3	2	2	3	2	4	4	2	No	No
51	4	4	4	4	4	4	3	3	4	4	4	No	No
52	3	3	2	2	2	2	2	2	1	1	2	No	Yes
53												Yes	No
54													
55	3	3	3	3	4	4	4	4	3	3	2	No	No
56	4	4	4	4	4	4	3	3	2	2	3	No	No
57	4	4	4	4	4	4	4	4	4	4	4	Yes	Yes
58	4	3	3	4	3	2	3	3	4	3	3	Yes	No
59	4	4	4	4	3	3	3	3	4	4	4	No	Yes
60	3	4	4	4	3	3	3	3	4	4	4	Yes	Yes
61	4	4	4	4	4	4	4	4	4	4	4	Yes	No
62												Yes	No
63	1	1	1	1	1	1	1	1	1	1	1	Yes	No
64	4	4	4	4	4	4	4	4	4	4	4	No	Yes
65	4	4	3	4	4	3	3	3	4	4	3	Yes	Yes
66	4	3	4	4	4	4	4	4	4	4	4	No	No
67	2	2	2	3	2	3	1	1	3	3	2	Yes	Yes
68	4	4	4	3	3	3	3	3	4	4	3	No	No
69												No	No
70	4	4	3	3	4	3	4	3	3	3	3	Yes	No
71	2	2	2	2	2	2	2	2	3	3	3	No	No
72	4	3	3	3	3	3	3	3	3	3	3	No	No
73	4	4	4	4	4	4	4	4	4	4	4	Yes	No
74	4	4	4	4	4	3	3	3	3	4	3	Yes	No
75	3	3	3	3	3	3	3	3	3	4	3	Yes	No
76	3	2	2	2	2	2	2	2	3	3	3	Yes	No
77	4	3	3	4	0.001	2	2	2	2	2	2	Yes	No
78	3	3	3	3	3	2	2	2	3	3	3	Yes	Yes
79	2	3	3	2	2	2	2	2	3	3	2	No	No
80	2	2	2	2	2	2	2	2	3	3	3	Yes	No

Appendix C (Cont.)

ID	Q12a	Q12b	Q12c	Q12d	Q12e	Q12f	Q12g	Q13	Q14	Q15a	Q15b
41	3	3	3	2	2	3	3	No		0	0
42	4	4	3	4	4	4	4	No		0	0
43	4	4	3	3	3	3	4	Yes	2010	1	0
44	3	3	3	3	3	3	3	No		0	0
45	3	3	3	3	3	3	2	Yes	1998	1	0
46	3	3	2	3	3	2	3	No		0	0
47	3	3	3	1	1	3	3	Yes	2010	1	1
48	3	3	3	2	2	3	3	Yes	2005	1	1
49								No		0	0
50								No		0	0
51								No		0	0
52	2	3	3	3	3	1	3	No		0	0
53	3	2	3	2	2	3	2	Yes	2009	1	0
54										0	0
55								Yes	2010	1	1
56								Yes	2010	1	1
57	4	4	4	4	4	4	4	No		0	0
58	3	3	3	2	2	2	3	No		0	0
59	4	4	4	4	4	4		No		0	0
60	3	3	3	2	2	2	2	No		0	0
61	4	4	3	3	2	3	2	Yes	2002	1	1
62	3	3	3	3	3	3	3	Yes		0	0
63	3	3	3	3	3	3	3	Yes	2010	0	1
64	3	3	3	3	3	3	2	Yes	2009	1	0
65	3	3	3	3	2	3	3	No		0	0
66								No		0	0
67	3	2	3	1	1	3	3	No		0	0
68								No		0	0
69								No		0	0
70		3	4	3	3	3	3	No		0	0
71								No		0	0
72								No		0	0
73	3	3	3	2	2	2	2	Yes	2007	1	1
74	4	3	3	1	1	3	2	Yes	2010	1	0
75	3	3	2	2	2	2	2	No		0	0
76	2	2	2	3	3	3	2	No		0	0
77	3	3	2	1	1	3	3	Yes		1	0
78	2	1	2	1	1	2	1	No		0	0
79								No		0	0
80	3	3	3	3	3	3	3	No		0	0

Appendix C (Cont.)

ID	Q15c	Q15d	Q15e	Q15f	Q15g
41	0	0	0	0	
42	0	0	0	0	
43	1	1	0	1	
44	0	0	0	0	
45	1	0	1	0	
46	0	0	0	0	
47	1	1	0	0	
48	0	0	1	1	
49	0	0	0	0	
50	0	0	0	0	
51	0	0	0	0	
52	0	0	0	0	
53	1	0	0	1	
54	0	0	0	0	
55	1	1	0	1	
56	1	0	1	0	
57	0	0	0	0	
58	0	0	0	0	
59	0	0	0	0	
60	0	0	0	0	
61	0	1	1	1	
62	0	0	0	0	
63	1	0	0	1	
64	1	1	1	1	
65	0	0	0	0	
66	0	0	0	0	
67	0	0	0	0	
68	0	0	0	0	
69	0	0	0	0	
70	0	0	0	0	
71	0	0	0	0	
72	0	0	0	0	
73	1	0	0	1	
74	1	1	0	1	
75	0	0	0	0	
76	0	0	0	0	
77	1	0	1	1	
78	0	0	0	0	
79	0	0	0	0	
80	0	0	0	0	

Appendix C (Cont.)

ID	Q16a	Q16b	Q16c	Q16d	Q16e	Q17a	Q17b	Q17c	Q17d	Q17e	Q17f	Q17g
41												
42												
43	0	4	3	0.001	3	3	3	3	3	3	3	3
44												
45	4	4	4	4	1	4	4	3	4	3	3	4
46												
47	0	3	3	3	4	2	1	2	3	3	3	4
48	2	3	2	2	4	2	2	4	4	4	3	4
49												
50												
51												
52												
53	0	4	2	3	3	2	3	2	3	3	4	4
54												
55	2	2	2	2	4	2	2	0	4	2	2	3
56	3	1	1	1	1	1	1	3	3	3	4	3
57												
58												
59												
60												
61	1	4	4	4	2	3	4	3	4	4	3	2
62												
63	0	0.001	0	0.001	0	3	3	3	3	3	3	3
64	3	4	4	3	4	3	4	3	4	4	4	4
65												
66												
67												
68												
69												
70												
71												
72												
73	4	4	4	4	4	4	3	3	4	3	3	4
74	1	4	2	2	1	2	2	3	3	3	4	4
75												
76												
77	3	4	4	4	4	4	3	3	4	4	3	3
78												
79												
80												

Appendix C (Cont.)

ID	Q18	Q20	Q22	Q25	Q26	Q27
41				Male	46-55	Graduate Degree
42				Male	26-35	Graduate Degree
43	Yes	No	D/K	Female	46-55	Undergraduate Degree
44				Female	26-35	Graduate Degree
45	No	Yes	Yes	Male	56 or better	Undergraduate Degree
46				Male	36-45	Undergraduate Degree
47	D/K	No	D/K	Female	46-55	Undergraduate Degree
48	Yes	No	D/K	Female	26-35	Graduate Degree
49				Female	46-55	Graduate Degree
50				Male	46-55	Undergraduate Degree
51				Male	26-35	Undergraduate Degree
52				Female	46-55	Undergraduate Degree
53	No	Yes	D/K	Female	36-45	Undergraduate Degree
54						
55	No	D/K	D/K	Male	46-55	
56	No	No	Yes	Male	26-35	Undergraduate Degree
57				Male	18-25	Undergraduate Degree
58				Female	46-55	Graduate Degree
59				Female	46-55	Some College
60				Female	26-35	Undergraduate Degree
61	Yes	Yes	Yes	Male	56 or better	Graduate Degree
62						
63	Yes	Yes	Yes	Male	26-35	Graduate Degree
64	Yes	No	D/K	Male	46-55	Graduate Degree
65				Male	46-55	Undergraduate Degree
66				Female	46-55	Undergraduate Degree
67				Male	26-35	Undergraduate Degree
68				Male	36-45	
69				Male	56 or better	Undergraduate Degree
70				Male	26-35	Undergraduate Degree
71				Male	56 or better	Graduate Degree
72				Male	26-35	Undergraduate Degree
73	Yes			Male	26-35	Undergraduate Degree
74	Yes	No	Yes	Male	46-55	Graduate Degree
75				Female	56 or better	Undergraduate Degree
76				Male	56 or better	Graduate Degree
77	D/K	Yes	D/K	Female	26-35	Graduate Degree
78				Male	36-45	Graduate Degree
79				Female	18-25	Some College
80				Female	26-35	Graduate Degree

Appendix C (Cont.)

ID	Q2	Q3	Q4	Q5a	Q5b	Q5c
81	1	No	Public land manager - tribal, state, federal, county	3	3	2
82	1	No	Public land manager - tribal, state, federal, county	3	3	3
83	0	Yes				
84	2	Yes	Public land grazing permittee	4	4	4
85	1	No	Public land manager - tribal, state, federal, county	3	4	3
86	1	No	ranch employee	3	4	3
87	2	Yes	Public land manager - tribal, state, federal, county	3	3	3
88	1	Yes	Public land manager - tribal, state, federal, county	4	3	3
89	1	Yes	Public land manager - tribal, state, federal, county	0	0	0
90	3	Yes	riparian scientist	1	3	3
91	1	No	Public land recreationist (e.g. for hiking, hunting, fishing)	3	2	3
92	2	Yes	Public land manager - tribal, state, federal, county	3	3	3
93	0	No				
94	2	No	Environmental staff for a Tribal consortium providing assistance to Tribes.	4	4	4
95	2	Yes	Public land manager - tribal, state, federal, county	4	4	3
96	1	No	Public land manager - tribal, state, federal, county	3	3	3
97	0	Yes				
98	3	Yes	Public land manager - tribal, state, federal, county	3	3	3
99	1	No	Public land manager - tribal, state, federal, county	4	4	4
100	0	Yes				
101	3	Yes	Public land manager - tribal, state, federal, county	3	4	3
102	1	No				
103	1	No	RCD Director	4	4	3
104	0	No				
105	1	Yes	State Fisheries Biologist	4	3	2
106	3	Yes	Public land manager - tribal, state, federal, county	3	3	3
107	1	No	Public land manager - tribal, state, federal, county	2	1	3
108	2	Yes	State	4	4	4
109	1	No	Public land manager - tribal, state, federal, county	3	4	4
110	1	No	Public land manager - tribal, state, federal, county	4	4	4
111	2	No	researcher	3	3	3
112	1	No	Public land manager - tribal, state, federal, county	3	4	4
113	1	No	Public land manager - tribal, state, federal, county	3	3	3
114	1	No	Public land manager - tribal, state, federal, county	3	3	3
115	1	Yes	Public land manager - tribal, state, federal, county	3	4	3
116	1	No	Public land manager - tribal, state, federal, county	4	4	4
117	0	No				
118	1	No	Public land manager - tribal, state, federal, county	3	3	3
119	0	No				
120	0	No				

Appendix C (Cont.)

ID	Q5d	Q5e	Q5f	Q5g	Q5h	Q6	Q7a	Q7b	Q7c	Q7d	Q7e	Q7f	Q7g
81	2	1	2	2	1	1	1	3	1	2	2	1	1
82	2	3	3	2	3	3	3	3	3	3	3	3	3
83													
84	4	4	4	4	4	4	4	4	4	4	2	4	3
85	2	3	2	3	3	3	2	2	2	2	3	4	2
86	4	2	2	2	3	4	2	2	2	3	2	3	3
87	2	3	2	2	2	3	2	2	2	2	2	4	4
88	3	3	3		3	3	2	3	2	3	4	4	3
89	0	0	0	0	0	0	2	2	2	2	2	3	2
90	2	1	1	2	1	0	1	1	1	1	1	1	1
91	3	3	2	3	3	3	3	2	4	4	3	4	4
92	3	4	3	3	3	3	3	2	2	2	2	2	2
93													
94	4	4	4	4	4	4	3	3	3	4	4	4	4
95	2	4	2	2	4	4	3	1	3	3	3	4	2
96	3	3	3	3	3	4	3	3	3	3	3	3	2
97													
98	3	3	3	3	2	3	2	3	2	3	3	3	2
99	4	4	4	4	4	4	4	4	4	4	4	4	4
100													
101	4	3	3	2	4	4	4	4	3	3	4	4	4
102													
103	4	4	2	2	4	4	3	4	3	4	4	4	3
104													
105	2	3	2	3	3	3	2	3	2	2	2	3	3
106	3	3	2	3	3	3	2	2	3	3	2	3	1
107	3	2	2	2	1	0							
108	4	4	4	3	4	4	4	4	3	3	2	4	3
109	2	3	3	3	3	3	4	4	4	4	4	4	4
110	4	4	4	4	4	4	3	3	3	4	4	4	4
111	2	3	3	2	3	0	2	3	3	2	4	4	4
112	4	4	3	3	4	4	4	4	4	4	4	4	4
113	4	3	3	3	3	4	3	3	3	4	3	4	3
114	3	3	2	2	3	3	2	2	3	3	3	3	3
115	2	3	3	3	3	3	4	4	4	4	3	4	3
116	3	4	4	4	4	4	4	4	4	4	4	4	4
117													
118	2	4	3	3	3	3	3	4	4	4	4	4	4
119													
120													

Appendix C (Cont.)

ID	Q7h	Q7i	Q7j	Q7k	Q7l	Q7m	Q7n	Q7o	Q8a	Q8b	Q8c	Q10	Q11
81	2	2	2	2	2	1	1	1	2	2	2	Yes	Yes
82	3		3	3	3	3	3	3	3	3	3	Yes	No
83												Yes	No
84	3	4	4	4	4	4	4	4	4	4	4	No	No
85	4	2	3	3	3	4	4	4	3	3	2	Yes	No
86	2	2	1	1	3	2	2	1	2	2	2	No	No
87	3	3	3	2	2	2	2	2	3	3	2	Yes	No
88	4	3	4	2	3	3	2	2	3	3	3	Yes	No
89	3	2	2	3	3	2	3	2	3	4	4	Yes	Yes
90	1	1	1	1	1	1	1	1	1	1	1	Yes	No
91	4	3	3	4	3	4	3	2	4	3	3	No	No
92	2	2	2	2	2	2	2	2	2	2	2	Yes	Yes
93												No	No
94	4	4	4	3	3	3	3	3	4	4	4	No	Yes
95	4	4	4	4	3	3	3	3	3	3	3	No	No
96	3	2	3	2	2	2	2	3	3	3	3	Yes	No
97												Yes	No
98	4	3	3	3	3	3	3	3	2	3	3	Yes	No
99	4	4	4	4	4	4	4	4	4	4	4	No	No
100												No	Yes
101	4	4	4	4	4	4	3	4	4	4	4	Yes	No
102													
103	4	4	4	2	3	3	4	4	4	3	2	Yes	No
104												No	No
105	4	2	4	3	3	3	3	3	3	4	3	No	No
106	2	3	2	1	2	2	2	1	2	2	1	No	Yes
107													
108	4	4	3	2	3	2	3	3	4	4	3	No	No
109	4	4	4	4	4	4	4	4	3	4	4	Yes	Yes
110	4	4	4	4	4	3	3	3	4	4	4	Yes	No
111	3	4	4	4	3	2	4	4	4	4	4	No	No
112	4	4	4	4	4	4	4	4	4	4	4	Yes	No
113	4	3	3	2	2	2	3	3	4	3	3	Yes	No
114	3	3	3	3	3	3	3	3	3	3	3	No	Yes
115	4	4	4	4	4	3	3	3	3	4	3	Yes	Yes
116	4	4	4	4	4	4	4	4	4	4	4	No	Yes
117												Yes	No
118	3	4	4	4	4	4	4	4	4	4	4	No	Yes
119												No	No
120												No	No

Appendix C (Cont.)

ID	Q12a	Q12b	Q12c	Q12d	Q12e	Q12f	Q12g	Q13	Q14	Q15a	Q15b
81	2	3	2	1	1	0	2	No		0	0
82	3	3	2	1	1	3	3	No		0	0
83	1	1	1	0	0	1	2	Yes	2008	1	1
84								Yes	2009	1	1
85	3	2	3	3	3	2	3	No		0	0
86								No		0	0
87	3	3	2	2	2	2	3	No		0	0
88	3	3	3	1	1	3	3	Yes		1	0
89	4	4	4	3	3	4	4	Yes	2009	1	1
90	3	3	3	2	2	3	3	Yes	1999	1	1
91								No		0	0
92	3	3	3	3	3	3	3	Yes	1994	1	1
93								No		0	0
94	4	4	4	2	2	3	4	No		0	0
95								No		0	0
96	3	3	4	3	3	4	3	No		0	0
97	4	4	3	2	2	3	3	Yes	2008	1	1
98	3	3	3	3	3	3	3	Yes	2008	1	0
99								No		0	0
100	1	2	3	3	3	1	2	No		0	0
101	4	4	4	3	3	4	4	Yes	2007	1	1
102										0	0
103	4	3	3	2	2	3	2	Yes	2007	1	0
104								No		0	0
105								No		0	0
106	3	3	2	3	3	3	3	Yes		0	0
107										0	0
108								No		0	0
109	3	3	3	3	3	3	3	No		0	0
110	3	3	3	3	3	3	3	No		0	0
111								No		0	0
112	4	4	4	4	4	4	4	Yes	2005	1	1
113	3	3	3	2	2	2	2	No		0	0
114	2	2	2	3	3	2	2	No		0	0
115	3	3	3	1	1	3	2	No		0	0
116	3	3	4	3	3	3	3	No		0	0
117	3	1	3	3	3	2	3	Yes	2010	1	1
118	3	3	2	1	1	2	2	No		0	0
119										0	0
120								No		0	0

Appendix C (Cont.)

ID	Q15c	Q15d	Q15e	Q15f	Q15g
81	0	0	0	0	
82	0	0	0	0	
83	1	0	0	1	
84	1	0	0	0	
85	0	0	0	0	
86	0	0	0	0	
87	0	0	0	0	
88	1	1	0	0	
89	1	1	0	1	
90	0	0	0	1	
91	0	0	0	0	
92	1	1	1	1	
93	0	0	0	0	
94	0	0	0	0	
95	0	0	0	0	
96	0	0	0	0	
97	1	1	0	1	
98	1	1	0	0	
99	0	0	0	0	
100	0	0	0	0	
101	1	1	0	0	
102	0	0	0	0	
103	0	0	1	1	Water quantity
104	0	0	0	0	
105	0	0	0	0	
106	0	0	0	0	
107	0	0	0	0	
108	0	0	0	0	
109	0	0	0	0	
110	0	0	0	0	
111	0	0	0	0	
112	1	1	1	0	
113	0	0	0	0	
114	0	0	0	0	
115	0	0	0	0	
116	0	0	0	0	
117	1	1	0	0	
118	0	0	0	0	
119	0	0	0	0	
120	0	0	0	0	

Appendix C (Cont.)

ID	Q16a	Q16b	Q16c	Q16d	Q16e	Q17a	Q17b	Q17c	Q17d	Q17e	Q17f	Q17g
81												
82												
83	4	2	4	4	3	4	4	2	4	3	4	3
84	4	4	4	4	4	3	3	3	4	4	4	4
85												
86												
87												
88	2	4	4	4	4	3	2	3	3	3	2	3
89	4	4	4	4	4	4	4	4	4	4	4	4
90	3	3	4	1	1	2	3	3	4	3	4	3
91												
92	4	4	4	4	4	3	4	4	4	3	4	4
93												
94												
95												
96												
97	4	4	4	4	4	4	4	2	4	4	4	2
98	1	4	4	3	4	4	3	3	4	4	4	4
99												
100												
101	3	4	4	4	4	4	4	4	4	4	4	3
102												
103	3	4	4	2	1	2	3	1	4	4	4	4
104												
105												
106	1	3	1	3	1	2	2	3	3	3	3	3
107												
108												
109												
110												
111												
112	4	4	4	4	4	3	3	3	4	4	3	4
113												
114												
115												
116												
117	3	4	4	4	3	4	3	3	4	4	4	4
118												
119												
120												

Appendix C (Cont.)

ID	Q18	Q20	Q22	Q25	Q26	Q27
81				Female	36-45	Graduate Degree
82				Female	26-35	Undergraduate Degree
83	Yes	Yes	D/K	Male	26-35	Undergraduate Degree
84	D/K	Yes	Yes	Male	56 or better	Some College
85				Female		Undergraduate Degree
86				Male	26-35	Undergraduate Degree
87				Male	56 or better	Undergraduate Degree
88			D/K	Female	46-55	Undergraduate Degree
89	Yes	Yes	Yes	Male	56 or better	Undergraduate Degree
90	Yes	Yes	Yes	Female	46-55	Graduate Degree
91				Female	26-35	Undergraduate Degree
92	Yes	Yes	Yes	Male	56 or better	Undergraduate Degree
93				Male	56 or better	Graduate Degree
94				Female	56 or better	Graduate Degree
95				Female	36-45	Graduate Degree
96				Male	18-25	Some College
97	Yes	Yes	D/K	Male	26-35	Graduate Degree
98	Yes	Yes	Yes	Male	26-35	Undergraduate Degree
99				Female	18-25	Graduate Degree
100				Female	46-55	Undergraduate Degree
101	Yes	D/K	D/K	Male	46-55	Graduate Degree
102						
103	Yes	Yes	No	Male	56 or better	Undergraduate Degree
104				Female	18-25	Undergraduate Degree
105				Male	46-55	Undergraduate Degree
106	Yes	Yes		Male	36-45	Graduate Degree
107						
108				Female	46-55	Graduate Degree
109				Female	26-35	Graduate Degree
110				Male	26-35	Undergraduate Degree
111				Male	36-45	Graduate Degree
112	Yes	Yes	Yes	Male	26-35	Graduate Degree
113				Male	36-45	Undergraduate Degree
114				Female	26-35	Graduate Degree
115				Female	18-25	Some College
116				Male	46-55	Graduate Degree
117	Yes	Yes	Yes	Male	26-35	Undergraduate Degree
118				Female	18-25	Undergraduate Degree
119						
120				Male	36-45	Graduate Degree

Appendix C (Cont.)

ID	Q2	Q3	Q4	Q5a	Q5b	Q5c
121	0	No				
122	1	Yes	Public land manager - tribal, state, federal, county	4	4	4
123	1	No	research	3		3
124	1	No	NRCS	3	3	4
125	0	No				
126	1	No				
127	1	Yes	Public land manager - tribal, state, federal, county	3	3	3
128	1	No	NGO restoration employee	4	4	3
129	1	Yes	Public land recreationist (e.g. for hiking, hunting, fishing)	4	4	4
130	2	No	Amargosa Conservancy 501(c)3	4	4	4
131	1	Yes	Federal/private	3	3	3
1001	1	Yes	Public land manager - tribal, state, federal, county	3	3	3
1002	1	No		3	3	3
1003	3	Yes	Public land manager - tribal, state, federal, county	4	4	4
1004	1	No	Public land manager - tribal, state, federal, county	3	4	3
1005	3	Yes	Public land manager - tribal, state, federal, county	4	4	3
1006	3	Yes	Public land manager - tribal, state, federal, county	1	1	1
1007	3	No	Public land manager - tribal, state, federal, county	3	3	3
1008	2	Yes	Public land manager - tribal, state, federal, county	3	4	3
1009	3	No	Public land manager - tribal, state, federal, county	3	3	3
1010	3	Yes	Public land manager - tribal, state, federal, county	4	4	4
1011	2	No	Public land manager - tribal, state, federal, county	3	3	3
1012	3	Yes	Public land manager - tribal, state, federal, county	3	3	3
1013	2	Yes	Tribal Environmental Director	4	4	4
1014	1	Yes	Public land manager - tribal, state, federal, county	3	4	4
1015	1	No	Assist private land owners	4	4	3
1016	1	Yes	consultant	4	4	4

Appendix C (Cont.)

ID	Q5d	Q5e	Q5f	Q5g	Q5h	Q6	Q7a	Q7b	Q7c	Q7d	Q7e	Q7f	Q7g
121													
122	2	3	3	2	1	3	2	3	2	2	2	3	3
123	2	2	2		2	2	3	2	2	3	2	4	3
124	2	3	3	3	3	4	3	3	3	3	3	4	3
125													
126													
127	3	3	3	3	3	3	3	3	3	3	4	4	3
128	3	4	4	3	4	4	3	3	3	2	2	3	3
129	4	4	4	4	4	4	3	4	4	4	4	4	4
130	4	4	4	4	4	4	4	4	4	4	4	4	4
131	3	3	3	3	3	3	4	3	4	4	4	4	4
1001	3	3	2	3	3	3	3	3	3	3	3	4	3
1002	3	3	3	3	3	3	3	3	3	3	3	3	3
1003	4	4	4	4	4	4	4	3	4	3	4	0.001	4
1004	3	3	2	2	3	4	3	4	4	3	4	4	4
1005	4	4	4	4	4	4	4	4	4	4	4	4	4
1006	1	1	2	2	0	0	1	2	2	1	1	2	1
1007	3	2		3	3	2	1	1	1	1	1	1	2
1008	4	3	3	3	3	3	3	4	3	3	4	4	4
1009	3	3	3	3	3	4	4	4	4	4	4	4	4
1010	4	4	4	4	4	4	4	2	3	3	3	4	4
1011	3	3	3	3	3	4	2	3	2	4	4	3	4
1012	2	2	2	2	3	0	2	1	3	3	2	3	3
1013	4	4	2	3	4	4	3	4	3	4	3	4	4
1014	2	4	3	4	4	4	3	3	3	3	3	3	0.001
1015	4	4	3	3	4	4	3	3	3	4	4	4	4
1016	4	4	4	4	4	4	3	3	3	3	3	4	3

Appendix C (Cont.)

ID	Q7h	Q7i	Q7j	Q7k	Q7l	Q7m	Q7n	Q7o	Q8a	Q8b	Q8c	Q10	Q11
121												No	No
122	2	2	2	2	2	2	2	2	3	3	3	Yes	No
123	1	2	3	3	2	3	2	2	3	3	2	No	No
124	3	3	3	3	3	3	3	2	3	3	3	No	Yes
125												No	No
126													
127	3	3	3	3	3	3	3	3	3	3	3	Yes	No
128	4	3	3	3	2	3	2	2	4	3	2	No	No
129	4	4	4	4	4	4	4	4	4	4	4	No	No
130	3	3	3	3	3	3	3	3	4	4	2	No	No
131	4	4	4	4	4	4	4	4	4	4	4	No	Yes
1001	4	3	4	4	4	4	3	3	4	4	4	Yes	No
1002	3	3	3	3	3	3	3	3	3	3	3	Yes	No
1003	4	4	4	3	4	3	3	3	4	4	4	Yes	Yes
1004	4	2	3	4	4	3	4	4	3	4	4	Yes	No
1005	4	4	4	4	4	3	3	4	3	3	3	Yes	Yes
1006	1	2	2	1	1	2	2	2	2	1	2	Yes	No
1007	2	1	1	2	1	1	1	1	2	2	2	Yes	Yes
1008	3	3	3	3	4	4	3	3	4	4	3	Yes	Yes
1009	4	4	4	4	4	4	4	4	4	4	2	Yes	No
1010	4	4	3	3	4	4	4	3	4	4	3	Yes	No
1011	4	4	4	3	3	3	2	2	2	3	2	Yes	No
1012	2	2	2	2	2	1	1	1	1	2	1	Yes	No
1013	4	4	3	4	4	3	3	3	4	4	3	Yes	Yes
1014	4	3	4	4	4	3	3	3	3	3	2	Yes	No
1015	4	4	4	3	3	3	3	3	4	4	3	Yes	No
1016	4	3	4	4	4	3	2	3	4	4	4	Yes	No

Appendix C (Cont.)

ID	Q12a	Q12b	Q12c	Q12d	Q12e	Q12f	Q12g	Q13	Q14	Q15a	Q15b
121								No		0	0
122	3	3	3	3	3	3	3	Yes	2010	1	1
123								No		0	0
124	3	3	3	4	4	3	3	Yes	2010	0	1
125								No		0	0
126										0	0
127	3	3	3	2	2	3	3	Yes	2009	1	0
128								No		0	0
129								No		0	0
130								No		0	0
131	3	3	3	3	3	3	3	Yes	2010	1	1
1001	3	2	2	3	3	3	2	Yes	2008	1	1
1002	3	3	3	3	3	3	3	No		0	0
1003	4	4	4	4	4	4	4	Yes	1995	1	1
1004	3	3	4	3	3	4	3	Yes	2008	1	1
1005	3	3	3	3	3	3	3	Yes	2006	1	0
1006	3	3	3	1	1	3	3	No		0	0
1007	2	3	3	1	1	3	3	Yes	2003	0	1
1008	3	3	3	2	2	3	3	Yes	2009	1	1
1009	3	3	3	2	2	3	2	No		0	0
1010	4	4	4	4	4	4	4	Yes	1998	1	1
1011	2	3	3	3	3	3	3	No		0	0
1012	3	3	1	2	2	2	2	Yes		1	1
1013	4	4	4	3	3	4	4	No		0	0
1014	4	4	3	3	3	3	3	Yes	1996	1	0
1015	3	3	3	4	4	3	3	No		0	0
1016	3	4	4	4	4	3	3	Yes	2009	1	1

Appendix C (Cont.)

ID	Q15c	Q15d	Q15e	Q15f	Q15g
121	0	0	0	0	
122	1	1	1	1	
123	0	0	0	0	
124	1	0	0	0	aesthetics
125	0	0	0	0	
126	0	0	0	0	
127	1	1	1	0	
128	0	0	0	0	
129	0	0	0	0	
130	0	0	0	0	
131	1	1	1	1	
1001	1	0	0	1	
1002	0	0	0	0	
1003	1	1	1	1	
1004	1	0	0	0	
1005	1	1	0	1	
1006	0	0	0	0	
1007	1	1	1	1	
1008	1	0	0	1	
1009	0	0	0	0	
1010	1	1	1	1	
1011	0	0	0	0	
1012	1	1	1	1	
1013	0	0	0	0	
1014	1	1	1	0	
1015	0	0	0	0	
1016	1	1	1	1	

Appendix C (Cont.)

ID	Q16a	Q16b	Q16c	Q16d	Q16e	Q17a	Q17b	Q17c	Q17d	Q17e	Q17f	Q17g
121												
122	4	4	4	4	3	4	4	4	4	4	4	4
123												
124	3	3	4	2	1	1	4	3	3	3	3	3
125												
126												
127	1	4	4	4	3	3	3	3	3	3	3	3
128												
129												
130												
131	3	3	3	3	0	3	3	3	3	3	3	3
1001	4	4	4	4	3	3	3	3	3	3	3	3
1002												
1003	4	4	4	4	4	4	4	4	4	4	4	4
1004	2	3	3	3	4	2	3	2	3	3	3	3
1005	4	3	4	4	1	4	4	3	4	4	4	4
1006												
1007	4	2	3	3	2	4	3	2	3	4	4	2
1008	3	3	4		3	4	4	3	4	4	4	4
1009												
1010	4	4	4	4	4	4	4	4	4	4	4	4
1011												
1012	3	3	4	1	3	4	3	3	3	3	3	3
1013												
1014	3	4	4	4	1	3	3	3	4	4	3	4
1015												
1016	3	4	4	3	2	4	4	3	3	4	4	4

Appendix C (Cont.)

ID	Q18	Q20	Q22	Q25	Q26	Q27
121				Female	36-45	Undergraduate Degree
122	Yes	Yes	Yes	Male	36-45	Graduate Degree
123				Female	26-35	Undergraduate Degree
124	No	No	D/K	Male	36-45	Graduate Degree
125				Female	26-35	Undergraduate Degree
126						
127	No	Yes	Yes	Male	26-35	Undergraduate Degree
128				Male	26-35	Graduate Degree
129				Female	26-35	Undergraduate Degree
130				Female	46-55	Some College
131	D/K	Yes	No	Female	26-35	Undergraduate Degree
1001	Yes	Yes	No	Male	36-45	Graduate Degree
1002				Male	56 or better	Undergraduate Degree
1003	Yes	Yes	Yes	Male	56 or better	Undergraduate Degree
1004	Yes	D/K	Yes	Male	36-45	Undergraduate Degree
1005	Yes	Yes	No	Male	46-55	Undergraduate Degree
1006				Female	56 or better	Graduate Degree
1007	Yes	D/K	Yes	Female	46-55	Undergraduate Degree
1008	D/K	Yes	D/K	Female	36-45	Undergraduate Degree
1009				Female	26-35	Graduate Degree
1010	Yes	Yes	Yes	Female	46-55	Graduate Degree
1011				Male	26-35	Undergraduate Degree
1012	Yes	Yes	Yes	Male	56 or better	Undergraduate Degree
1013				Male	18-25	Undergraduate Degree
1014	Yes	Yes	D/K	Male	46-55	Undergraduate Degree
1015				Female	36-45	Graduate Degree
1016	No	No	No	Male	26-35	Graduate Degree

6.4 Appendix D

Survey Descriptive Tables

Table 1. Participation in PFC Classes.

Question	Never	Once	Twice	Three or more times			
2.)	25 (17%)	80 (54%)	23 (16%)	19 (13%)			
	No	Yes					
3.)	93 (64%)	53 (36%)					
	Public Land Manager	Private Land Owner	Public Land Recreationist	Public Land Grazing Permittee	Other		
4.)	93 (79%)	5 (4%)	3 (3%)	4 (3%)	12 (10%)		
	Very Unlikely	Somewhat Unlikely	Neither Unlikely or Likely	Somewhat Likely	Very Likely	Total Responses	Mean Score
6.)	10 (8%)	2 (2%)	9 (8%)	39 (33%)	60 (50%)	120	3.14

Table 3. PFC Class Presentation.

Question 5	Strongly Disagree	Disagree	Neither Agree Nor Disagree	Agree	Strongly Agree	Total Responses	Mean Score
5a.)	1 (1%)	2 (2%)	3 (3%)	75 (63%)	38 (32%)	119	3.24
5b.)	1 (1%)	3 (3%)	4 (3%)	53 (45%)	56 (48%)	117	3.38
5c.)	1 (1%)	1 (1%)	8 (7%)	75 (63%)	34 (29%)	119	3.24
5d.)	1 (1%)	3 (3%)	37 (31%)	46 (39%)	32 (27%)	119	3.17
5e.)	1 (1%)	3 (3%)	9 (8%)	63 (53%)	43 (36%)	119	3.26
5f.)	1 (1%)	1 (1%)	48 (41%)	45 (38%)	23 (19%)	118	3.14
5g.)	1 (1%)	3 (3%)	41 (35%)	50 (43%)	21 (18%)	116	3.08
5h.)	2 (2%)	4 (3%)	11 (9%)	67 (56%)	35 (29%)	119	3.14
5 mean.)	1 (1%)	2 (2%)	21 (18%)	58 (49%)	35 (30%)	118	3.22

Appendix D (Cont.)

Table 4. PFC Classes Content

Question 7	Not at all	A little bit	A fair amount	A great deal	Total Responses	Mean Score
7a.)	9 (8%)	27 (23%)	51 (44%)	29 (25%)	116	2.86
7b.)	8 (7%)	22 (19%)	50 (44%)	34 (30%)	114	2.96
7c.)	7 (6%)	24 (21%)	50 (43%)	34 (30%)	115	2.97
7d.)	7 (6%)	16 (14%)	52 (45%)	40 (35%)	115	3.09
7e.)	9 (8%)	25 (22%)	41 (36%)	40 (35%)	115	2.97
7f.)	8 (7%)	8 (7%)	27 (24%)	70 (62%)	113	3.41
7g.)	8 (7%)	18 (16%)	40 (35%)	49 (43%)	115	3.13
7h.)	4 (3%)	14 (12%)	27 (23%)	70 (61%)	115	3.42
7i.)	5 (4%)	22 (19%)	39 (34%)	49 (43%)	115	3.15
7j.)	5 (4%)	17 (15%)	44 (38%)	49 (43%)	115	3.19
7k.)	5 (4%)	22 (19%)	41 (36%)	46 (40%)	114	3.12
7l.)	4 (4%)	28 (25%)	38 (33%)	44 (39%)	114	3.07
7m.)	10 (9%)	27 (23%)	46 (40%)	33 (28%)	116	2.88
7n.)	10 (9%)	30 (26%)	46 (40%)	28 (25%)	114	2.81
7o.)	12 (10%)	29 (25%)	47 (41%)	27 (23%)	115	2.77
7 mean.)	7 (6%)	22 (19%)	43 (37%)	43 (37%)	115	3.05
Question 8	Not at all	A little bit	A fair amount	A great deal	Total Responses	Mean Score
8a.)	7 (6%)	17 (14%)	43 (36%)	51 (43%)	118	3.17
8b.)	5 (4%)	16 (14%)	44 (37%)	53 (45%)	118	3.23
8c.)	7 (6%)	34 (29%)	43 (36%)	34 (29%)	118	2.88
8 mean.)	6 (5%)	22 (19%)	43 (37%)	46 (39%)	118	3.09

Appendix D (Cont.)

Table 5. Field PFC Participation.

Question	Yes		No	
10.)	88	(62%)	55	(38%)
11.)	42	(29%)	101	(71%)

Table 6. Utility of PFC.

Question 12	Strongly Disagree		Disagree		Neither Agree Nor Disagree		Agree		Strongly Agree		Total Responses	Mean Score
12a.)	1	(1%)	3	(3%)	10	(10%)	68	(67%)	20	(20%)	102	3.01
12b.)	0	(0%)	6	(6%)	10	(10%)	65	(64%)	21	(21%)	102	2.99
12c.)	0	(0%)	5	(5%)	18	(17%)	65	(63%)	15	(15%)	103	2.87
12d.)	1	(1%)	14	(14%)	24	(23%)	53	(51%)	11	(11%)	103	2.57
12e.)	1	(1%)	14	(14%)	26	(25%)	51	(50%)	11	(11%)	103	2.55
12f.)	1	(1%)	4	(4%)	16	(16%)	67	(65%)	15	(15%)	103	2.88
12g.)	0	(0%)	2	(2%)	34	(33%)	52	(51%)	14	(14%)	102	2.76
12 mean.)	1	(1%)	7	(7%)	20	(19%)	60	(59%)	15	(15%)	103	2.81

Table 7. Management Participation.

Question	Yes		No	
13.)	57	(40%)	84	(60%)
Question 15	Yes		No	
15a.)	50	(89%)	6	(11%)
15b.)	35	(63%)	21	(38%)
15c.)	47	(84%)	9	(16%)
15d.)	35	(63%)	21	(38%)
15e.)	24	(43%)	32	(57%)
15f.)	35	(63%)	21	(38%)

Appendix D (Cont.)

Table 8. Using PFC in Management.

Question 16	Not Important	Not Very Important	Important	Very Important	Total Responses (w/o DK)	Mean Score
16a.)	5 (10%)	6 (12%)	18 (37%)	20 (41%)	49	3.08
16b.)	1 (2%)	4 (7%)	16 (29%)	34 (62%)	55	3.51
16c.)	2 (4%)	4 (7%)	13 (24%)	35 (65%)	54	3.50
16d.)	4 (8%)	6 (12%)	14 (27%)	28 (54%)	52	3.27
16e.)	12 (23%)	8 (15%)	12 (23%)	20 (38%)	52	2.77
16 mean.)	5 (9%)	6 (11%)	15 (28%)	27 (52%)	52	3.23
Question 17	Not Important	Not Very Important	Important	Very Important	Total Responses	Mean Score
17a.)	4 (7%)	10 (18%)	18 (32%)	24 (43%)	56	3.11
17b.)	2 (4%)	5 (9%)	28 (50%)	21 (38%)	56	3.21
17c.)	2 (4%)	10 (19%)	31 (57%)	11 (20%)	54	2.94
17d.)	0 (0%)	0 (0%)	26 (46%)	30 (54%)	56	3.54
17e.)	0 (0%)	3 (5%)	28 (50%)	25 (45%)	56	3.39
17f.)	0 (0%)	2 (4%)	27 (48%)	27 (48%)	56	3.45
17g.)	0 (0%)	5 (9%)	21 (38%)	29 (53%)	55	3.44
17 mean.)	1 (2%)	5 (9%)	26 (46%)	24 (43%)	56	3.30

Table 9. Management Miscellaneous.

Question	Yes	No	Don't Know
18.)	37 (67%)	10 (18%)	8 (15%)
20.)	36 (67%)	12 (22%)	6 (11%)
22.)	27 (50%)	8 (15%)	19 (35%)

Table 2. Demographic Information.

	Male	Female			
Gender	85 (62%)	53 (38%)			
	18-25	26-35	36-45	46-55	56 or better
Age	13 (9%)	40 (29%)	26 (19%)	36 (26%)	22 (16%)
	High School	Some College	Undergrad Degree	Graduate Degree	
Education	0 (0%)	8 (6%)	73 (54%)	55 (40%)	

6.5 Appendix E

List of Management Documents

ID	Title
EK001	West Basin/Scott Creek Fires 2007 Monitoring Results from 2009
EK002	Charleston Fire 2006 Monitoring Results from 2007, 2008, and 2009
EK003	Charleston Fire 2006 Monitoring Results from 2008, and 2010
EK004	Riparian Fire Closure Monitoring - 2006 Winters Fire, Little Humboldt Allotment
EK005	South Fork Little Humboldt River Basin 2008 Monitoring Analysis
EK006	Final Multiple Use Decision for the Salmon River Allotment
EK007	West Basin/Scott Creek Fires 2007 Monitoring Results from 2009
EK008	Grazing use in the Native Pasture on the Jackstone Allotment.
EK009	Agreement for Fire Closure and Management on the Adobe Hills and Jackstone Allotments
EK010	ESR Monitoring Results for the 2006 East Humboldt Complex Fire Closure and Recommendations for Grazing Management on the Bullion Road Allotment
EK011	2007 Barth2 Fire Rehabilitation - Assessment, Conclusions, and Recommendations
EK012	Undated Letters to Tomera Ranches, Inc.
EK013	2007 Bailey Fire Rehabilitation - Assessment, Conclusions, and Recommendations
EK014	Mill Creek Spring Exclosure Project
EK015	Willy Billy Springs Exclosure(s) Project
EK016	Partial Denial of Grazing Application And Notice of Temporary Closure to Livestock Grazing with the Trout Creek Pasture of the Pine Mountain Allotment.
EK017	Northeastern Great Basin Standards and Guidelines Assessment, Pine Mountain Allotment, Trout Creek Pasture
EK018	SFLHR Basin 2006 Monitoring Analysis
EK019	Final Decision Effective Upon Issuance Regarding Livestock Grazing in the SFLHR portion of the Little Humboldt Allotment
EK020	South Fork Little Humboldt River Basin Biological Assessment 2002
EK021	South Fork Little Humboldt River Basin 2002 Biological Opinion
EK022	Final Multiple Use Decision for the Sheep Allotment Complex
EK023	Maggie Creek Watershed Restoration Project 2006 Monitoring Summary and Evaluation of Biological Standards
EK024	Cottonwood Allotment PMUD EA
EK025	Cottonwood Allotment: Allotment Evaluation Summary Report
EK026	Cottonwood Allotment Re-evaluation
EK027	FONSI, Cottonwood PMUD
EK028	Multiple Use Decision, Cottonwood Allotment
EK029	Cottonwood Allotment Re-evaluation EA: Appendices
EK030	Notice of Closure to Livestock Grazing on the…Amazon, Snow Canyon, and Winters Fires
EK031	Lifting the Amazon and Winters fire closure on the Spanish Ranch Allotment

Appendix E (Cont.)

ID	Title
EK032	Little Humboldt Allotment SFLHR Basin Livestock Grazing Proposal
EK033	Hubbard Vineyard Allotment Grazing Permit Renewal
EK034	Hubbard Vineyard Allotment EA Appendix 2
EK035	Final Decision for the Beaver Creek, Double Mountain, and South Four Mile Allotments
EK036	Livestock Grazing Management Decision: Notice of Closure to Livestock Grazing…etc.
EK037	Charleston 2006 Fire Monitoring Results from 2007 and 2008
EK038	Lifting the 2006 North Antelope, Round Mountain and Sheep Fire Closure on the 25 Allotment
EK039	Sheep Fire 2006 & Winters Fire 2006 - ES&R Monitoring Results 2008
EK040	Agreement for Management of the El Jiggs (Dixie Creek) Allotment
EK041	Northeastern Great Basin Standards and Guidelines Assessment, Lindsay Creek Allotment
EK042	Northeastern Great Basin Standards and Guidelines Assessment, 2006 Supplement and Final Determinations, Pearl Creek Allotment
EK043	FMUD for the Maverick/Medicine Complex
EK044	FONSI, Owyhee FMUD EA
EK045	Final Grazing Management Decision and Record of Decision for the Sheep Complex, Big Springs, and Owyhee Grazing Allotments
EK046	Northeastern Great Basin Standards and Guidelines Assessment, Spanish Ranch and Andrae Allotments