Final Report to the Terra Foundation

RESTORATION/RESILIENCE-BUILDING OF RIPARIAN AND WET MEADOW HABITATS: UPPER GUNNISON RIVER BASIN, COLORADO

By The Nature Conservancy
in Collaboration with the Gunnison Climate Working Group
January 6, 2017

Table of Contents

Cover photos: Lower right monitoring: Renée Rondeau, Colorado Natural Heritage Program; Lower rock structures: Shawn Conner, BIO-Logic, Inc.; Upper rock structures: Betsy Neely, The Nature Conservancy.

Summary

Riparian areas and wet meadows occupy a small proportion of the overall sagebrush ecosystem in the Gunnison Basin, yet provide important habitat for many species. They are critical to the success of the federally threatened Gunnison sage-grouse, as they provide brood-rearing habitat for the grouse to raise their chicks. These areas are also important habitat for neo-tropical migratory birds, mule deer, and elk, and provide forage for domestic livestock. Many of these areas are already degraded by down-cutting and lowered water tables and are likely to be further impacted by increasing drought and erosion due to intense runoff events and invasive species associated with our changing climate. This degradation is likely to result in diminished food supplies for sage-grouse chicks and decreased chick survival.

To address these challenges, the Gunnison Climate Working Group (GCWG)[1] is working to enhance ecosystem resilience of riparian areas and wet meadows by restoring hydrologic and ecologic function to help the Gunnison sage-grouse, other wildlife species, and ranchers who depend on these habitats for their livelihoods adapt to a changing climate. The team is using a variety of restoration methods, e.g., rock structures, drift fences and plug and spreads, designed by restoration experts Bill Zeedyk, Zeedyk Ecological Consulting, and Shawn Conner, BIO-Logic, to help slow down water during flow events, raise water tables, reduce erosion and stabilize head cuts, reduce impacts of elk and cattle trailing, reconnect channels to floodplains, and increase wetland plants and insects.

In 2016, the partners completed the fifth year of this collaborative climate-informed riparian and wet meadow restoration project. This report summarizes the accomplishments of Phase Two (2014-2016) of this project within the context of the five-year project to date (2012-2015).

During Phase Two, the project team worked with youth field crews, volunteers and contractors to build 844 new structures within four new priority watersheds (or sites) and significantly expanded restoration at four previously treated sites. The team also modified 100 previously installed structures, important for improving their effectiveness. This work contributes to the team's total five-year accomplishments of building 1,090 structures to restore approximately 143 acres in 12 reaches along 21 stream miles in eight watersheds. The team has enhanced over 1,000 acres of brood-rearing habitat for the Gunnison sage-grouse. The team also developed initial designs for new treatments on approximately 46 acres along six stream miles at five new priority sites for implementation in 2017. The team increased efficiency of building structures from 123/year during Phase One to 281/year during Phase Two.

The structures are already effectively slowing flow of water, capturing sediments, holding and/or spreading water across floodplains, enabling wetland species to expand, and improving important brood-rearing habitat for the Gunnison sage-grouse. Holding water later into the summer season helps the system and is beneficial to the grouse for rearing chicks, particularly during drought. The structures are also improving habitat for migratory birds, mule deer, elk and other wildlife, and increasing forage production for livestock. This is an important ecosystem service in arid environments, particularly as temperatures continue to rise.

One of the key management objectives -- to increase the average cover of wetland plants in the restored portion of the treated sites by at least 20% -- is being met, although at variable rates of response across sites and number of years post treatment. Wetland species cover increased between 28-245% -- well exceeding the objective – along four treated stream reaches at two sites over four field seasons. Seven out of the 12 stream reaches at the eight sites have increased wetland species cover by greater than 24%.

[1] GCWG Project Team Members: Gay Austin (BLM-Gunnison Field Office), Andrew Breibart (BLM-Gunnison Field Office), Teresa Chapman (TNC), Jim Cochran (Gunnison County), Shawn Conner (BIO-Logic, Inc.), Jonathan Coop (WSCU), Frank Kugel (UGRWCD), Pat Magee (WSCU), Betsy Neely (TNC), Imtiaz Rangwala (WWA), Renée Rondeau (CNHP), Nathan Seward (CPW), Theresa Childers (NPS), Brooke Vasquez (Gunnison Conservation District), Matt Vasquez (USFS), Liz With (NRCS), and Bill Zeedyk (Zeedyk Ecological Consulting).

Researchers found a higher abundance and diversity of arthropods (primarily insects) in treated sites vs. untreated sites. This is important because insects are a key food source of sage-grouse chicks, and it documents the fact that these treatments have multiple ecological benefits.

This project is an important demonstration of simple yet effective tools for restoring and increasing resilience of wet meadow and riparian systems. The techniques have demonstrated significant results that that have potential to improve wildlife habitat, hydrologic function and build resilience at a much larger scale. We have trained over 150 natural resource managers from Gunnison and western Colorado. As a result, the methods are already being adopted and replicated by partners both in the Gunnison Basin and others working to conserve habitat for the Gunnison sage-grouse in other populations. NRCS has adopted these restoration methods for Farm Bill funding to implement projects on private lands at the state level, which has huge potential to benefit to both Gunnison and Greater sage-grouse.

One of the highlights of this project has been working with both youth field crews and volunteers. The young adults working for the Western Colorado Conservation Corps (WCCC) had the opportunity to spend a summer building rock structures and learning about conservation. The annual multi-day volunteer event organized by Wildlands Restoration Volunteers (WRV) was a fun a productive way to build rock structures. The number of volunteers increased from 83 to 144 between 2014 and 2016. And the number of local volunteers more than doubled in 2016 (120) as compared to previous years (54, 56), e.g., students from Western State Colorado University (WSCU).

This project has been successful for many reasons, including: 1) on-the-ground tangible results of restored small streams in eight watersheds; 2) increases in wetland plant cover; 3) strong partner engagement and collaboration; 4) built local capacity through training and volunteer events; 5) partners and natural resource managers are scaling up the project, replicating the techniques and planning new work; and 6) Terra Foundation funding leveraged over $511,000 in funding and many in-kind contributions from agency partners. The strong partner engagement and community support for this project have exceeded all expectations; this is the type of community–wide collaborative effort that is needed to prepare nature and people for an increasingly unpredictable and changing climate.

We are most grateful to the Terra Foundation and other funders including the Bureau of Land Management (BLM), Colorado Parks and Wildlife (CPW), Great Outdoors Colorado (GOCO), Natural Resources Conservation Service (NRCS), Upper Gunnison River Water Conservancy District (UGRWCD), and the US Forest Service (USFS) for supporting Phase Two of this project. The Wildlife Conservation Society provided initial funding for the pilot phase of this project. Partners also provided numerous in-kind contributions.

Introduction

Riparian areas and wet meadows within sagebrush ecosystems in the Gunnison Basin provide critical brood-rearing habitat for the federally threatened Gunnison sage-grouse. These areas are also important habitat for neo-tropical migratory birds, mule deer, and elk, and provide forage for domestic livestock. However, a number of these areas are already degraded by down-cutting and lowered water tables and are likely to be further impacted by increasing severity and frequency of drought and increased erosion due to intense runoff events, and invasive species associated with our changing climate. This degradation is likely to result in diminished food supplies for sage-grouse chicks and decreased chick survival.

To address these challenges, the team is working to enhance ecosystem resilience of riparian areas and wet meadows by restoring hydrologic and ecologic function to help the Gunnison sage-grouse and other wildlife species adapt to a changing climate. The team is using a variety of restoration methods designed by restoration experts Bill Zeedyk, Zeedyk Ecological Consulting, and Shawn Conner, BIO-Logic, to help slow down water during flow events, raise water tables, reduce erosion and stabilize head cuts, reduce impacts of elk and cattle trailing, reconnect channels to floodplains, and increase wetland plants and insects.

Project Vision and Objectives

The vision for long-term success of this project: Natural wet meadows and riparian habitats within the sagebrush landscape of the Gunnison Basin are resilient and support a sustaining population of the Gunnison sage-grouse and other species, biological communities, ecosystem services and livelihoods in the face of a changing climate. Sustained and long-term community commitment to stewardship of wet meadows and riparian areas helps nature and people adapt to a changing climate. The objectives of this project are to:

1. Increase ecosystem resilience to climate change by restoring ecosystem/hydrologic function of priority wet meadow and riparian habitats at a scale large enough to help the Gunnison sage-grouse, neo-tropical migratory birds, big game species and people who depend on these habitats for their livelihoods cope with impacts of a changing climate.
2. Build a sustainable and enduring program to increase restoration across the Basin.
3. Ensure scientific rigor of this project through a long-term monitoring program.
4. Develop and evaluate cost-effective tools, methods, and planning to help scale up the project.
5. Share best practices and lessons learned to encourage application of methods within and outside the Basin.

Summary of Accomplishments

<u>Priority Sites</u>

The team prioritized sites based on agreed upon criteria to identify the greatest potential for improvement in riparian condition using these methods, building on GIS analyses, sharing local knowledge, and conducting rapid field assessments to verify restoration needs (see climate-informed site selection analysis below), The team applied restoration treatments along small streams within eight priority sites at the watershed level, working across landownership boundaries, i.e., private, CPW State Habitat Areas, BLM and USFS lands. These small streams occur within the watersheds of three tributaries of the Gunnison River, including Cebolla, Ohio, Tomichi Creeks. The sites represent a range of elevation, stream gradients, water sources, and geology across the Gunnison Basin. During Phase Two of this project, the team treated four new priority sites, significantly expanded and/or modified treatments at previously treated sites to enhance effectiveness. The team also identified five new sites for future work. See Figure 1 for a map of both treated and new priority sites. See Table 1 for a list of priority sites with landownership.

<u>Restoration Treatments</u>

Bill Zeedyk, restoration expert and author of *Let the Water do the Work: Induced Meandering and Evolving Methods for Restoring Incised Channels* (2014), designed the restoration treatments for this project. The treatments are intended to restore hydrologic and ecological function of streams by raising the water table, connecting the channel to the floodplain, restoring head cuts, restoring livestock and wildlife trails and increasing wetland plant cover at priority sites. The structures are intended to capture sediments, hold/spread water, allow water to percolate beyond compacted areas, enabling wetland plant species to expand.

Restoration techniques include grade control structures (one rock dams, log mats, sod dams and low water crossings), flow dispersal structures (media lunas, low water crossings, plug and spreads, filter dams) and headcut control structures (Zuni bowls, rock rundowns, laybacks, log and fabric structures). Most of structures are made of rock, but several other techniques were used depending on restoration needs. Drift fences, a line of fence built perpendicular to the stream channel, were used to reduce cattle and elk trailing and soil compaction, increasing water retention. See Appendix C for diagrams of the different treatments designed by Bill Zeedyk, Zeedyk Ecological Consulting.

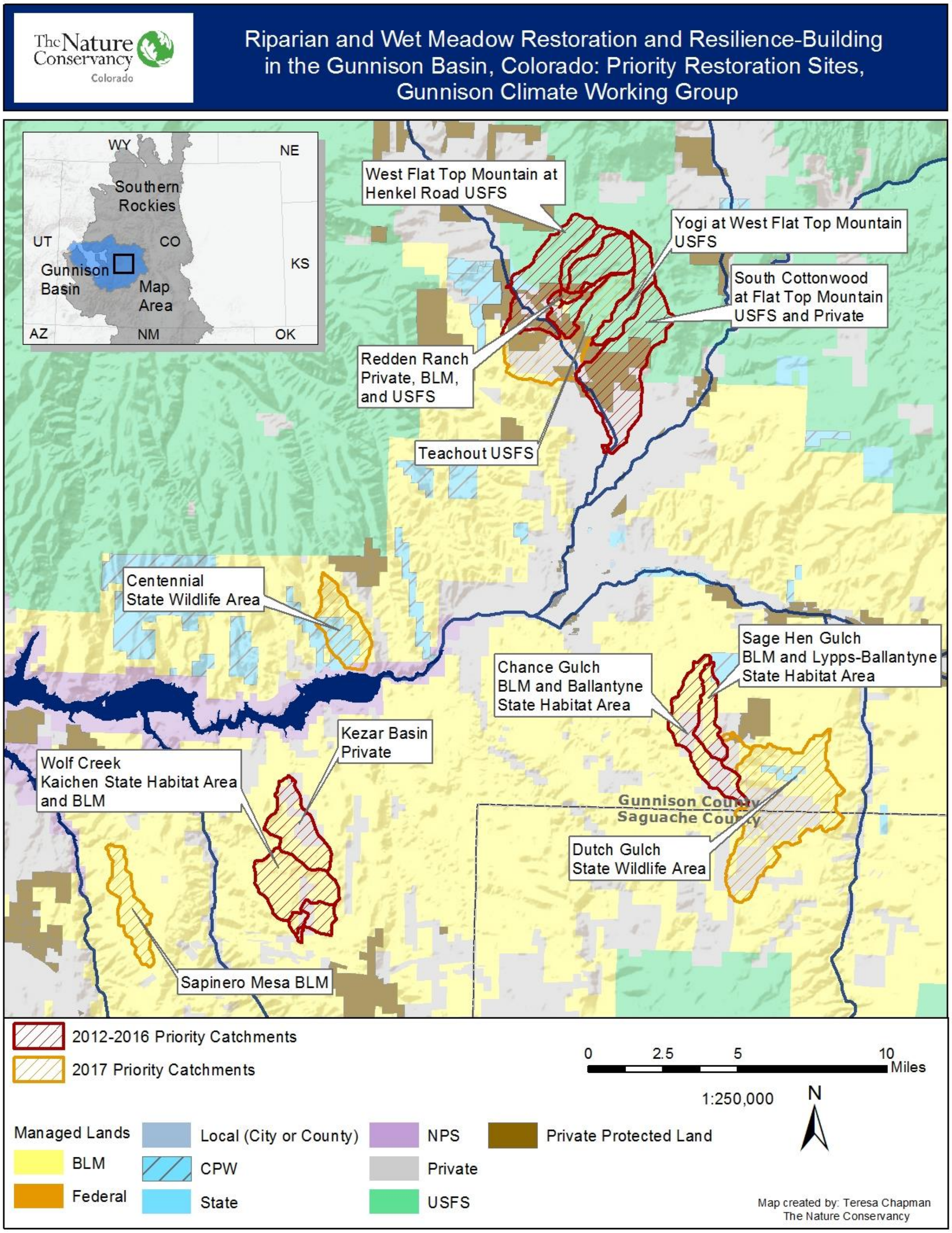
The team used a relative new technique to the area called the "plug and spread" structure, built with a bulldozer and skid steer, used to counteract the effects of channel incision and restore hydrologic connectivity with adjacent wet meadows. These structures were used in areas where transporting rock was not practical; they can restore many acres of former wetland with just a few structures. We also modified road crossings at several locations to restore meadow and/or re-graded roads to harvest water using Zeedyk's methods for low-standard rural roads (2006).

Appendix A includes tables of sites with numbers and types of restoration structures. See Appendix B for maps of the priority sites with locations and types of structures.

Table 1. Priority Restoration Sites Treated, Maintained and/or Monitored in the Gunnison Basin between 2012-2016. The asterisk indicates new sites started during phase 2 of this project; treatments at all other sites were significantly expanded, maintained and/or monitored during this time.

Site Name and Stream Reach	Landownership	Tributary
1. Chance Gulch*	BLM and Private: Ballantyne State Habitat Area	Tomichi Creek
2. Kezar Basin	Private	Cebolla Creek
3. Redden Ranch	Private, BLM and USFS	Ohio Creek
4. Sage Hen Gulch*	BLM and Private: Lypps-Ballantyne State Habitat Area	Tomichi Creek
5. South Cottonwood at Flat Top Mountain: Lower, Upper and East Fork*	USFS and Private:	Ohio Creek
6. West Flat Top Mountain at Henkel Road USFS: Bebb's Willow Reach, Section 36 & Exclosure	USFS	Ohio Creek
7. Wolf Creek: East Fork, Middle Fork, Lower and Upper	BLM and Private: Kaichen State Habitat Area	Cebolla Creek
8. Yogi, West Flat Top Mountain*	USFS	Ohio Creek

Figure 1. Overview Map of Priority Restoration Sites in the Gunnison Basin.



Planning and Design

Restoration experts and partners conducted field visits to assess specific restoration needs and design treatments for both new structures and maintenance of structures built in previous years. They staked locations for structures, documented type, size, objectives, and determined amount of rock needed for each site. Contractors completed US Army Corps of Engineers Section 404 wetland permit applications and agency staff completed NEPA requirements. Team members met with the UGRWCD and Colorado Division of Water Resources (CDWR) to ensure that there were no impacts to water rights holders with proposed restoration treatments. Restoration experts refined specifications for rock supplies working with Gunnison Gravel Company and ordered rock supplies. The contractors then delivered and staged the rock near to the treatment locations.

Training and Building Structures with Field Crews and Volunteers

To kick off the field season, restoration experts led trainings on the restoration methods for team members, field crews and natural resource managers during this project. Over 150 people participated in these annual trainings, including Western Colorado Conservation Corps (WCCC), Youth Conservation Corps (YCC), state and federal agencies, Gunnison sage-grouse working groups, non-governmental organizations, community members, ranchers, volunteers, and universities. The trainings included presentations on the natural history of the Gunnison sage-grouse and other species, restoration techniques, importance of preparing for climate change, road management techniques, vegetation monitoring and case studies from across the region. The trainings also featured a hands-on training to demonstrate construction of different rock structures, e.g., one rock dams.

Following the training, restoration experts and team members provided technical oversight to youth field crews in building rock structures for approximately 4-6 weeks from late July to early September. See Figure 2 for a photograph of the WCCC field crew members showing off their completed rock structure.

Table 2 below provides a summary of project accomplishments over the life of this project (2012-2016). The team treated at total of approximately 143 acres along 21 stream miles, and enhanced 1,018 acres of Gunnison sage-grouse brood-rearing habitat at eight priority sites. The sites were treated with 1,091 new structures and 101 modified/maintained structures; see below table for details of stream miles, acres and buffered acres broken out by new and maintained treatments. Note that because we reworked stream reaches to increase and enhance treatment effectiveness, these numbers are not broken out by year. Table 3 provides a summary of acres, stream miles and enhanced acres broken out by site. See Appendix A for details of structures by each site.

Table 2. Total wet meadow and riparian stream miles and acres treated, including acres of enhanced Gunnison sage-grouse brood-rearing habitat across all priority sites including new structures and modified/maintained structures.

Years	Restoration	Stream Miles	Acres	Riparian Acres Buffered 50m
2012-2016	New	15.8	107.9	773.5
2012-2016	Maintained	4.8	35.5	245.0
Total		20.6	143.4	1,018.5

Table 3. Summary of stream miles, acres restored and acres enhanced of Gunnison sage-grouse habitat by the restoration treatments in the Upper Gunnison Basin from 2012-2016 (Phase One and Phase Two).

Site	Stream Miles	Acres	Riparian Acres Buffered 50m
Chance Gulch BLM	2.23	17.5	107.30
Chance Gulch Private	0.18	1.17	7.77
Chance Gulch Private State Habitat Area	0.63	3.18	33.91
Kezar Basin BLM	0.04	0.09	1.73
Kezar Basin Private	0.94	6.11	50.83
Redden Ranch at West Flat Top Mountain BLM	0.29	2.08	8.66
Redden Ranch at West Flat Top Mountain Private	0.02	0.38	0.56
Redden Ranch at West Flat Top Mountain Private (w/ Protection)	0.56	3.04	25.46
Redden Ranch at West Flat Top Mountain USFS	0.22	0.6	10.27
Sage Hen Gulch BLM	2.34	12.3	106.78
Sage Hen Gulch Private State Habitat Area	0.18	0.55	8.84
South Cottonwood at Flat Top Mountain Private (w/ Protection)	0.48	2.84	27.10
South Cottonwood at Flat Top Mountain USFS	1.60	6.2	71.92
West Flat Top Mountain at Henkel Road USFS	2.82	24.2	140.07
Wolf Creek BLM	1.29	12	68.51
Wolf Creek Private State Habitat Area	1.85	12.6	86.97
Yogi at West Flat Top Mountain USFS	0.20	3.06	16.86
Total	**15.86**	**108**	**773.54**

Figure 2. Western Colorado Conservation Corps celebrate completion of a one rock dam at West Flat Top with Shawn Conner, restoration expert with BIO-Logic, Inc. Photo by Matt Vasquez, USFS.

One of the highlights of this project has been the annual volunteer event organized by Wildlands Restoration Volunteers (WRV). Restoration experts and partners provided technical expertise and oversight to the volunteers; staff conducted a leadership training for new crew leaders. Volunteers from the Gunnison area and across Colorado built rock structures on USFS, BLM and private lands. The WRV structure of using experienced crew leaders, training new crew leaders and working in small teams is an excellent model, resulting in high-quality structures. This event has been a great community capacity-building effort involving multiple agencies, organizations, community members as well as university and high school classes. WRV provided expertise on crew organization, safety, and quality control. We also organized an annual community barbecue to thank partners and volunteers for their contributions and accomplishments over the year.

The number of volunteers increased from 83 in 2014 to 144 in 2016. Total volunteer hours nearly doubled from 1,247 to 2,088 from 2014 to 2016. The most volunteers were from Western State Colorado University (WSCU), but volunteers were also from Colorado Mountain College and Gunnison High School. See Table 3 for details. The number of local volunteers more than doubled in 2016 (120) as compared to previous years (54, 56). See Table 4.

Partner leads also organized several other volunteer events to build structures. For example, BLM organized groups of WSCU students to build structures as part of National Public Lands Day over the three years. The CPW organized several volunteer days with WSCU's Student Chapter of the Wildlife Society, other classes and the Rocky Mountain Elk Foundation. These volunteer events provided terrific opportunities for learning and community service for students and community members.

Table 4. Number of volunteers, crew leaders trained, total volunteer hours, value of volunteer time and number of local vs. Front Range volunteers at the WRV volunteer event. D=Day, Vol=Volunteers

Year	# Unique Volunteers	Number of Volunteers per Day					# Crew Leaders trained	Total Vol Hrs	Value of Volunteer Time	Gunnison Volunteers: WSCU and GHS Students	Front Range Volunteers
		D1	D2	D3	D4	D5					
2014	83	36	18	34	30	26	6	1247	$29,379	54	29
2015	76	26	38	38	23		4	1353	$31,877	56	20
2016	144	68	80	67	46		7	2088	$49,193	120	24

Vegetation Monitoring

One of the aspects of this project that really sets this project apart from others is the scientific rigor of the monitoring program. As this project applied new restoration techniques in the Basin, we wanted to ensure that we could monitor results using professional and repeatable methods. Ecologists Colorado Natural Heritage Program (CNHP), BLM, and USFS monitored vegetation response of the treatments using methods that can be replicated in other areas and over time. Because wetland plants indicate soil moisture and provide insect habitat and cover for sage-grouse chicks, the ecologists measured wetland plant cover as an indicator of restoration success. The team monitored vegetation along 192 permanent transects and collected 543 photo points on 12 stream reaches at eight priority sites.

Our management objective -- to increase the average cover of wetland plants (sedges, rushes, willows, forbs, etc.) in the restored portion of the treated sites by at least 20% -- is being met, although at variable rates of response across sites and number of years post treatment. Wetland species cover increased between 28-245% -- well exceeding the objective – along four treated stream reaches at two sites over four growing seasons. Several factors are likely contributing to the variable rate: amount and timing of snowmelt, storm events, sediment load, geology, floodplain width, livestock grazing, and stock ponds. In addition to providing observational trend data by stream type, the monitoring results have provided numerous photo points that enhance visualization of results, thus allowing managers and funders to quickly assess restoration response.

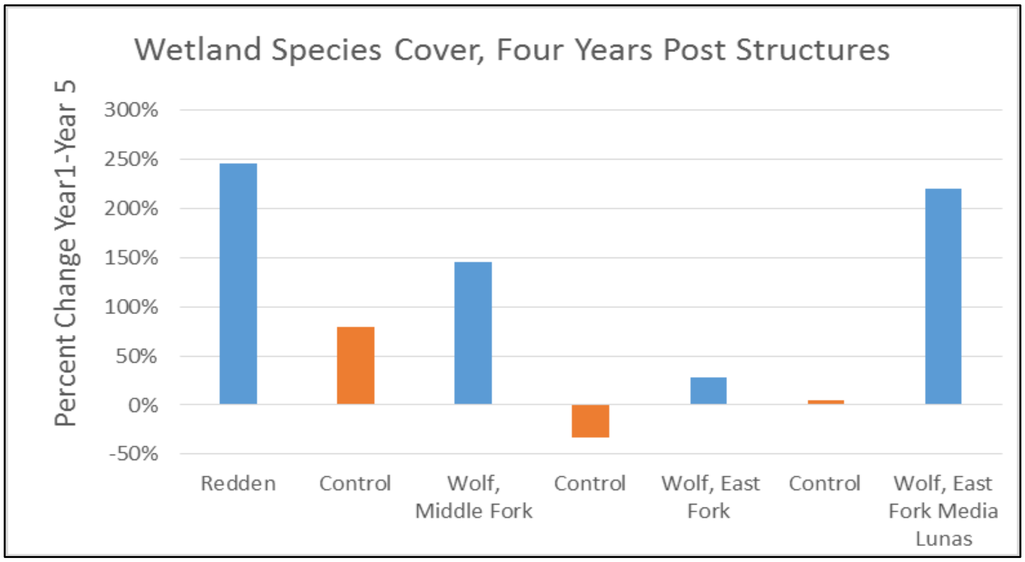
See Figures 2-3 for photos and Figure 4 for graphic showing percent change in wetland species cover for reaches over three and four years after structures were built. See Table 5 for a summary of wetland species cover response rates at priority sites by stream reach grouped into fast, slow and no response categories for priority sites and stream reaches. See Appendix D and E for the vegetation monitoring report and photo documentation of vegetation response to treatments.

The scientific rigor of the monitoring program has been critical for evaluating the success of the program and convincing other entities of restoration potential. A picture "can say a thousand words" and we have found that a strong before-and-after photo sequence can quickly convey a great deal as to the effectiveness of these treatments.

Figure 2. The Wolf Creek East Fork site showed fast response to media lunas. Wetland area increased from approximately 25% of the floodplain in 2012 and 80% in 2016. Wetland species cover increase by 220% over 4 years.

Figure 3. West Flat Top Exclosure showed slow to no response to a log-fabric structure to treat a deep head cut three years after construction in 2013. Wetland plant cover only increased by 6%, but the head cut is not moving upstream and gully is filling with sediment.

Figure 4. Percent change in wetland species cover for reaches with four years (top) and three years (bottom) after structures were built. Blue bars represent treated areas and orange bars represent controls (untreated areas).



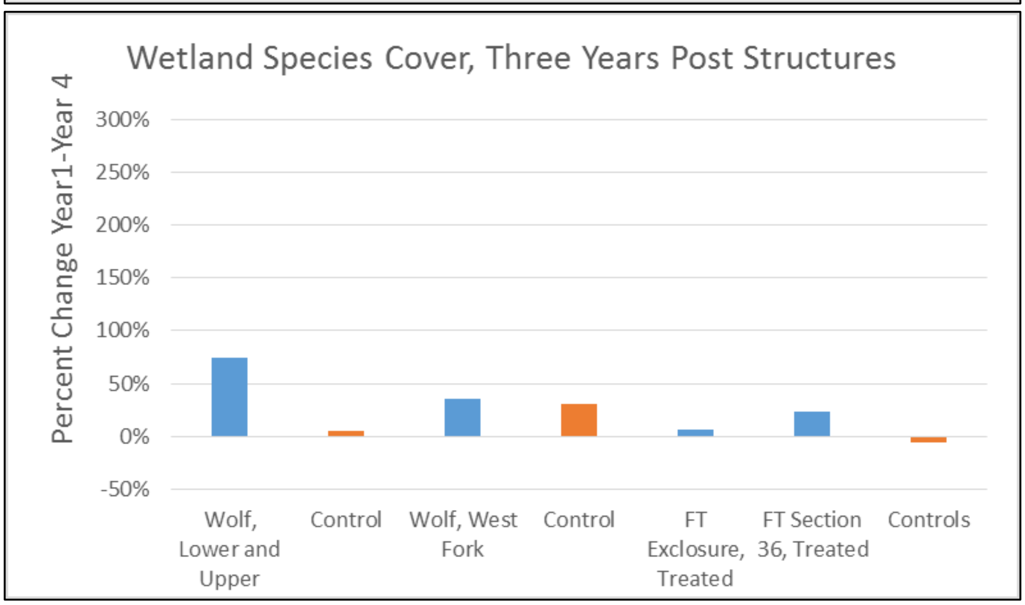


Table 5. Wetland species cover response rates at priority sites by stream reach grouped into fast, slow and no response categories for priority sites and stream reaches (from Rondeau et al. 2016).

Site/Stream Reach	Wetland Species Cover Increase	Number of Years Post Treatment	General Characteristics/Comments
Fast Response			
Wolf Creek-East Fork Media Lunas	220%	4	Perennial water from spring; wide flood plain with approximately 25% of floodplain occupied by wetlands prior to treatment
Redden	245%	4	Ephemeral; snow melt and storm events are primary water source; medium wide floodplain; sediment source upstream
Wolf Creek-Middle Fork	37%	4	Ephemeral; snow melt and storm events are primary water source; narrow floodplain
Wolf Creek-Upper and Lower	37%	3	Perennial water from spring; wide floodplain with approximately 25% of floodplain occupied by wetlands prior to treatment
Kezar Basin	27%	2	Perennial water from springs; wide floodplain with approximately 25% of floodplain occupied by wetlands prior to treatment
Slow Response			
Wolf Creek-East Fork above Media Lunas	28%	4	Mixed water source with some perennial, snow melt and storm events; narrow to medium flood plain width
Flat Top-Henkel Road	24%	3	Ephemeral snow melt and storm events are primary water source; narrow to moderately wide floodplain
No Response Yet			
Flat Top-Exclosure	6%	3	Ephemeral; snow melt and snow events; preventing the migration of a large headcut was the primary goal
Flat Top-Above Exclosure	0%	2	Repeat photos show that sediment is building and we expect to see a positive response next year
Above Redden	0%	2	Purpose was to provide additional ground water to meadow below (not to increase wetland plant cover)
Wolf Creek-West Fork	5%	3	Multiple upstream ponds capture snow melt, water from storm events and sediment; low water crossing has been problematic
Chance Gulch	0%	2	More time is needed to determine trends

Monitoring Other Ecological Responses

We have been able to move beyond vegetation monitoring and investigate other ecological responses to these treatments, with assistance from partners.

Arthropods: A WSCU graduate student study documented higher abundance and diversity of arthropods (primarily insects, spiders and centipedes) in treated sites vs. untreated sites. This is important because insects are a key food source of sage-grouse chicks, and it documents the fact that these treatments have multiple ecological benefits.

Wildlife Use: The CPW installed remote motion-activated cameras in 2016 in treated and untreated reaches at four sites to monitor Gunnison sage-grouse and other wildlife use. Early results indicate that sage-grouse are using the treated areas. See Figure 5 below.

Other monitoring efforts resulting from the project include investigations related to increased biomass production, water table monitoring and soil moisture monitoring. The rigorous monitoring program set up from the beginning with this project has branched into many opportunities for ecological restoration monitoring and has set a sound example for other projects to follow this template.

Figure 5. Three Gunnison sage-grouse hens captured on camera on July 16, 2016 in a wet meadow treated with plug and spread structures in Kezar Basin (Photo by Nathan Seward, CPW).

Gunnison Sage-Grouse Listing

The recent federal listing of the Gunnison sage-grouse as threatened by the US Fish and Wildlife Service (USFWS) could have delayed the project work, but the NPS, USFS and BLM collaborated on an interagency Programmatic Biological Assessment (PBA) to help streamline the consultation process on public and adjacent private lands. The USFWS also finalized a Biological Opinion with NRCS to streamline the consultation process on private lands. In 2015, the USFWS provided a Concurrence Letter for the PBA for these projects, noting that the proposed actions will prove beneficial to the Gunnison sage-grouse, and agreeing that they are not likely to adversely affect the species or its Critical Habitat. The Concurrence Letter applies to projects on public and private lands accomplished under the terms of the PBA.

Finally, BIO-Logic documented the regulatory process of USFWS and USACE in light of the recent federal listing of the Gunnison sage-grouse. Her document will help guide future efforts in navigating the complex rules and regulations associated with restoration of habitat of a federally listed species.

Outreach Activities and Field Tours

Team members presented the project to a wide variety of audiences, including: CDWR, Colorado State University, Gunnison Basin Gunnison sage-grouse Strategic Committee, Gunnison County Stockgrowers' Association, GCD, National Adaptation Forum, NOAA, NRCS, Quivira Coalition, Sage Grouse Initiative, USACE, USFWS, 13th Biennial Conference: Science and Management of the Colorado Plateau, Sustainable Watersheds Conference, Western Slope Native Plant Committee, Wildlife Society. The team organized field tours for federal and state agencies and universities, including CSU's Center for Collaborative Conservation graduate class, National Fish and Wildlife Foundation, TNC, WSCU classes, UGRWCD, and USACE. Restoration experts also designed treatments and conducted a technical training for the San Miguel Gunnison Sage-grouse working group.

Climate-Informed Site Selection Analysis

In our proposal to the Terra Foundation, we estimated that the Gunnison Basin would require restoration of 875 acres of wet meadow along 100 stream miles based on a preliminary GIS analysis. In our proposal, we noted the original targets were preliminary and that the team planned to revise the outcome goals based on new climate-informed analyses.

TNC's GIS manager conducted a comprehensive climate-informed analysis, refining the initial analysis over the past two years. The objective of the analysis was to identify and prioritize stream reaches for restoration work, providing a landscape-scale model of the restoration need and potential of stream reaches in the entire Basin. The model was used to identify stream reaches within critically important Gunnison sage-grouse habitat that offer the greatest potential to respond favorably to the restoration techniques. Once reaches with the highest potential are identified, on-the-ground investigations can further refine opportunities and constraints for restoration at each site. We used four criteria to select and prioritize stream reaches for restoration: 1) location within potential Gunnison sage-grouse brood rearing habitat; 2) close proximity to lek locations (<= 2 miles); 3) Restoration Potential Index measuring difference in greenness between a wet year and a dry year; and 4) Riparian Condition Index measuring the extent of the floodplain and the current extent of riparian vegetation. See Figure 6 for priority stream reaches and Appendix F for methods and results of this analysis.

The revised analysis indicates that 765 acres of riparian vegetation along 272 stream miles in 32 sub-watersheds would benefit from these restoration techniques. See Figure 6. Note that the acreage target dropped but the number of stream miles increased. These results are a starting point for prioritization -- field work is needed to narrow down the priority stream reaches and restoration needs.

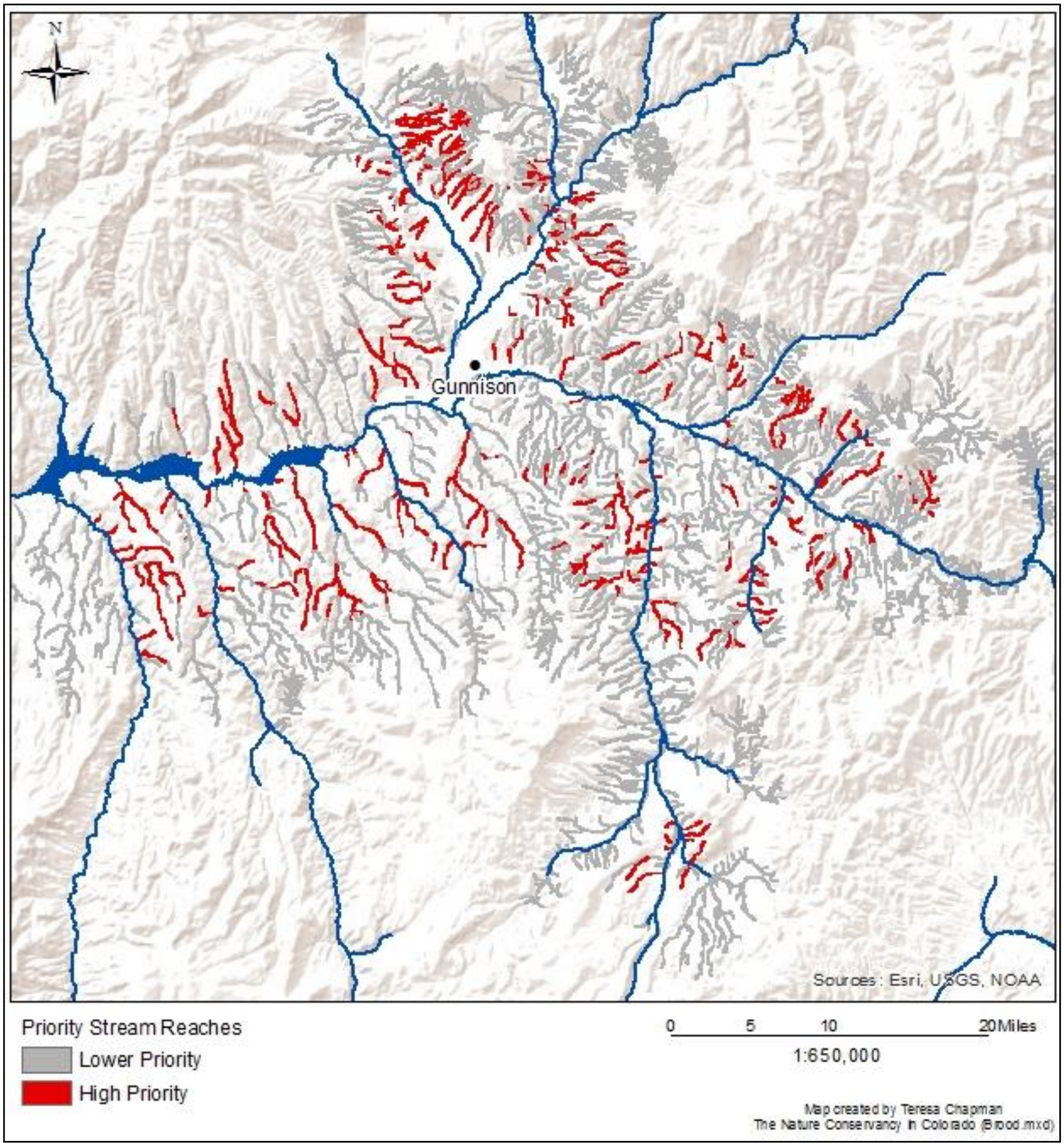
Challenges to Meeting Stream Miles and Acreage Outcomes in Terra Foundation Proposal

We treated approximately 20% of the acres (143/765) identified in the revised site selection analysis. In implementing this project, we realized that the targeted goals were overly ambitious for the short timeframe of the project, given the complexity of implementing a collaborative project of this size and scope. Had we worked only with contractors and hired field crews, we might have treated more acres and stream miles. But we also felt that it was more important to build a strong partnership and capacity to continue applying these techniques over the long term to reduce the long-term impacts of climate change. It was also more important to do quality work on fewer stream miles than to treat more stream miles in a cursory manner. This was particularly important because this was a pilot project to demonstrate a suite of restoration techniques and monitor response.

The challenges we faced in achieving restored acres and stream miles centered around the time and resources needed to: 1) identify priority sites using a climate-informed GIS analysis and field assessment of sites; 2) plan design and build a variety of structures; 3) train and oversee field crews to manually build structures; 4) monitor and evaluate the effectiveness of structures; 5) complete wetland delineation and obtain permits, agency requirements, and landowner agreements well in advance of work; 6) develop a programmatic biological assessment for these projects within critical habitat for the newly listed federally threatened Gunnison sage-grouse; 7) revisit treated sites to determine needs for modification and/or expansion; 8) reworking previously treated sites cost us acres and miles in new sites, but the team felt this was the right thing to do to ensure quality work; 9) share best practices with outside groups interested in replicating these methods; and 10) purchase and delivery of rock to remote sites can be expensive; local rock could not be used due to agency guidelines needed for the federally threatened Gunnison sage-grouse and cultural resources

Finally, the use of plug and spread treatment, which is more economical at larger scales than rock work, was not readily acceptable early on to agencies and had to be demonstrated. Our restoration expert believes that we could have treated other sites more economically and more thoroughly (thus gaining more acres) had it been acceptable to agencies early on.

Figure 6. Map of high priority stream reaches in the Gunnison Basin based on four criteria: 1) brood rearing habitat, 2) within two miles of a lek, 3) *Restoration Potential Index* between 60 and 100 (indicating riparian areas that significantly dried during the drought but maintain greenness during wet years), and 4) *Riparian Condition Index* between 1 and 25 (indicating that current riparian vegetation occupies a small percentage of the floodplain). These stream reaches have high potential to improve using restoration techniques and to increase resilience to the impacts of climate change; field verification is needed to confirm specific needs and restoration treatments.



Funding and Partner Contributions

TNC raised approximately $511,000 towards this project from BLM, CPW, GOCO, NRCS, UGRWCD, and USFS to leverage the Terra Foundation's grant during Phase Two of this project (2014-2016). This funding has been used to cover project costs, including contractors, travel, meetings, and supplies (rock, fencing, seed, and food for volunteer events). Contractors included restoration experts to design and oversee installation of treatments, ecologists to complete wetland permitting, youth field crews to build rock structures, WRV for organizing volunteer events, ecologists to conduct vegetation monitoring, equipment operators to deliver rock, and private contractors to install of plug and spreads, low water crossings, drift fences and armor existing plug and spread structures. Below is a list of the agencies and amounts contributed towards this project during Phase 2 of this project.

1. BLM: $218,167.00
2. CPW: $100,000.00
3. GOCO: $25,000.00
4. NRCS: $75,000.00
5. UGRWCD: $43,300.00
6. USFS: $93,500.00.00

The partners and team members that contributed many in-kind contributions towards the project include: 1) BIO-Logic, Inc.; 2) BLM; 3) CPW; 4) GCD; 5) Gunnison County; 6) USFS; 7) National Park Service; 8) NRCS; 9) UGRWCD; 10) WCCC; and 11) Zeedyk Ecological Consulting. These contributions consisted of working with landowners, completing NEPA requirements, completing Programmatic Biological Assessment for the Gunnison sage-grouse, completing wetland permits, mapping sites and structures, meeting space, staff time and expertise in planning design and implementation including overseeing field crews and volunteers, seed supplies and seeding disturbed areas, private landowner relations, presentations and webinars, use of CPW's Miller Ranch State Wildlife Area for volunteers, providing trucks and UTVs for hauling rock, vegetation monitoring, and youth field crews.

Future Plans and Direction

<u>Restoration Treatment Plans for 2017</u>

During the 2016 field season, the project team planned and/or designed treatments for implementation in 2017 along stream reaches at the sites listed below. Rock was ordered and delivered to Dutch Gulch and Graflin Gulch. In addition, BIO-Logic, Inc., BLM and NRCS are working on Section 404 Wetland Permits for these areas, so that the team can hit the ground running in 2017.

a. BLM: Sapinero Mesa-BLM, Sage Hen-BLM
b. Private/CPW: Dutch Gulch State Wildlife Area, Centennial State Wildlife Area, Graflin Gulch-Lypps Ballantyne State Habitat Area, and South Cottonwood
c. USFS: Teachout, South Cottonwood and Henkel Road, West Flat Top.

<u>Project Coordination</u>

This collaborative project has been highly successful due to the incredible engagement and support by partners, stakeholders and team members, excellent restoration design, long-term monitoring program, hands-on trainings, technical oversight of crews and volunteers, high-quality work on structures, good response to the structures, and increasing interest on the part of stakeholders in other watersheds in applying the techniques. We have built local capacity and expertise to implement this project to the point where partners are already initiating and implementing projects. The time has come to transition the coordination of the project to the local partners to continue applying the techniques across the Basin. It is also an exciting time to share best practices and lessons learned with those working to build resilience of brood-reading habitat for other satellite populations of the Gunnison sage-grouse, as well as the Greater sage-grouse.

TNC has worked closely with the CPW, BLM, USFS and Gunnison County to coordinate this project since late 2011, and is strongly supportive of seeing the project continue into the future. However, it is time for TNC to transition coordination of the project to local partners in 2017. The restoration experts have built strong local capacity to continue this work through excellent trainings and sharing best practices and lessons learned focused on building structures. The team is working to raise funds to cost-share a coordinator position modeled after other successful efforts, e.g., the collaborative private land biologist positions co-funded by NRCS, Bird Conservancy of Rockies, and others. Ideally, the coordinator will focus on the wet meadow restoration work in Gunnison Basin, but also help scale the project up and build capacity for the six other satellite sage-grouse populations, as well as building landscape resilience to climate change, water and range health. The coordinator will also be responsible for marketing, recruitment and communication with local community members to create a successful volunteer program. The team needs to consider the importance of contractors, e.g., rock, hauling rock, restoration experts, wetland permits, monitoring and volunteer events. Restoration expertise to design and oversee installation of structures is essential to the continued success of this project.

<u>Taking the Project to Scale</u>

The project team has been sharing best practices and important lessons learned with colleagues in other watersheds that are interested in applying these restoration methods. For example, over 60 participants from across the Western Slope attended our two-day restoration training in 2015, that included both lecture and hands-on training on the restoration techniques and building rock structures.

The project is rapidly gaining attention from ranchers, natural resource managers, and other groups both in and beyond the Basin, as there are numerous degraded streams that would benefit from these treatments. In 2016, our project team partners began design of treatments for five new sites for 2017 work, and plan to enhance treatments at three previously treated sites in the Gunnison Basin. This new work will restore about 46 acres along six stream miles, benefiting approximately 330 acres of Gunnison sage-grouse brood-rearing habitat.

Four of our team members have already funded and implemented several other spinoff projects in the Gunnison Basin. The National Park Service treated several acres in three drainages at Dry Creek Picnic Area. The CPW, the Gunnison Conservation District and NRCS funded treatment expansion at South Cottonwood, a tributary of Ohio Creek. The NRCS is working directly with at least three other ranchers to apply these techniques on private lands.

At least three agencies/groups from outside the Basin who attended our trainings have started similar projects. For example, the BLM treated two stream miles near Crawford and the San Miguel Gunnison Sage-grouse Working Group treated just under a mile in the Dry Creek Basin. BLM managers are planning new projects for 2017 within Gunnison sage-grouse habitat in the Crawford population, the USFS plans new work near Norwood, and CPW plans new work along two stream miles in Dry Creek. All of these projects in other areas important to Gunnison sage-grouse conservation are a direct result of the Gunnison project, and the word from our extensive trainings is starting to spread even further.

One of the most exciting developments is that the NRCS has approved these restoration practices for Farm Bill funding to implement projects on private lands, which has huge potential to benefit to both Gunnison and Greater sage-grouse. This effort has been spearheaded by the Gunnison office of the NRCS. They have already contracted with at least three landowners and are working with other landowners to design future projects near Gunnison. NRCS staff in Montrose, Delta, Glenwood Springs, Alamosa and other areas are interested in applying the techniques. The Gunnison NRCS reports that they field several calls a month from NRCS colleagues to discuss questions about project design, costs, and planning. The national NRCS is working on consistency across states and moving the practice to be a non-engineering practice so that wildlife and range staff can plan them without sign-off of an engineer (personal communication, Liz With, NRCS, Gunnison, Colorado).

Other groups are increasingly interested in adopting these methods for the Greater sage-grouse in northwestern Colorado and even Montana. The Intermountain West Joint Venture/Sage Grouse Initiative has expressed an interest in scaling-up these techniques across 11 Western states to improve habitat for the Greater sage-grouse. One speaker with the IWJV announced at the 2016 Gunnison sage-grouse Summit that “wet meadow restoration is the next big thing!” for the Sage Grouse Initiative. The team plans to share best practices and lead field tours as part of the 2017 Sage Grouse Initiative annual meeting to be held in Gunnison. The Middle Park Conservation District is interested in organizing trainings for their producers in Grand, Summit and Routt Counties. This is exactly the opportunity the team has been was looking for to share these techniques with landowners and managers on a bigger scale.

Lessons Learned and Recommendations

Lessons learned from this project are: 1) collaboration and partner engagement are key; 2) building local capacity can help ensure long-term success; 3) restoration treatments need technical planning and design by restoration experts to ensure quality work; 4) at least three years of vegetation monitoring is needed to document trends in response; 5) monitoring, modification and maintenance of existing structures is critical to ensure effectiveness; 6) working at the watershed-scale across boundaries is important to ensure optimal response; and 7) sharing best practices with managers across the Basin and beyond takes time but is critical for success. A few detailed lessons learned and recommendations are discussed below.

<u>Youth Field Crews and Volunteers</u>

Building rock structures involves manual labor and lots of hard work lifting and placing rocks in wet meadows. Hiring youth field crews to build rock structures is essential to implementing this project. The team has found that there are several keys to successful and high quality results, including: regular communication and troubleshooting, strong crew leaders, solid hands-on training for smaller groups, technical oversight by restoration experts, and participation by agency leads to discuss goals and significance of the project. The team was particularly pleased with the WCCC crews in 2016; early planning on the part of the team with the WCCC really paid off!

The annual multi-day volunteer event held in early September over the past three years has been a big success and extremely productive. Volunteers love this project largely because of the opportunity to return to the same work sites, see previous years’ work, camp in a familiar location and work with the same agency staff year after year. Essential to the success and quality of the work accomplished is due to the trained crew leaders who are familiar with the work type and technical aspects of the project. The project team strives to recruit and retain local volunteers in order to build capacity for future projects. Intermittent volunteer or social opportunities are critical for building community among the volunteer base. Community building together with meaningful work is the key to success in recruitment and retention of volunteers.

<u>Vegetation Monitoring</u>

Further investigation as to why we see such a variation in response rate would help us scale this project up into new areas. It may be possible to provide guidelines for more detailed management objectives, including metrics such as bare ground, erosion control, or number of wetland acres. Potentially each stream reach could have its own management objectives, just as each structure type could have its own objectives. With more fine-scaled analysis and additional monitoring it may be possible to compare the efficiencies in plug and spreads versus rock structures in meeting goals.

At least five years of vegetation monitoring is necessary to observe real trends. In addition, if a site has additional structures built on top or near the original structures, an additional three years of monitoring would be ideal. While all new sites do not require monitoring at the current level, we recommend additional monitoring on plug and spreads and contour swales to ensure good representation across different stream reaches and help us assess the effectiveness and efficiency of these structures. At sites where extensive monitoring is not needed, we recommend using photo points to assess change. Note that even with photo points, it is important to have controls to compare treated and untreated sites within a reach.

Any good adaptive management project requires management objectives and monitoring to determine if objectives are being met. As one learns from the project, it is important to review and adjust the objectives. We need to revisit our objectives and potentially add additional objectives or develop objectives for each reach. An important attribute of a well-designed restoration project is to make sure that one does not treat the entire area, thus providing control area that can be used to detect trends in response to treatments versus changes in weather.

Structure Maintenance and Repair

The restoration treatments need occasional and continued maintenance to ensure maximum effectiveness over time, depending on the amount and timing of precipitation and the amount of sediment in the upper watershed. For example, rock structures often need additional layers of rock added in subsequent years as the lower layers fill with sediment and plants. In addition, an intense precipitation event last August 2016 damaged approximately 10-15 newly built structures at Sage Hen Gulch that need to be repaired in 2017.

Restoration Training

Critical to scaling up this effort across the region is technical training in planning, design and implementing restoration techniques. Our training has focused primarily on building structures, but further training beyond the basics is needed for successful application of the techniques.

Carbon Sequestration Benefits

This project provides an excellent opportunity to study carbon sequestration benefits, related to, and/or resulting from, the wetland and wet meadow restoration activities in the Gunnison Basin and beyond. If the benefits could be measured, confirmed and evaluated, it might lead to future funding opportunities by way of carbon offsets that might be sponsored by various corporations. For example, Coca Cola is underwriting wetlands restoration projects on Carson National Forest as a means to offset, by means of ground water recharge, the loss of water used in its products. Future treatment locations might lend themselves to study if we could plan far enough ahead in project design to be scientifically sound in our application of the treatments and perhaps garner financial support from untapped sources. We might plan or select future projects with that in mind and might attract one or more qualified students to study the results.

Next Steps

1. Complete reports to other funders, i.e., BLM, CPW, NRCS and USFS in 2017.
2. Hire a local coordinator and develop fund-raising proposals to continue the project in the Gunnison Basin and build capacity of others to replicate these methods across the region.
3. Complete executive summary and fact sheets describing best practices from the past five years of work to share with other practitioners and stakeholders interested in applying these techniques across the region.
4. Hold team meeting to discuss 2017 plans for treating Dutch Gulch, Graflin Gulch, Sage Hen (repair of structures damaged during big runoff event in August 2016), Sapinero Mesa, Teachout and South Cottonwood.
5. Hold team meeting to review results of site prioritization and identify top sites needing field assessments to determine restoration needs, assess feasibility and prioritize future work.
6. Finalize coordinated strategy for monitoring response to the restoration treatments, including benefits to the Gunnison sage-grouse and method for mapping change in wetland area in response to the treatments. Continue vegetation monitoring to document wetland plant species cover response.
7. Share best practices with others across the region to promote widespread adoption of the restoration techniques through presentations, webinars, trainings and field trips. For example, present project at the upcoming High Altitude Restoration meeting and provide training and field trips during the June 2017 Sage Grouse Initiative Meeting.
8. Recruit a researcher to study the carbon storage benefits of the restoration project.

Acknowledgements

Special thanks to the Terra Foundation for making Phase Two of this project possible, and to other funders, BLM, CPW, GOCO, NRCS, USFS, and UGRWCD. Many thanks to the Gunnison Climate Working Group and the project team, partners and contractors for their significant contributions, in-kind support, sharing of expertise, assisting with outreach events, and contributing many hours towards making the project a success.

Bill Zeedyk and Shawn Conner provided extensive restoration expertise, design and evaluation of treatments. Jim Cochran reviewed proposals, reports, hosted team meetings, provided expertise and review of regulations related to the Gunnison sage-grouse listing, and assisted with troubleshooting issues. Bill Zeedyk, Shawn Conner, Nathan Seward, Andrew Breibart, and Matt Vasquez led youth field crews and volunteers in building rock structures. Andrew Breibart, Renée Rondeau, Gay Austin, Nathan Seward, Liz With, Brooke Vasquez and Bill Zeedyk conducted rapid field assessments. Gay Austin and Alison Graff completed the wetland delineations and permit applications. Nathan Seward, Jim Cochran and Matt Vasquez provided grouse expertise. Renée Rondeau, Gay Austin, Suzie Parker and Wendy Brown conducted vegetation monitoring; Renée Rondeau provided preliminary results of monitoring and repeat photographs for selected sites. Imtiaz Rangwala provided climate expertise. Jim Cochran, Nathan Seward, Liz With, and Brooke Vasquez provided private landowner connections. Shawn Conner, Andrew Breibart and Matt Vasquez provided GPS locations of structures. Thanks to Frank Kugel and George for hosting team meetings and for providing programmatic support of the project.

Gay Austin, Andrew Breibart, and Matt Vasquez completed all NEPA requirements for federal-managed public lands. Mark Flower, volunteer project leader, organized the WRV event with Morgan Crowley, WRV staff member. Nathan Seward kindly provided the use of CPW’s Miller Ranch State Wildlife Area during the three annual volunteer events and barbecues. He also initiated the remote camera pilot study of wildlife use, designed treatments, and worked with crews and volunteers to build structures. We greatly appreciate Andrew Breibart, Matt Vasquez, Frank Kugel, Nathan Seward, Brooke Vasquez and Liz With for acquiring key matching funds.

This project would not have been possible without the cooperating landowners (and permittees) Curtis Allen, Wayne Ballantyne, Wendy Collins, Nick Lypps, Brett Redden, Rufus Wilderson, and ranch manager Ted Harter for enabling these projects to be completed on private lands and for opening their lands to team members, field crews, contractors and/or volunteers.

TNC staff contributed in many ways to this project. Luann Rudolph provided technical expertise on grants, contracts, and finances. Steve Cann provided legal review of all contracts and advice on water issues. Teresa Chapman conducted the GIS site selection analysis and compiled structure data, developed maps of sites. Paige Lewis, John Sanderson, Christina Cheatham and Paige Lewis provided programmatic support; Missy Davis assisted with proposal writing and Chris Pague provided early technical expertise on site selection and analyses.

This report was written by Betsy Neely, with review and/or input by Jim Cochran, Shawn Conner, Renée Rondeau, Luann Rudolph, Nathan Seward, Matt Vasquez, and Bill Zeedyk. Teresa Chapman, completed the site prioritization report and summary tables, site maps and analyses of data provided by Shawn Conner, Matt Vasquez, and Andrew Breibart. Renée Rondeau, Gay Austin, and Suzie Parker provided the vegetation monitoring report. Matt Vasquez provided the pre and post structure photos. For questions or further information, contact Betsy Neely at bneely@tnc.org.

References

Seward, N. 2016. Wildlife Use of Restored Wet Meadows in the Gunnison Basin, Colorado. Research Proposal. Colorado Parks and Wildlife, Gunnison, Colorado. 15 pp.

Zeedyk, B. 2006. *Harvesting water from Low-Standard Rural Roads.* A Joint Publication of the Quivira Coalition, Zeedyk Ecological Consulting, LLC, The Rio Puerco Management Committee – Watershed Initiative, and the New Mexico Environment Department – Surface Water Quality Bureau.

Zeedyk, B and Clothier, V. 2014. *Let the Water Do the Work: Induced Meandering, an Evolving Method for Restoring Incised Channels*, 2nd edition. Chelsea Green Publishing.

Zeedyk, B. 2015. *The Plug and Spread Treatment: Achieving Erosion Control, Soil Health and Biological Diversity.* Sapello, NM: Zeedyk Ecological Consulting, LLC.

Appendices

A. Tables of Priority Sites with Restoration Structures
B. Maps of Priority Sites with Restoration Structures
C. Restoration Techniques (Zeedyk)
D. Wetland Restoration Vegetation Monitoring Report (Rondeau, Austin, Parker)
E. Wetland Restoration Monitoring PowerPoint Presentation (Rondeau, Austin, Parker)
F. Prioritizing Sites for Restoration/Resilience Building Report (Chapman)
G. Pre and Post Restoration Treatment Photographs (Vasquez)

APPENDIX A

Table 1. Priority Sites with Numbers and Types of New Structures built during Phase Two (2014-2016) relative to Total Structures Built over the five years (2012-2016). Note: this includes both new structures, maintained and structures with a second layer.

Site/ Manager	Chance Gulch		Kezar Basin	Redden Ranch at West Flat Top Mountain			Sage Hen Gulch		South Cottonwood at Flat Top Mountain		West Flat Top Mountain at Henkel Road	Wolf Creek		Yogi at West Flat Top Mountain
Structures	BLM	Private State Habitat Area	Private	BLM	Private	USFS	BLM	Private State Habitat Area	Private	USFS	USFS	BLM	Private State Habitat Area	USFS
Contour Swale	0	0	2	1	0	0	0	0	1	1	0	0	0	0
Ditch Bank Berm	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Drift Fence	0	0	8	0	0	0	0	2	1	0	2	0	0	0
Filter Dam	1	0	0	0	0	0	0	0	0	0	2	0	0	0
Flow Splitter	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Lay Back	0	1	0	2	0	1	5	0	0	1	11	2	2	2
Log and Fabric	0	0	0	0	0	0	0	0	0	0	2	0	0	0
Low Water Crossing	0	0	0	0	0	0	2	0	0	0	0	1	1	0
Media Luna	2	0	0	0	0	1	2	0	0	1	3	3	4	0
One Rock Dam	66	78	0	17	57	9	53	0	20	38	111	41	48	4
Plug and Spread	3	2	6	2	0	0	3	0	8	2	0	0	0	0
Rock Baffle	1	0	0	0	0	2	1	0	1	0	4	1	0	0
Rock Mulch	6	6	0	7	2	0	25	0	0	2	14	1	2	0
Rock Rundown	33	30	0	7	15	8	54	0	6	36	87	6	13	0
Sod Plugs	2	1	0	0	2	0	0	0	0	0	3	1	2	0
Steel Dam	0	0	0	0	0	0	0	0	0	0	0	0	3	0

Site/ Manager	Chance Gulch		Kezar Basin	Redden Ranch at West Flat Top Mountain			Sage Hen Gulch		South Cottonwood at Flat Top Mountain		West Flat Top Mountain at Henkel Road	Wolf Creek		Yogi at West Flat Top Mountain	
Water Bar	0	0	0	0	0	0	0	0	0	7	0	0	0	0	
Worm Ditch	2	0	0	0	0	0	2	0	1	0	3	0	0	0	
Zuni Bowl	4	12	0	2	4	2	8	0	0	0	16	3	1	0	
TOTAL 2012-2016	**120**	**130**	**16**	**38**	**80**	**23**	**155**	**2**	**39**	**88**	**258**	**59**	**77**	**6**	**1091**
TOTAL 2014-2016	**120**	**130**	**13**	**38**	**25**	**23**	**155**	**2**	**39**	**88**	**173**	**15**	**17**	**6**	**844**

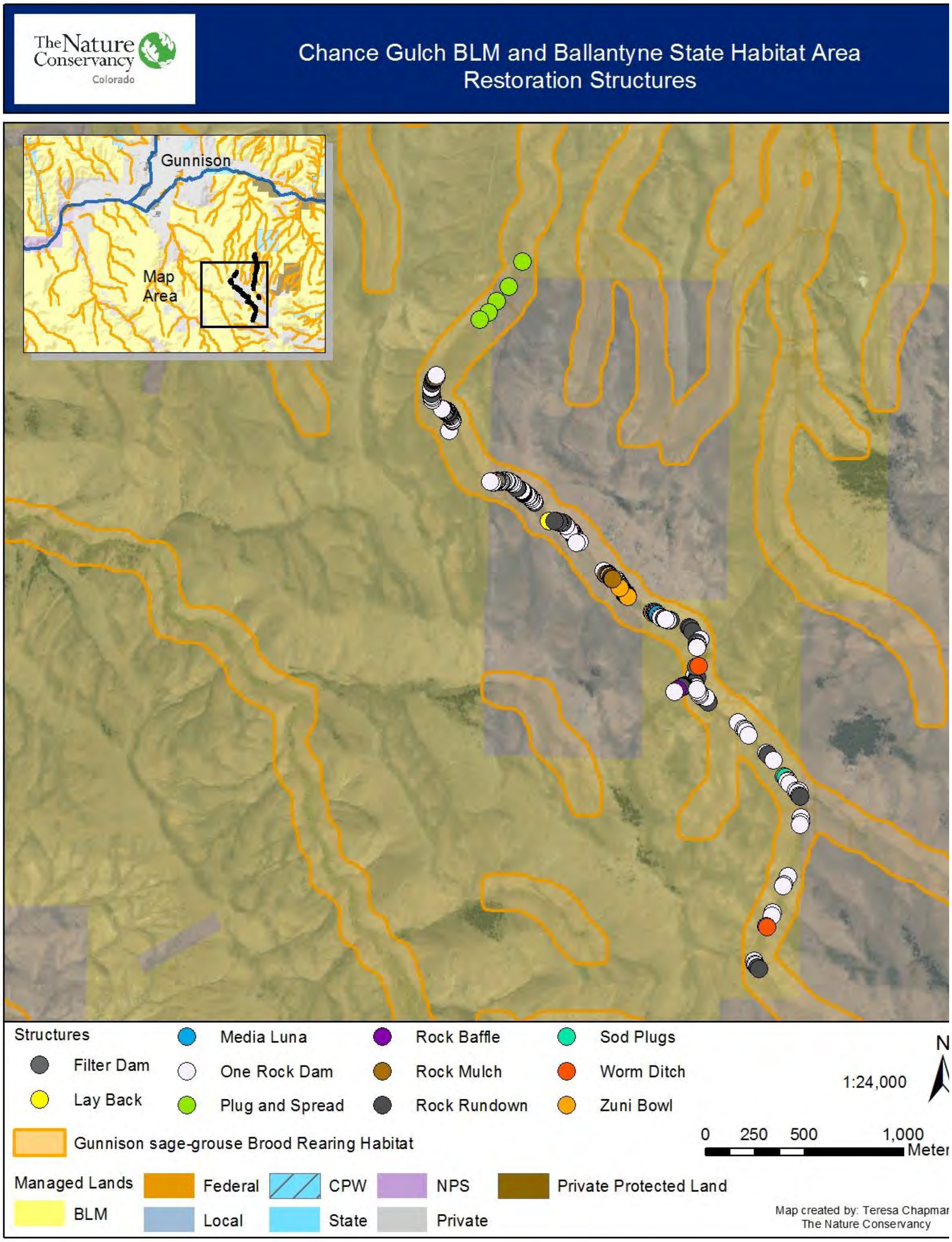
APPENDIX A

Table 2. Priority Sites with Numbers and Types of Maintained Structures.

Site	**Chance Gulch**			**Kezar Basin**	**Redden Ranch at West Flat Top Mountain**			**Sage Hen Gulch**		**South Cottonwood at Flat Top Mountain**		**West Flat Top Mountain at Henkel Road**	**Wolf Creek**		**Yogi at West Flat Top Mountain**	
Structure	BLM	Private	Private State Habitat Area	Private	BLM	Private	USFS	BLM	Private State Habitat Area	Private	USFS	USFS	BLM	Private State Habitat Area	*USFS*	
Flow Splitter														1		
Media Luna												1	2			
One Rock Dam			5			28						18	12	11		
Rock Baffle												1				
Rock Rundown			1			5						9		3		
Steel Dam														2		
Zuni Bowl						1							1			Total
Total 2012-2016	**0**	**0**	**6**	**0**	**0**	**34**	**0**	**0**	**0**	**0**	**0**	**29**	**15**	**17**	**0**	**101**
Total 2014-2016	**0**	**0**	**6**	**0**	**0**	**34**	**0**	**0**	**0**	**0**	**0**	**29**	**0**	**14**	**0**	**83**

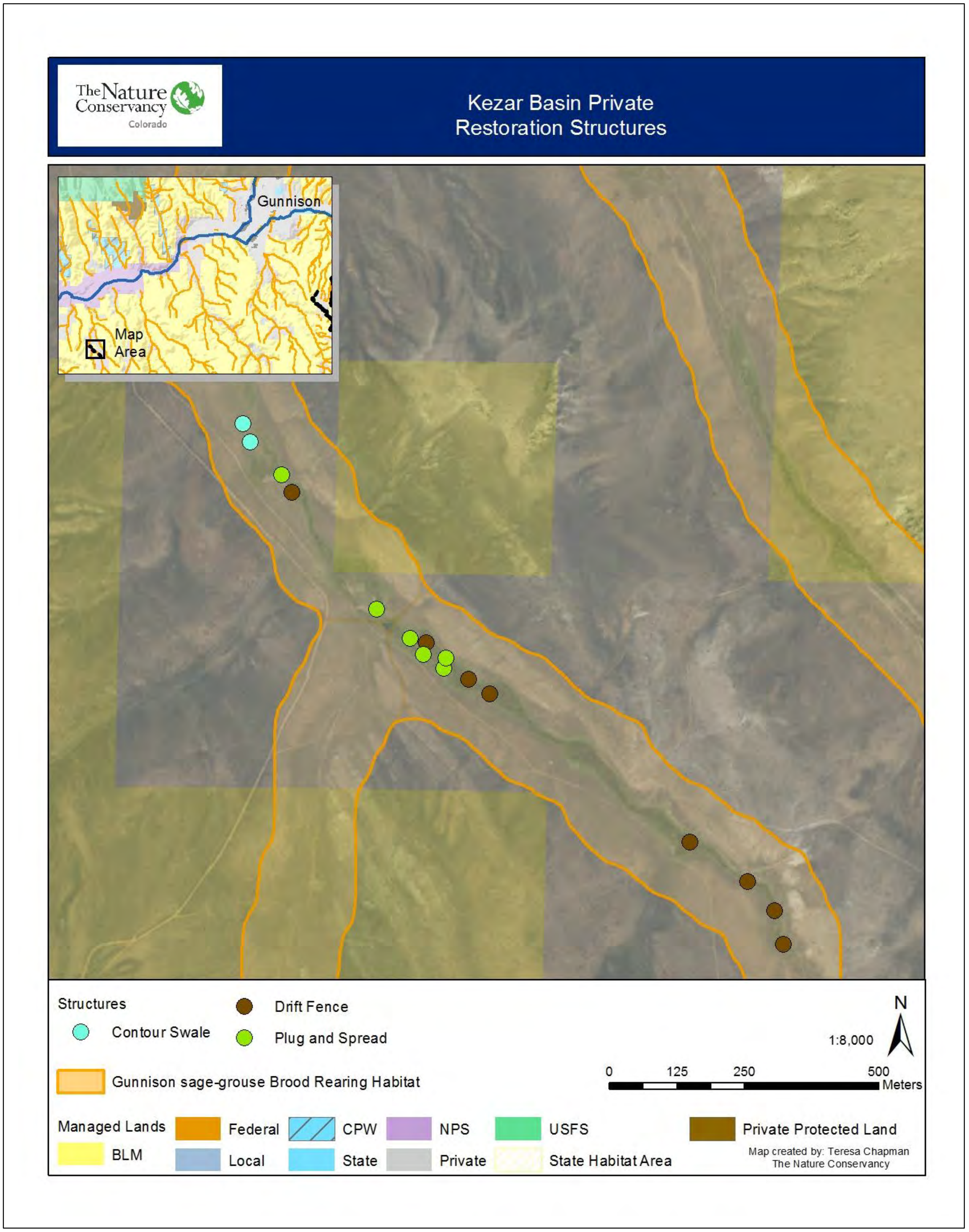
APPENDIX B: MAPS OF PRIORITY SITES WITH RESTORATION STRUCTURES

1. Chance Gulch BLM and Ballantyne State Habitat Area



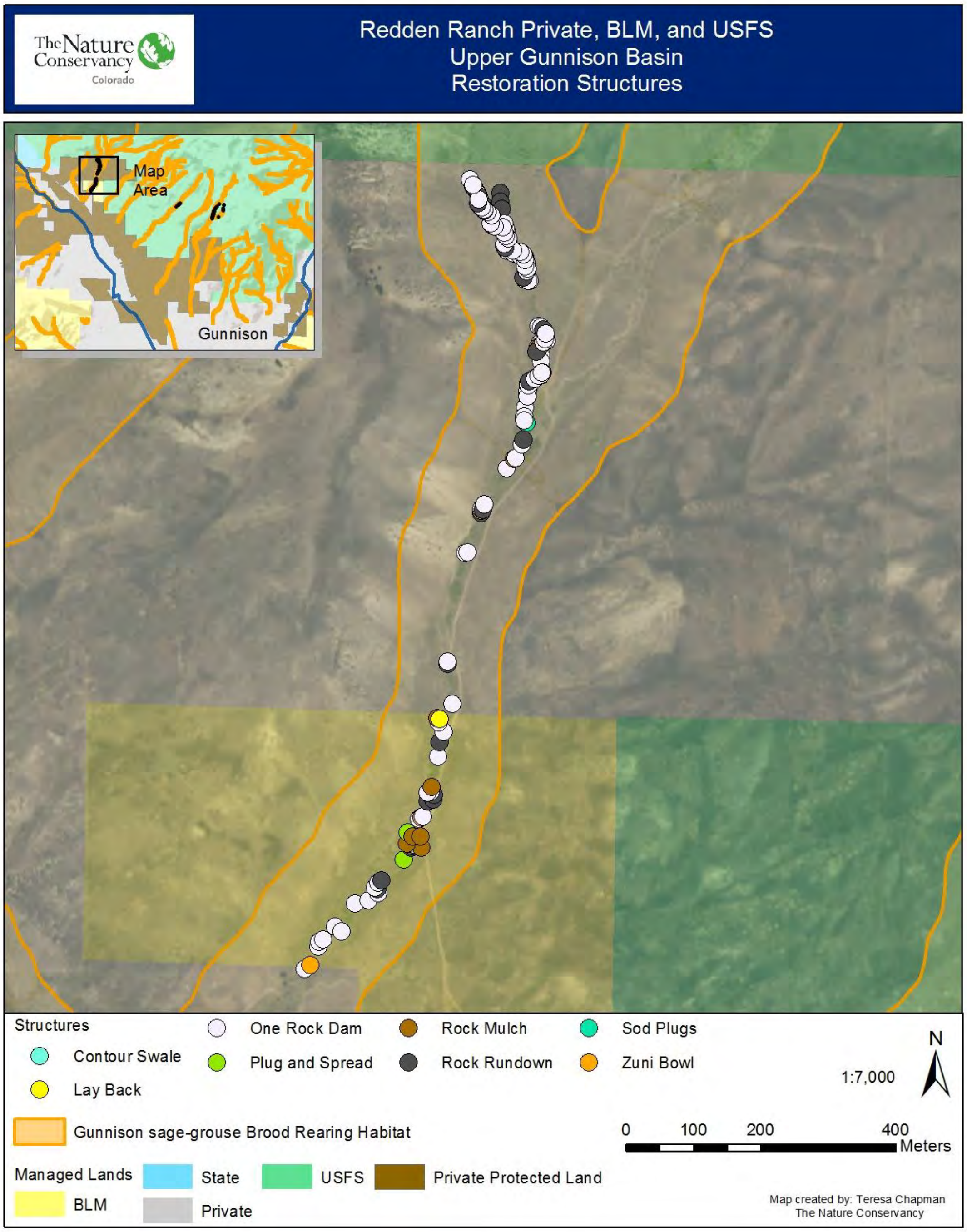
APPENDIX B

2. Kezar Basin Private



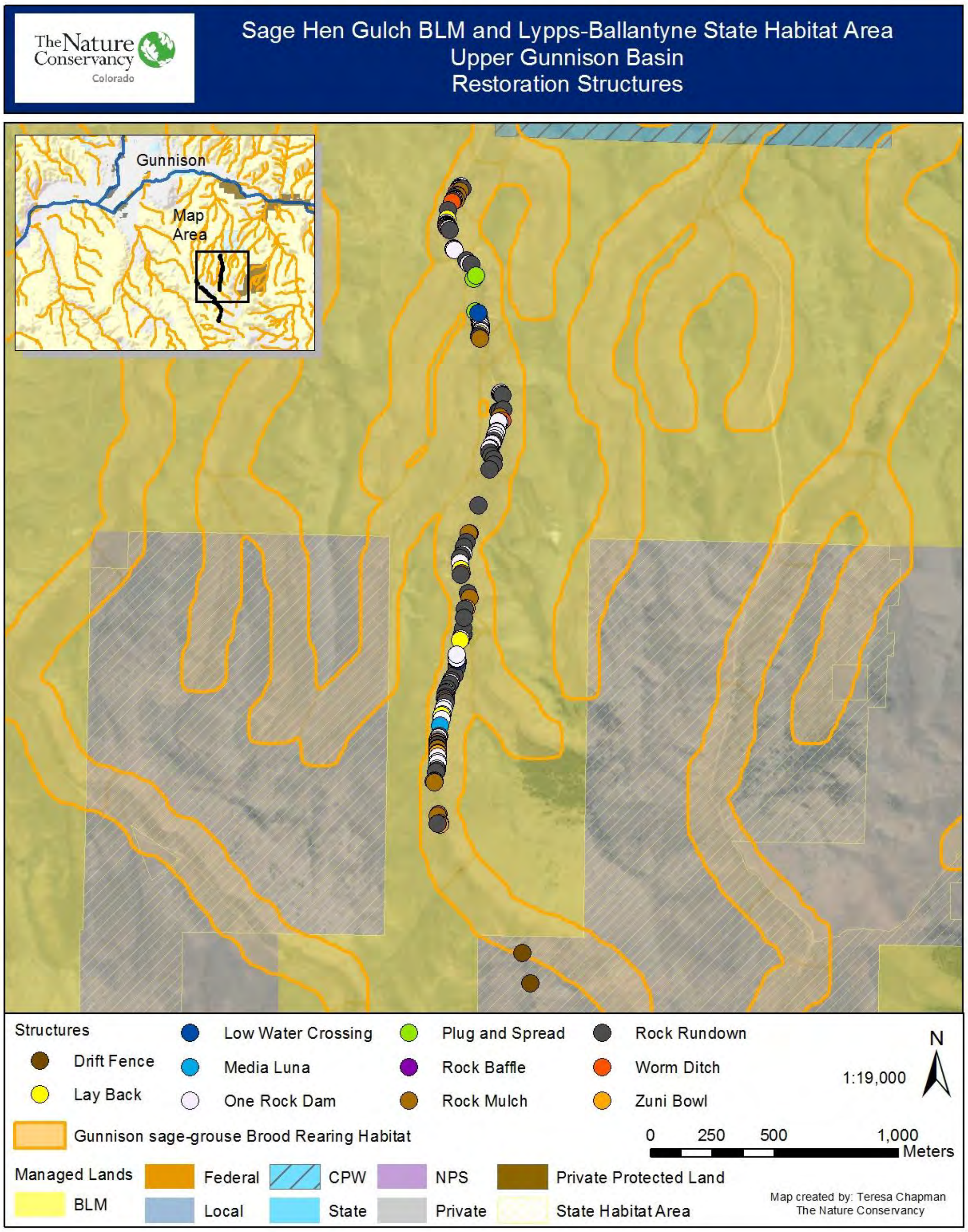
APPENDIX B

3. Redden Ranch Private, BLM and USFS



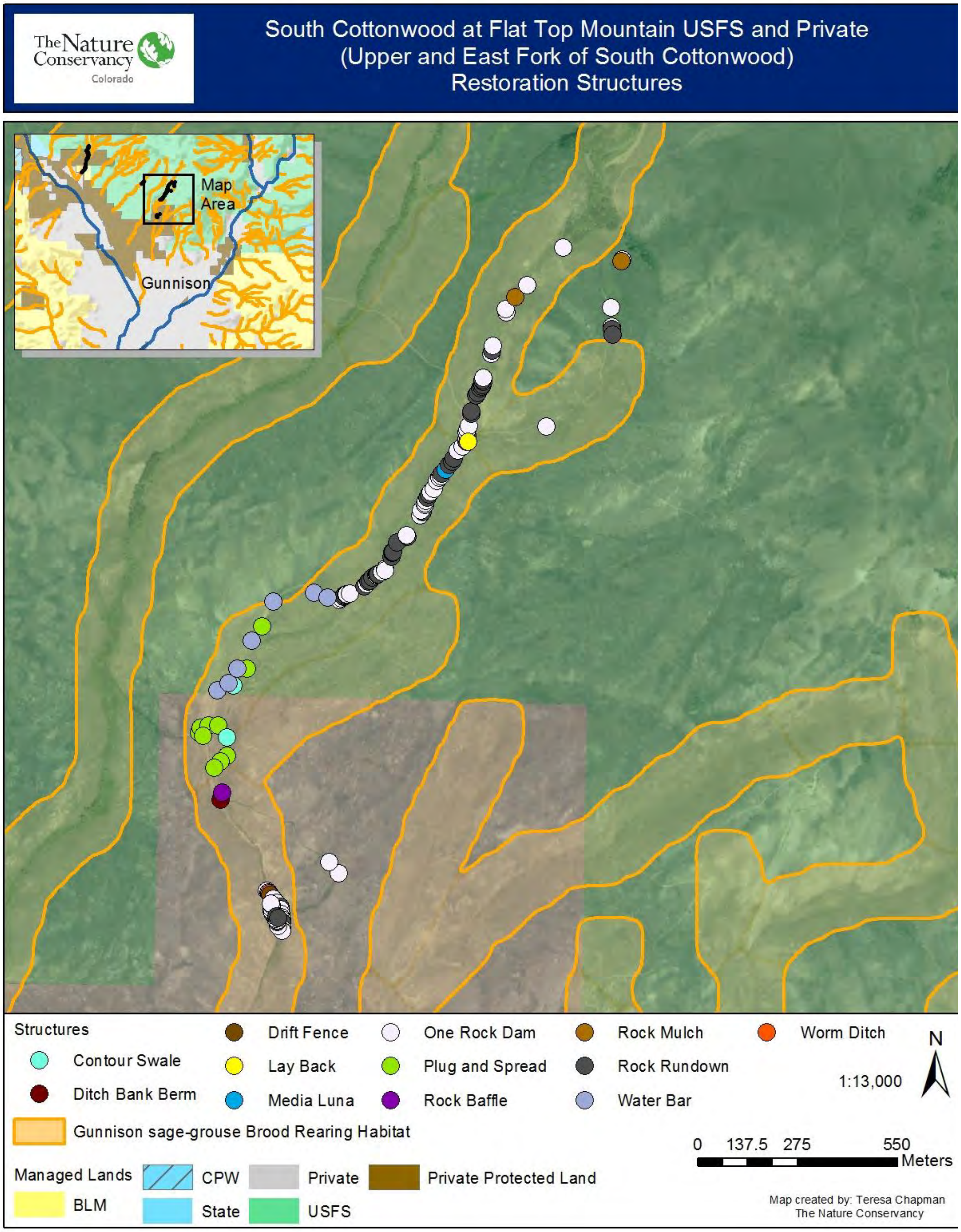
APPENDIX B

4. Sage Hen Gulch BLM and Ballantyne State Habitat Areas



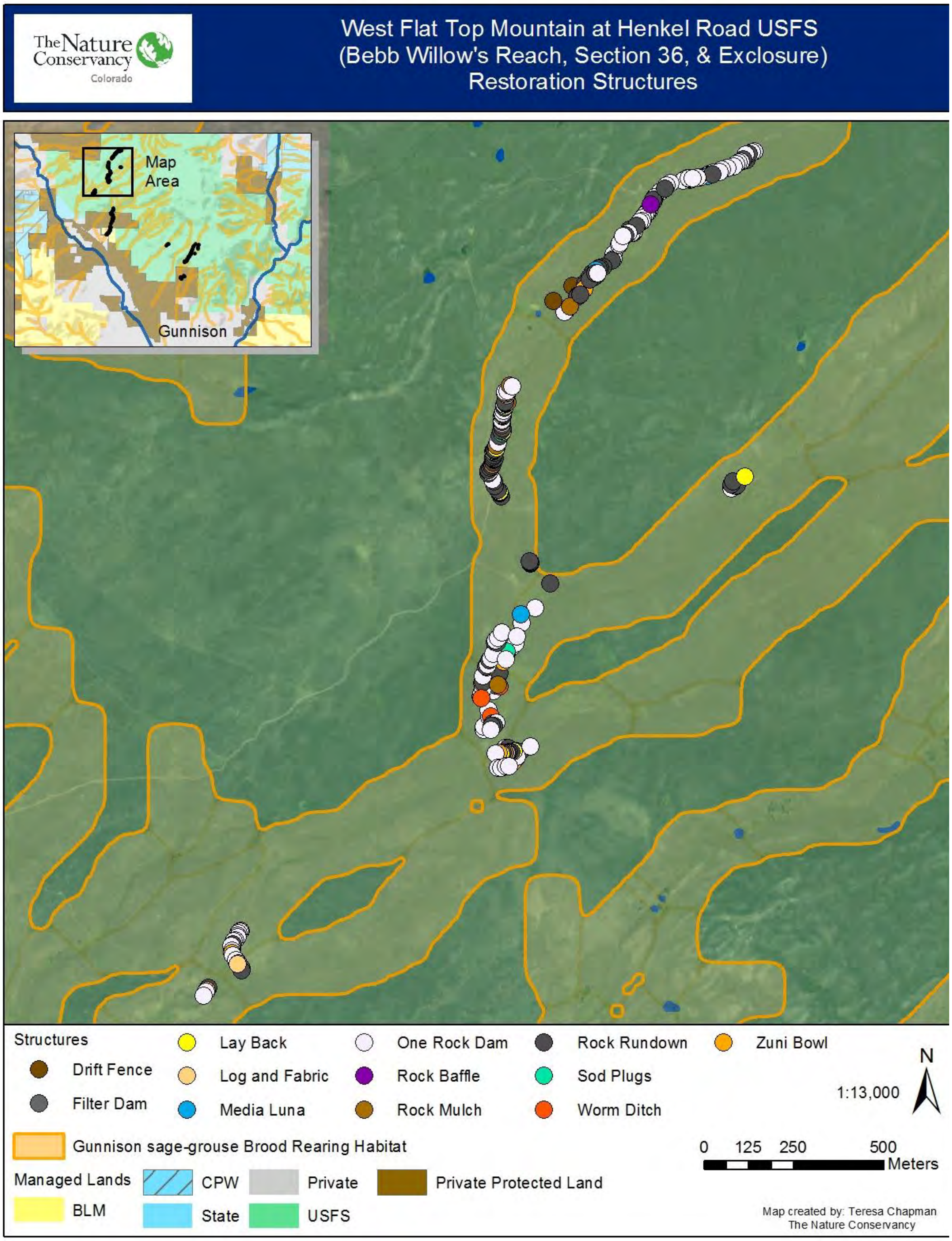
APPENDIX B

5. South Cottonwood at Flat Top Mountain USFS and Private



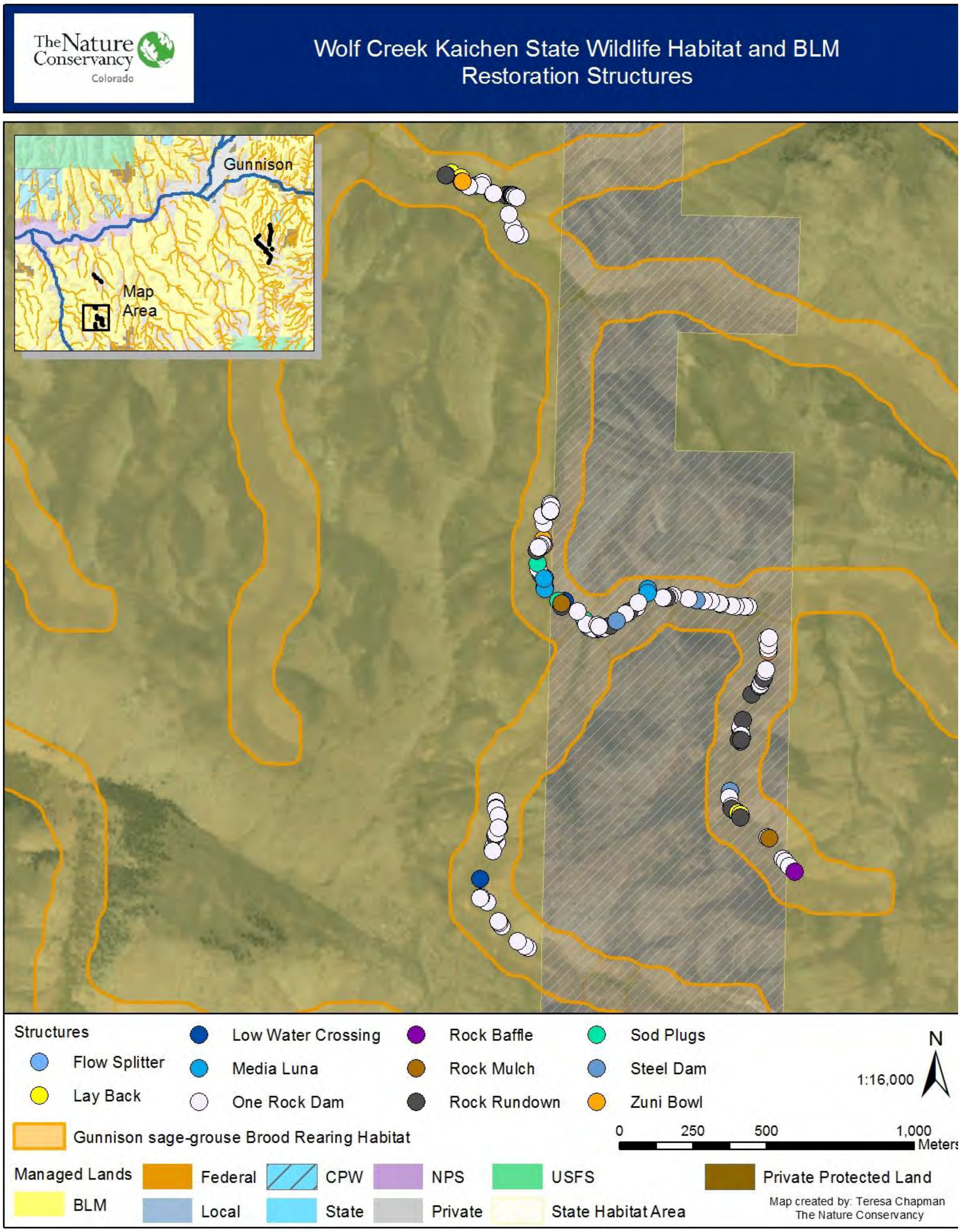
APPENDIX B

6. West Flat Top Mountain at Henkel Road USFS



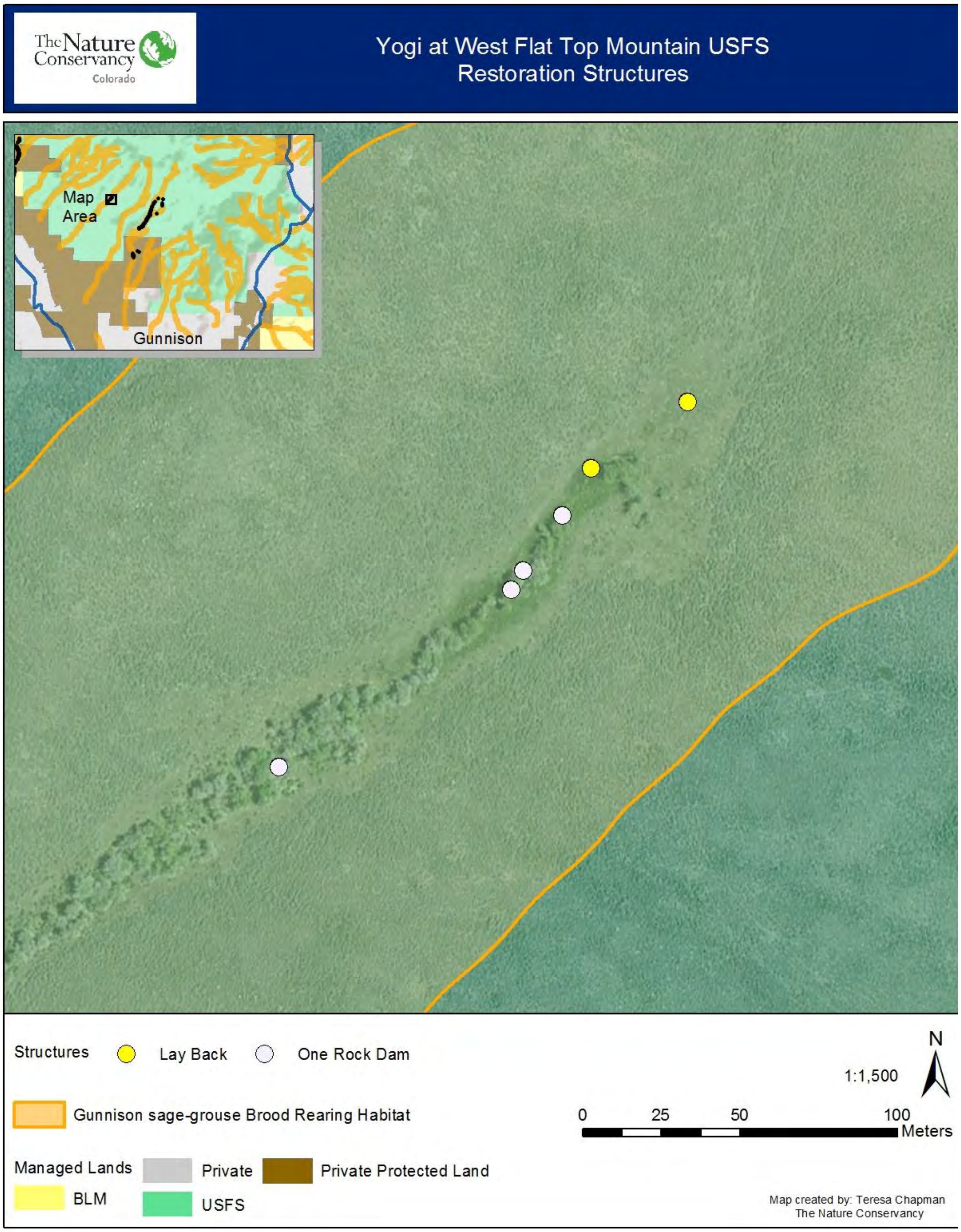
APPENDIX B

7. Wolf Creek Kaichen State Habitat Area and BLM lands



APPENDIX B

8. Yogi at West Flat Top USFS



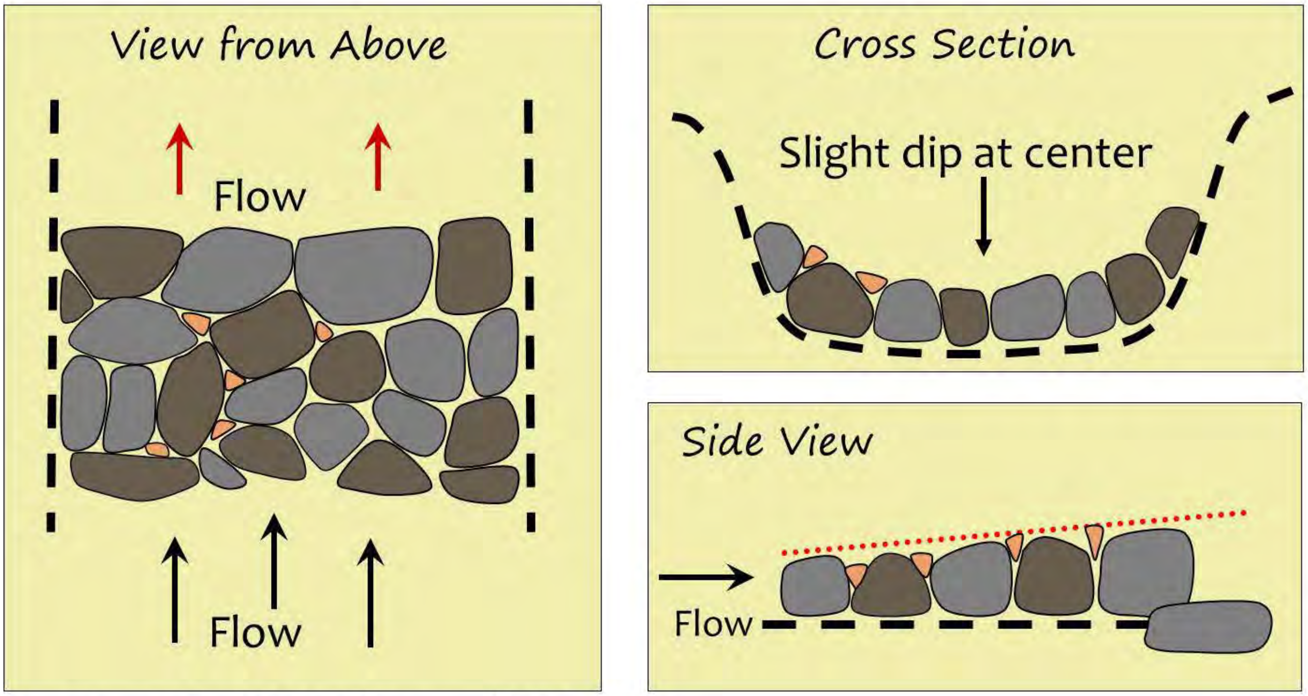
APPENDIX C

RESTORATION STRUCTURES

(from Bill Zeedyk, Zeedyk Ecological Consulting)

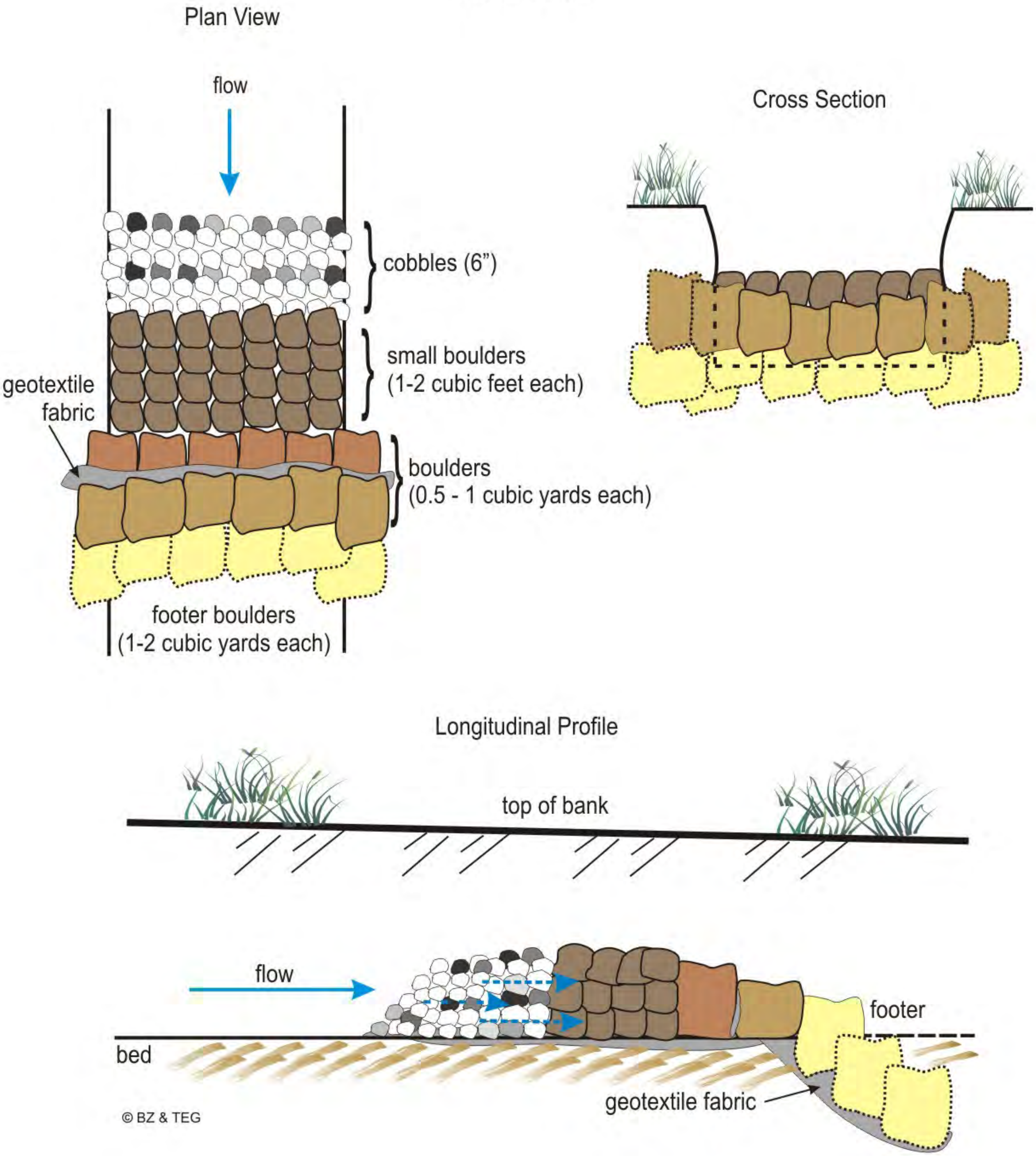
One Rock Dam

= 1 rock high + uniform surface



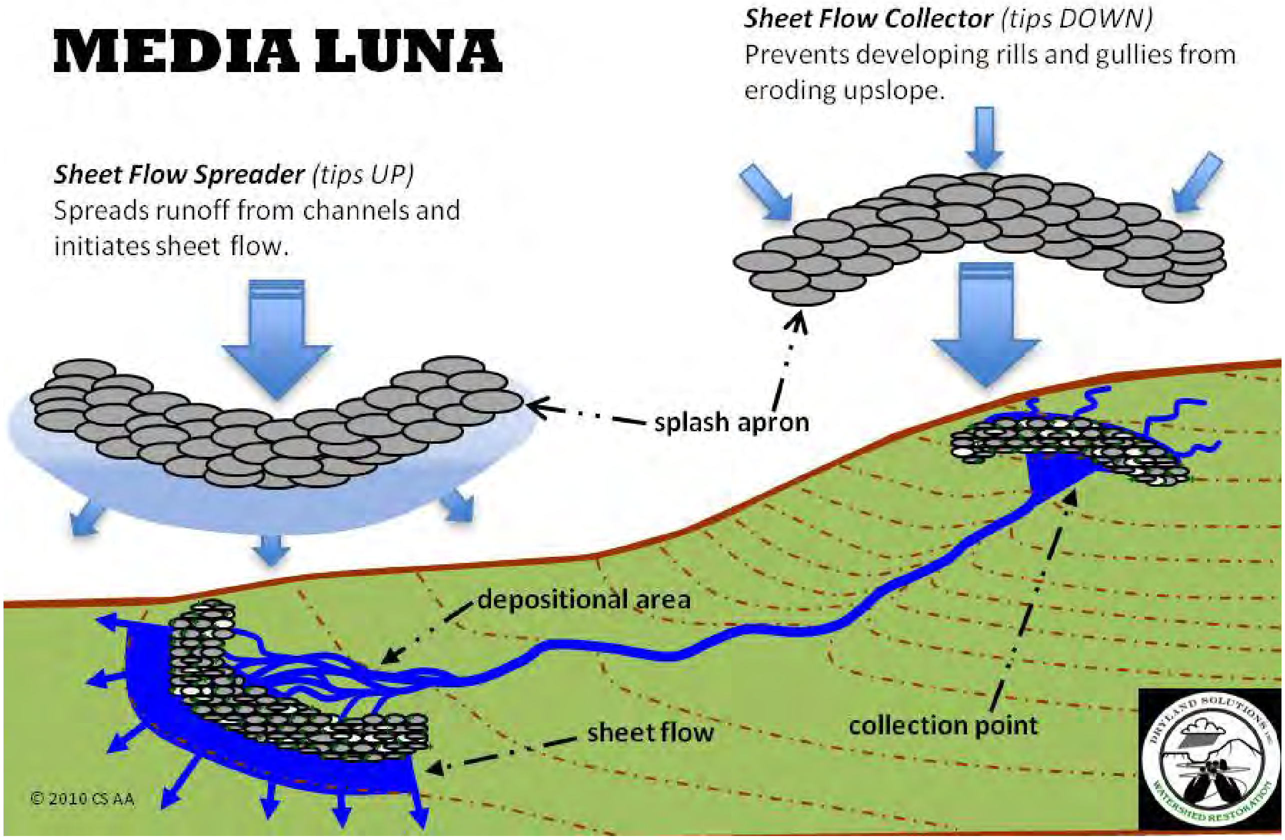
Gene Tatum and Glenda Muirhead, Albuquerque Wildlife Federation

Filter Weir

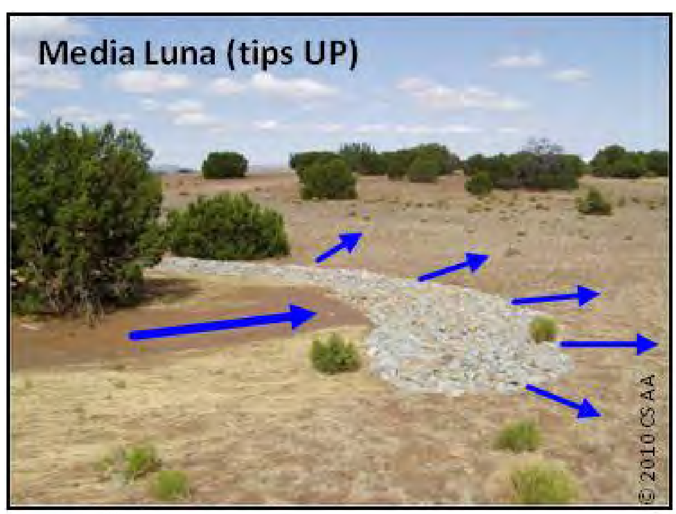


Plan View
flow
cobbles (6")
small boulders
(1-2 cubic feet each)
geotextile
fabric
boulders
(0.5 - 1 cubic yards each)
footer boulders
(1-2 cubic yards each)
Cross Section
Longitudinal Profile
top of bank
flow
footer
bed
geotextile fabric
© BZ & TEG

MEDIA LUNA

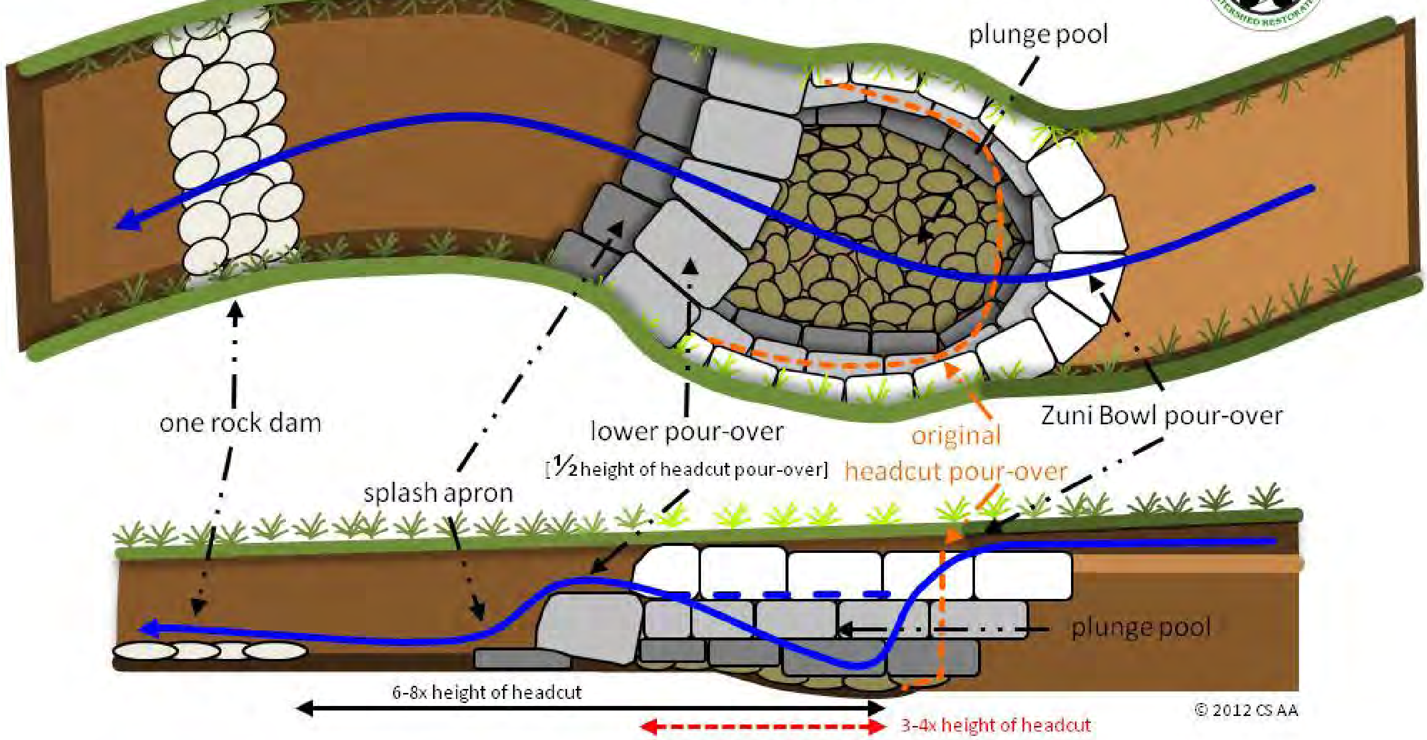


Sheet Flow Collector *(tips DOWN)*
Prevents developing rills and gullies from eroding upslope.
Sheet Flow Spreader *(tips UP)*
Spreads runoff from channels and initiates sheet flow.
splash apron
depositional area
sheet flow
collection point
© 2010 CS AA

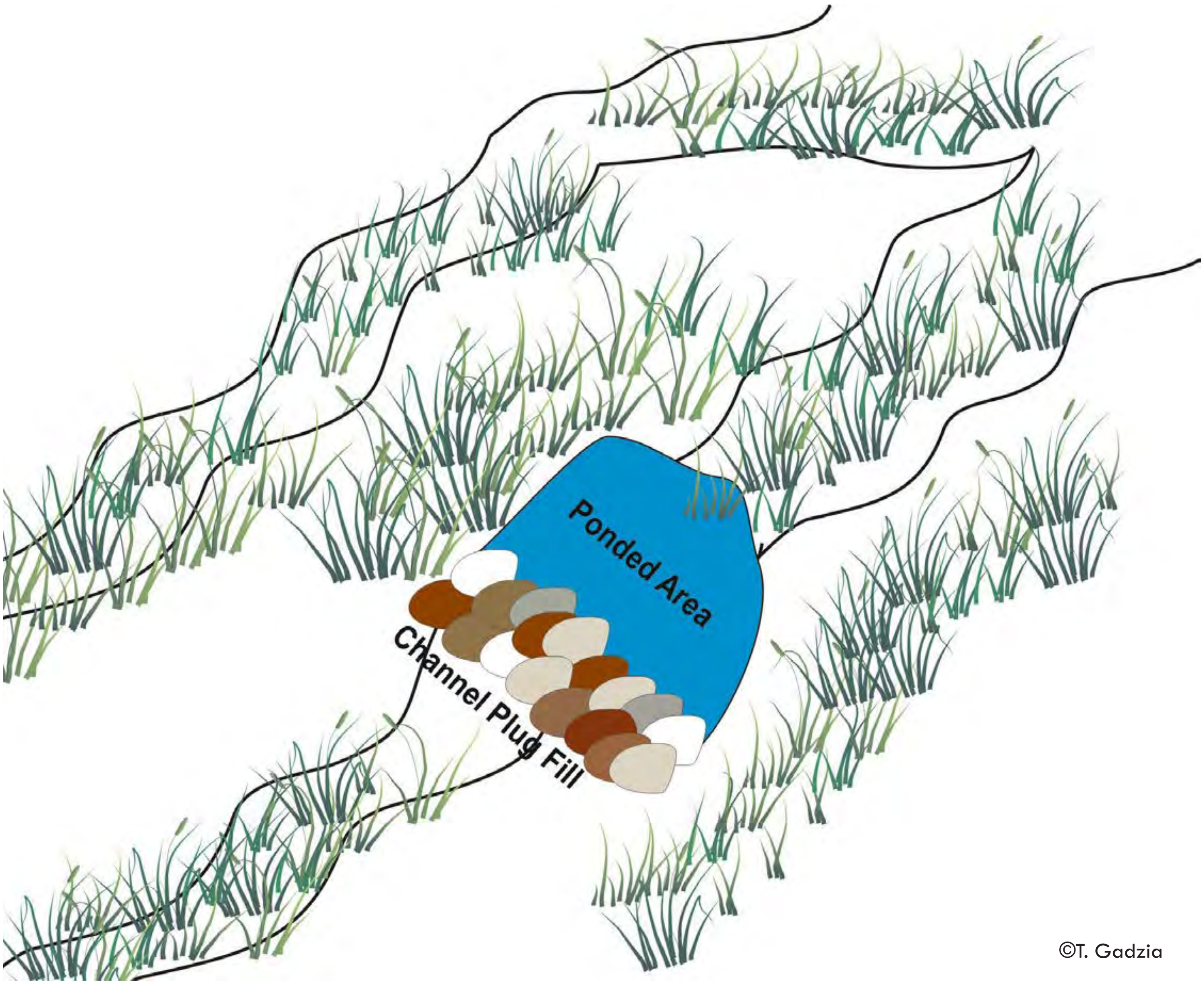


Media Luna (tips UP)
© 2010 CS AA

ZUNI BOWL


plunge pool
one rock dam
lower pour-over
[½ height of headcut pour-over]
original
headcut pour-over
Zuni Bowl pour-over
splash apron
plunge pool
6-8x height of headcut
3-4x height of headcut
© 2012 CS AA

Plug and Pond



APPENDIX D
Gunnison Basin Wetland Restoration Vegetation Monitoring
Renée Rondeau (CNHP), Gay Austin (BLM), Suzanne Parker (USFS)
October 2016

The goal of setting up the monitoring program for the riparian and wetland restoration projects was to determine if management objectives were met. The management and sampling objectives were:

> **Management objective 1**: *Increase* the average cover and density of native sedges, rushes, willows, and wetland forbs (obligate and facultative wetland species) in the **restored** portion of the treated properties by at least 20% within 5 years after treatment.
>
> **Sampling objective 1**: We want to be 90% sure of detecting a 20% change in the absolute cover and density of sedges, rushes, and wetland forbs and will accept a 10% chance that change took place when it really did not (false-change error).
>
> **Management objective 2:** *Decrease* the average cover of rabbitbrush, sagebrush, and other upland species in the **restored** portion of treated properties within 5 years after treatment.
>
> **Sampling objective 2**: We want to be 90% sure of detecting a 20% change in the absolute cover of rabbitbrush, sagebrush and other upland species and will accept a 10% chance that change took place when it really did not (false-change error).

Introduction:

In 2016, a subset of the Gunnison Climate Working Group completed the fifth year of a restoration project to enhance resilience of riparian and wet meadow habitats in the Gunnison Basin to help the Gunnison Sage-grouse (*Centrocercus minimus*) adapt to a changing climate. These areas are also important habitat for other wildlife species, e.g., neo-topical migratory birds, mule deer, and elk. Already compromised by lowered water tables and erosion, many of these areas are likely to be further impacted by drought, invasive species, and erosion from intense runoff events.

To address these impacts the team used innovative yet simple restoration methods (Zeedyk et al. 2014) e.g. rock structures, plug and spreads, and drift fences, to improve hydrologic and ecological function of wet meadows and riparian areas managed by federal, state and private entities. Restoration Ecologist Bill Zeedyk designed the treatments to raise the water table, reduce erosion, connect the channel to the floodplain and increase wetland plant cover.

This project serves as an important demonstration of simple and effective tools for restoring and increasing resilience of wet meadow and riparian habitats. The techniques provide significant results that have potential to improve hydrologic function over a much larger area.

Monitoring the effectiveness of the restoration project is an important part of the project. The following report documents the results of the vegetation monitoring as it relates to specific management objectives.

Methods:

The vegetation monitoring used a stratified random sample design for each reach. In general, approximately 1/4 of the structures were sampled for species composition, utilizing a random start within the first set of structures. If our random sampling design did not pick up at least one of each type of structure, we manually chose the structure; for example, if there are three media lunas within the drainage yet none were randomly chosen, we choose at least one media luna. A total of 203 vegetation transects were established, of which 49 were control transects and are not influenced by the structures. Table 1 summarizes the number of transects for each reach and what year they were established.

Table 1. Vegetation transects and associated attributes by site.

Site Name	Year established	No. of years, post construction	No. of transects associated with structures	No. of controls	Total	No. of photopoints
Wolf Creek, East Fork	2012	4	9	4	13	33
Wolf Creek, Middle Fork	2012	4	7	3	10	30
Redden	2012	4	15	5	20	60
Flattop, exclosure	2013	3	9	6	15	27
Flattop, Section 36	2013	3	13	6	19	45
Wolf Creek, Upper and Lo	2013	3	11	4	15	39
Flattop, above exclosure	2014	2	19	6	25	66
USFS, above Redden	2014	2	6	3	9	18
Chance	2014	2	21	3	24	72
Kezar	2014	2	9	3	12	30
Cottonwood	2015	1	15	3	18	54
Sage Hen	2016	0	20	3	23	69
Total			**154**	**49**	**203**	**543**

Vegetation transects were generally placed above the restoration structure except in the case of the media lunas and plug and ponds. Transects crossed the stream channel and ran from bank to bank, thus transect length was variable. Using the line-point-intercept method, a methodology accepted by BLM (AIM 2011) and the Forest Service, we collected cover data every 0.5 m along a transect, including bare ground, rock, or litter if the point was not occupied by a plant. Height of vegetation was collected at every meter by measuring the droop height of the tallest plant within a 10 cm^2 frame. Photos were taken from the 0 m mark and end of transect, with the transect line in the middle of the photo. UTM's and bearing of transect were noted for the beginning of each transect. Photo time was also noted. Additional photos (labeled as photo points) were taken, generally looking upstream (i.e. downstream of the transect) with the transect in the photo. This was meant to capture a view of the area that is most likely to change. UTM's (NAD83), time, date, camera height, compass bearings were recorded for each photo.

Subsequent year's data collection occurred within weeks of the original sample period and repeat photos were generally within two hours of the original photo time.

We identified plants to the species level, except for rare instances. In order to analyze the data, we classified each species into the following groups, using the NRCS list. For the purpose of our study a species was considered a wetland species if it was an obligate or facultative wetland species.

Obligate wetland (OBL). Almost always occurs in wetlands (estimated probability > 99%) under natural conditions

Facultative wetland (FACW). Usually occurs in wetlands (estimated probability 67% – 99%), but occasionally found in non-wetlands.

Facultative (FAC). Equally likely to occur in wetlands (estimated probability 34% – 66%) or non-wetlands.

Facultative upland (FACU). Usually occur in non-wetlands (estimated probability 67% – 99%), but occasionally found in wetlands (estimated probability 1% – 33%).

Obligate upland (UPL). Occur almost always (estimated probability > 99% in non-wetlands under natural conditions.

Data Analysis

Data analysis was conducted on sites with at least two years of data. In order to assess meeting the management objectives, we pooled all wetland species and graphed differences in cover between years. Data was analyzed by stream reach and is presented rate of response: fast, slow, no response yet.

Results

The increase in wetland species cover varied by reach and the number of years post treatment and ranged from 0-245%. We have categorized the response rate into three categories: fast, slow and no response yet (Table 2).

Fast Response: Those reaches that responded quickly include reaches with and without perennial water and narrow to wide flood plains (Table 2). Wolf Creek-East Fork media lunas and Redden had very significant increases in wetland species cover, 220% and 245% respectively. These two reaches are very different from each other with Wolf Creek media lunas in a large floodplain with low gradient and a perennial flow from a spring. Redden is a steep gradient stream with a narrow to medium wide floodplain that relies on snow melt and storm events. Wolf Creek- Middle Fork is more similar to Redden than Wolf Creek East Fork, while Wolf Creek, Upper and Lower as well as Kezar Basin are more similar to Wolf Creek East Fork at the media lunas.

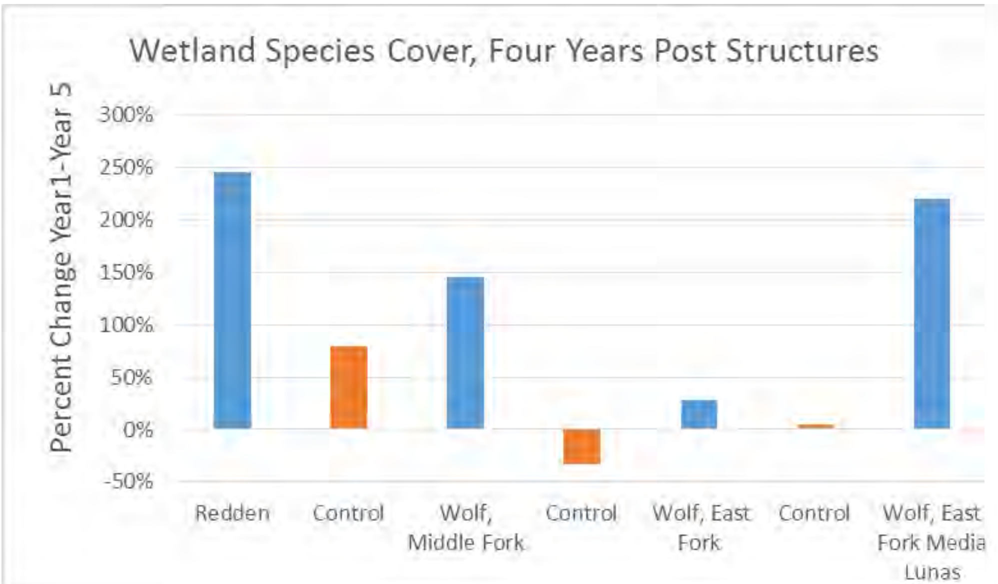
Slow Response: Two reaches had a relatively slow response rate, one at Wolf Creek, East Fork (above media lunas) and Flat Top, Henkel Road (Table 2). Once again, these two reaches are very different from one another. Wolf Creek, East Fork has a range of water availability, from snow melt to perennial water while Flat Top, Henkel Road is snow melt and more similar to Redden than Wolf Creek. Flat top continues to have moderate to heavy cattle grazing and the grazing may be slowing the response rate down but that is not the case at Wolf Creek.

No Response Yet: Out of the five reaches mentioned (Table 2), two of them (Flat Top above exclosure, and Chance) require more monitoring before we can make a definitive call and we expect these reaches will move into either the slow or fast response rate category. The other three reaches, Flat Top-Exclosure, Wolf Creek-West Fork, and Above Redden are worth further explanation. The Flat Top Exclosure reach had a deep (approx. 3 foot) headcut that was migrating upstream. The primary management goal for this reach was to stop the head cut from migration upstream. Thus our general management objective of increasing wetland species cover may never be met, or will slowly be met, but our primary goal for that reach was met (see Appendix for more details). Wolf Creek-West Fork appears to have numerous issues that may keep the reach from responding. There are two ponds on the immediate drainage and additional ponds on side drainages that prevent much of the natural water from reaching the stream, in addition to capturing the sediments that are so critical to building up the stream bottom. While fixing the low water crossing may help this reach respond positively, it is unlikely that the response rate will ever be high due to water holding ponds.

We can also compare the percent change in wetland species cover across all sites by number of years post treatment. It does appear that the structures continue to increase wetland species cover the longer they are in place, and that at least three years post construction is generally when we start to see a response (Fig. 1). With that said, Redden, East Fork media lunas and Kezar Basin all had a response one to two years post construction (Table 3).

Table 2. Wetland species cover response rates grouped into fast, slow and no response categories.

Site/Stream Reach	Wetland Species Cover Increase	Number of Years Post Treatment	General Characteristics/Comments
Fast Response			
Wolf Creek-East Fork Media Lunas	220%	4	Perennial water from spring; wide flood plain with approximately 25% of floodplain occupied by wetlands prior to treatment
Redden	245%	4	Ephemeral; snow melt and storm events are primary water source; medium wide floodplain; sediment source upstream
Wolf Creek-Middle Fork	37%	4	Ephemeral; snow melt and storm events are primary water source; narrow floodplain
Wolf Creek-Upper and Lower	37%	3	Perennial water from spring; wide floodplain with approximately 25% of floodplain occupied by wetlands prior to treatment
Kezar Basin	27%	2	Perennial water from springs; wide floodplain with approximately 25% of floodplain occupied by wetlands prior to treatment
Slow Response			
Wolf Creek-East Fork above Media Lunas	28%	4	Mixed water source with some perennial, snow melt and storm events; narrow to medium flood plain width
Flat Top-Henkel Road	24%	3	Ephemeral snow melt and storm events are primary water source; narrow to moderately wide floodplain
No Response Yet			
Flat Top-Exclosure	6%	3	Ephemeral; snow melt and snow events; preventing the migration of a large headcut was the primary goal
Flat Top-Above Exclosure	0%	2	Repeat photos show that sediment is building and we expect to see a positive response next year
Above Redden	0%	2	Purpose was to provide additional ground water to meadow below (not to increase wetland plant cover)
Wolf Creek-West Fork	5%	3	Multiple upstream ponds capture snow melt, water from storm events and sediment; low water crossing has been problematic
Chance Gulch	0%	2	More time is needed to determine trends



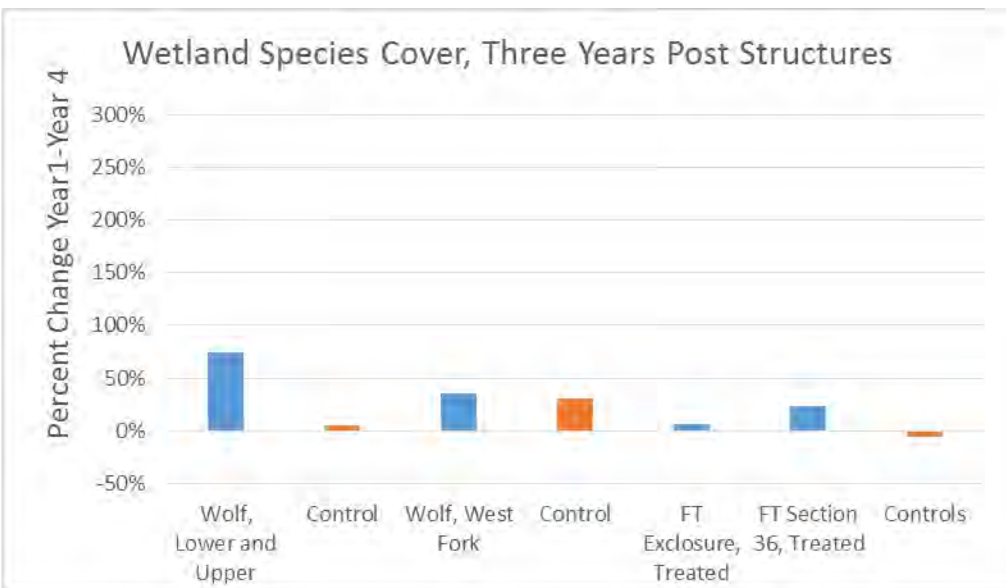


Figure 1. Percent change in wetland species cover for reaches with four years (top) and three years (bottom) after structures were built. Blue bars represent treated areas and orange bars represent controls.

Table 3. Average wetland species cover by year and total percent change in wetland species cover for all reaches for two or more years of post-construction.

Reach	Year 1	Year 2	Year 3	Year 4	Year 5	Diff 1st yr vs last year (%)	Water Source
Four Years Post-Structures							
Redden	11%	26%	43%	48%	37%	**245%**	*Snow Melt*
Control	12%	15%	18%	17%	21%	**80%**	*Snow Melt*
Wolf, Middle Fork	15%	28%	26%	33%	37%	**146%**	*Snow Melt*
Control		7%	15%	5%	6%	**-33%**	*Snow Melt*
Wolf, East Fork	57%	82%	82%	90%	73%	**28%**	*Spring-fed*
Control			67%	70%	70%	**5%**	*Snow Melt*
Wolf, East Fork Media L	25%	45%	75%	75%	80%	**220%**	*Spring-fed*
Three Years Post-Structures							
Wolf, Lower and Upper	56%	65%	95%	98%		**74%**	*Spring-fed*
Control		67%	70%	70%		**5%**	*Spring-fed*
Wolf, West Fork	67%	89%	81%	90%		**35%**	*Pond-fed*
Control	68%	84%	88%	89%		**30%**	*Snow Melt*
FT Exclosure, Treated	49%	44%	47%	52%		**6%**	*Snow Melt*
FT Section 36, Treated	55%	55%	71%	68%		**24%**	*Snow Melt*
Controls		49%	48%	46%		**-6%**	*Snow Melt*
Two Years Post-Structures							
FT Above Exclosure, Tre	55%	64%	55%			**0%**	*Snow Melt*
Controls		49%	48%			**0%**	*Snow Melt*
Kezar	46%	50%	58%			27%	*Spring-fed*
Control	125%	120%	106%			-15%	*Spring-fed*
Chance	72%	94%	84%			17%	*Spring, Pond, S*
Control	67%	72%	79%			17%	*Spring, Pond, S*
Above Redden	22%	22%	22%			0	*Snow Melt*
Control	7%	12%	10%			46%	*Snow Melt*

See Appendix A for a power point presentation that provides photos, graphs, and more tables.

Discussion and Conclusions

The simple and repeatable line-point intercept method is adequate for addressing our management objectives. Management objectives are being met at most sites that have had at least 3 years post treatment. For those sites that management objectives were not met, it is either too early to detect a change or our structures were never intended to improve wetland species cover, but rather stop head cuts or alter the area downstream. The one exception to this is Wolf Creek West Fork where multiple upstream ponds hold water and a partially functioning low water crossing inhibits flow and is likely constraining the recovery time. Note that this low water crossing is to be adjusted in the fall of 2016.

We have highlighted the widely varying response rates in wetland species cover and noted that there is no one pattern that explains this. Further investigation as to why we see such a variation in response rate would help us scale this project up into new areas. It may be possible to provide some guidelines for more detailed management objectives, including metrics such as bare ground, erosion control, or number of wetland acres. Potentially each stream reach could have its own management objectives, just as each structure type could have its own objectives. With more fine scaled analysis and additional monitoring it may be possible to compare the efficiencies in plug and spreads versus rock structures in meeting one's goals.

We suggest that at least 5 years of vegetation monitoring is necessary to observe a real trend and that if a site has additional structures built on top or near the original structures, an additional 3 years of monitoring would be ideal. While all additional sites that we work in do not require monitoring to the level we currently have, we recommend additional monitoring on plug and spreads and contour swales. This would allow us to have good representation across different stream reaches and help us assess the effectiveness and efficiency of plug and spreads and contour swales. In addition, Sapinero Mesa (will be built in 2017) appears to be an excellent one to monitor due to the different design (with numerous plug and spreads) as well as a different geomorphology. On sites where extensive monitoring does not need to take place, we recommend utilizing photo points as a monitoring tool on those sites, recognizing that analyses of photo points can be challenging, but they are still a valuable tool for assessing change. Note that even with photo points, we recommend having controls so that one can compare treated and not treated sites within a reach.

Any good adaptive management project requires that one develops management objectives, and that you monitor to ascertain if the objectives are being met. As one learns from the project, it is necessary to review and adjust your objectives. We are at the point that it is time for us to revisit our objectives and potentially add additional objectives or develop objectives for each reach. An important attribute of a well-designed restoration project is to make sure that one does not treat the entire area, thus providing us with a control area that can be used to convince ourselves and others that any trends we see are due to our treatments and not due to changes in the annual weather.

The wet meadow restoration work in the Gunnison Basin has been very successful and through this monitoring coupled with the design crew and additional analysis, we have the ability to provide important lessons learned to other basins that are interesting in applying these restoration methods.

We thank numerous persons for assisting us with field work including, Wendy Brown, Betsy Neely, James Cooper, Liz With, Tom Grant, Cynthia Billings, and BLM summer technicians. Funding for the monitoring was provided by BLM, CPW and Terra Foundation.

See Appendix E for PowerPoint presentation with repeat photos, additional tables, and graphs that help visualize our results and future directions.

APPENDIX E

Vegetation Monitoring Results: 2012-2016

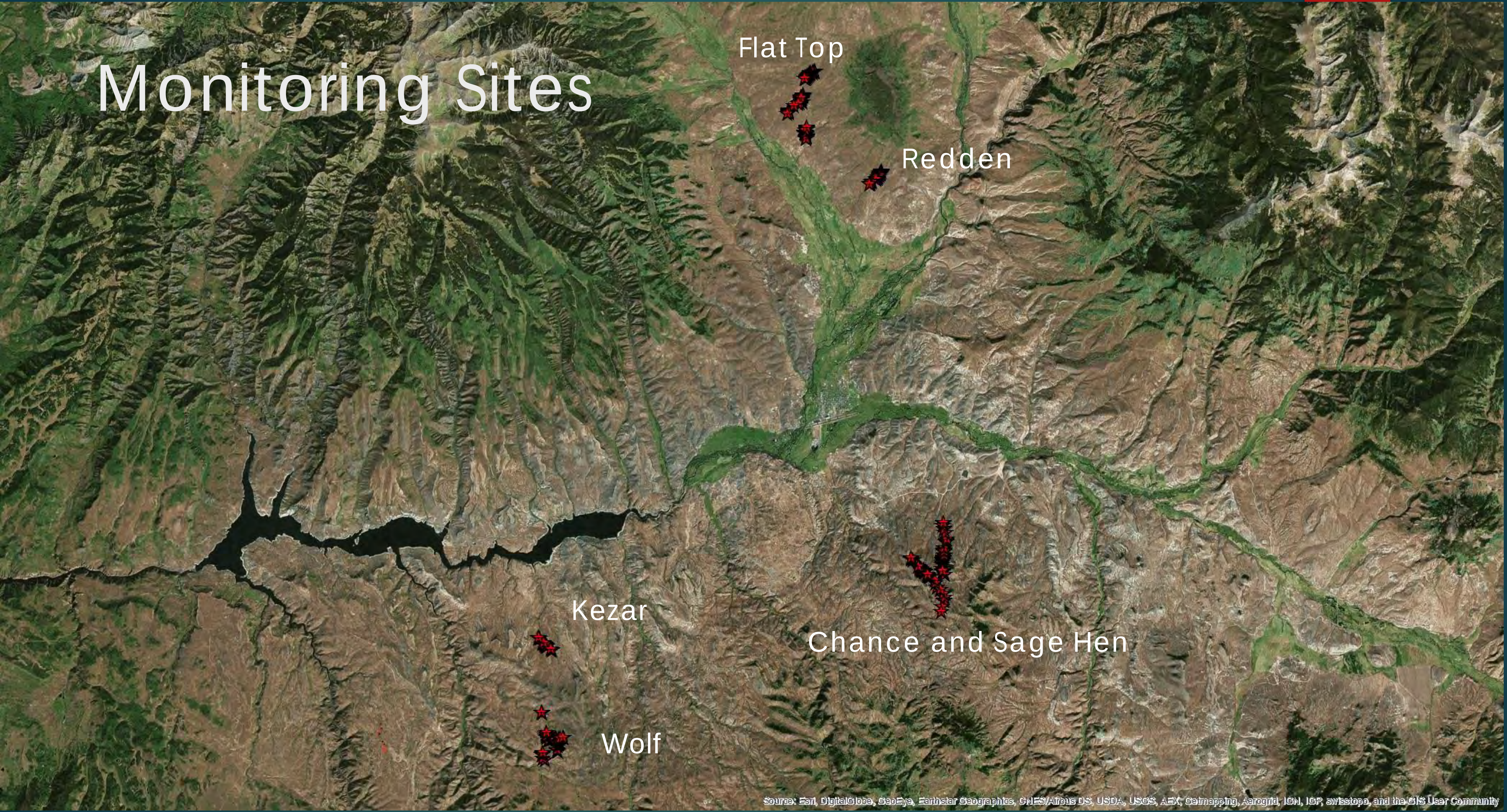
RENEE RONDEAU (PRESENTER)
GAY AUSTIN, SUZIE PARKER

OCT. 2017

Management Objectives

Increase the cover of native wetland species (obligate and facultative) in the **restored** portion of the treated properties between 2012 and 2017

Monitoring Sites



Methods

- Random sample of structures, stratified by reach
- Approximately ¼ of the structures were sampled within a reach
- Manually chose a structure if that structure type (media luna, zuni bowls, worm ditch, one rock dam, etc) was not randomly selected within a reach
- Selected 3 controls (no structures) within each reach, often upstream of structures' influence

Methods Continued

- Baseline measurement occurred prior to building structures
- Established a permanent bank-to-bank transect near structure
- Using the line-point-intercept method, collected cover data every 0.5 m along a transect
  - Identified species for each point, or if no plant then bare ground, litter or rock
  - Height of vegetation was collected at every meter
- Photos of transect taken from ends and a side view
- A species list was compiled for each site

Data Analysis

- Classified each species into one of the following groups:
  - Obligate — almost always occurs in wetlands
  - Facultative wetland — usually occurs in wetland, but occasionally found in non-wetlands
  - Facultative upland — Usually occur in non-wetlands, but occasionally found in wetlands
  - Obligate upland —– Occur almost always in non-wetlands

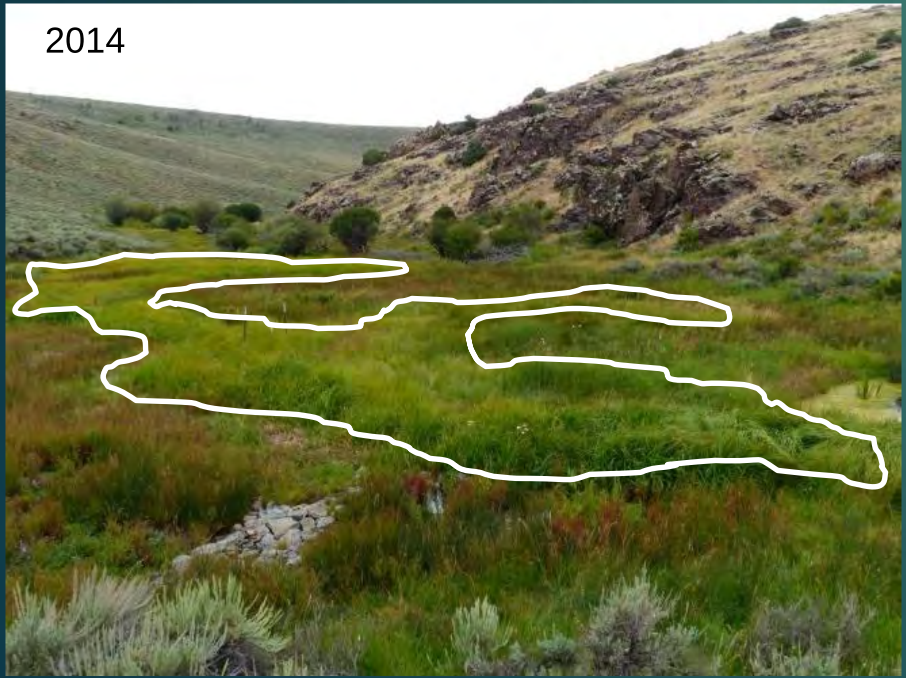
Results

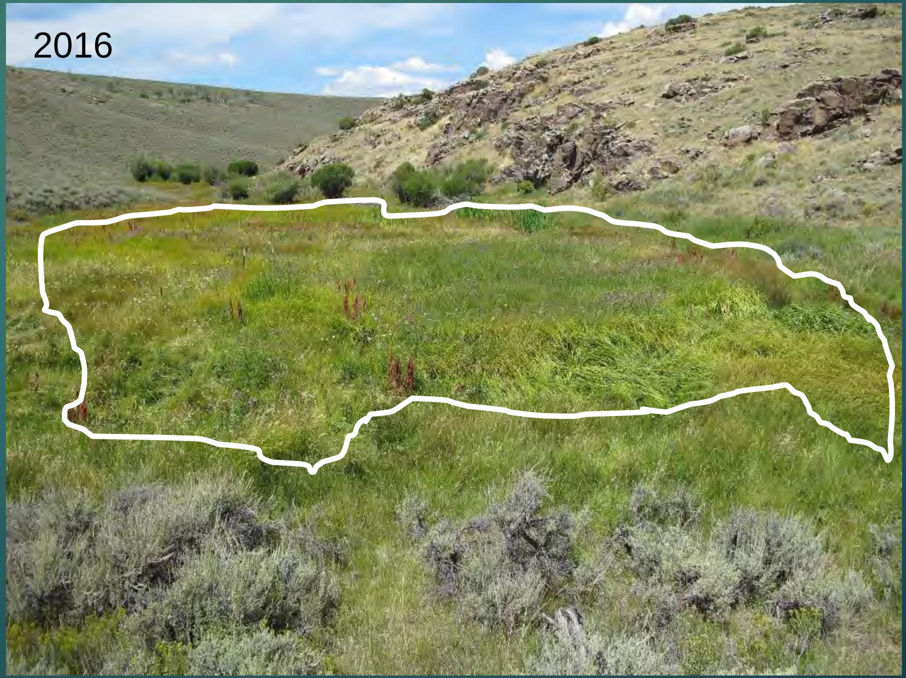
Results by Rate of Response on Wetland Species Cover (compared to controls)

Fast Response Rate	Slow Response Rate	No Response Yet
Wolf, East Fork, Media Lunas	Wolf, East Fork (above media lunas)	Flat Top Exclosure
Redden	Flat Top, Section 36	Flat Top Above Exclosure
Wolf, Middle Fork		Above Redden
Wolf, Upper and Lower		Wolf West Fork
Kezar		Chance

Fast to Respond

Fast Response Rate	Wetland Species Cover Increase	No. of Years Post Structure	General Characteristics
Wolf, East Fork, Media Lunas	220%	4	Perennial water source from spring; wide flood plain with wetland acres approx. 25% of floodplain extent when we put structures in.
Redden	245%	4	Ephemeral, snow melt and storm events.
Wolf, Middle Fork	37%	4	Ephemeral, snow melt and storm events.
Wolf, Upper and Lower	74%	3	Perennial water source from spring; wide flood plain with wetland acres approx. 25% of floodplain extent when we put structures in.
Kezar	27%	2	Perennial water source from spring; wide flood plain with wetland acres approx. xx% of floodplain extent when we put structures in.

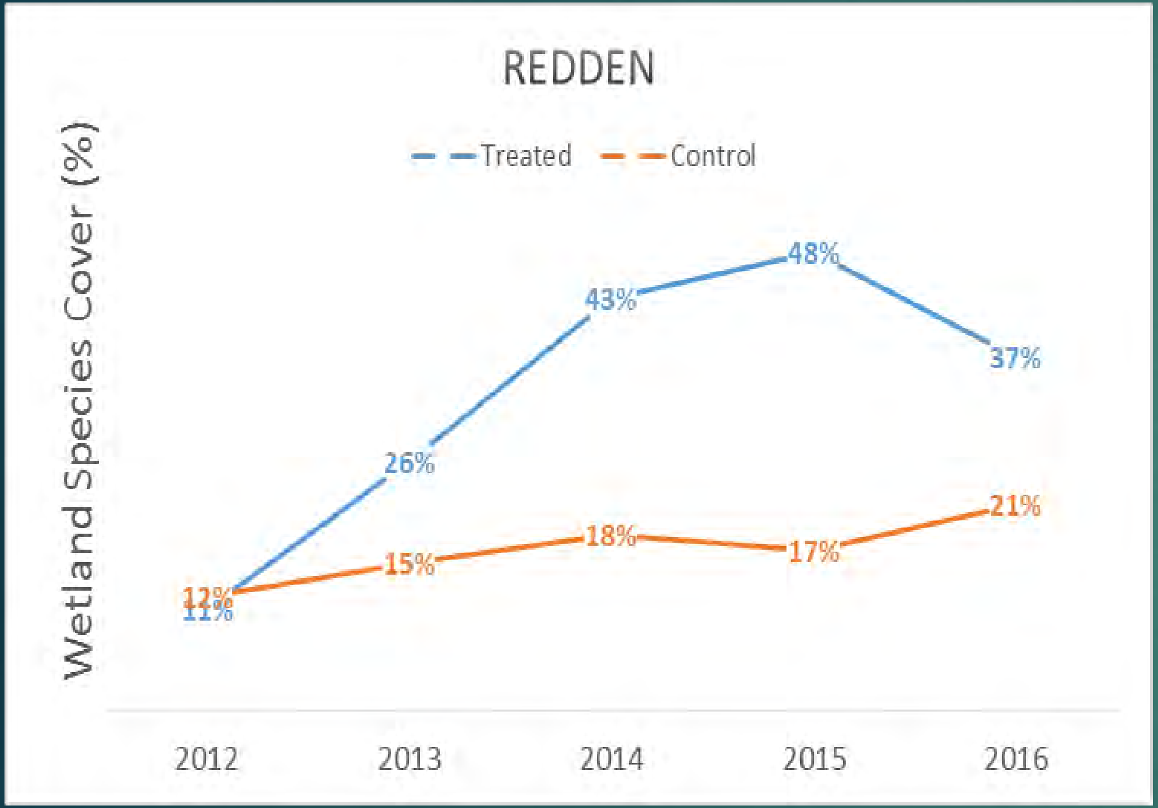




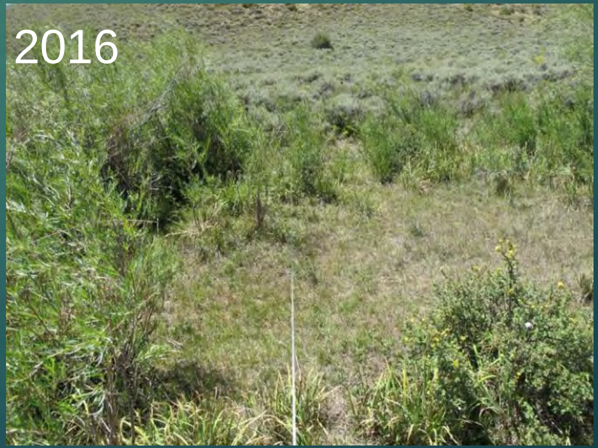
The white polygon represents the wetland area. In general the wetland area occupied approx. 25% of the floodplain in 2012 and around 80% in 2016.

2012 and 2013 photos by Claudia Strijek

Redden: 2012-2016



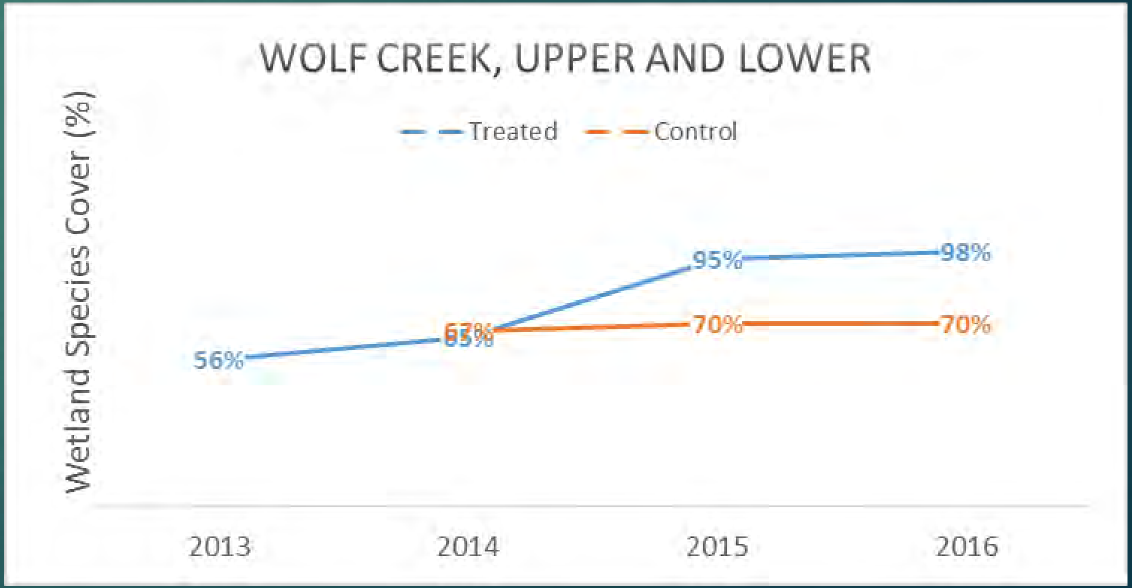
All 15 transects associated with the structures had an increase in wetland species cover. A second layer of rocks was added in 2016, post monitoring



Wolf Creek, Upper and Lower

Wetland Species Cover

	2013	2014	2015	2016	2013-2016 Diff
Glwbt06	9%	11%	14%	30%	**233%**
Glwbt07	33%	30%	58%	55%	**69%**
Guwbt02	98%	114%	121%	134%	**37%**
Guwbt07	28%	40%	64%	62%	**125%**
Guwbt13	90%	120%	189%	180%	**100%**
Guwbt16	80%	75%	125%	125%	**56%**
Average	**56%**	**65%**	**95%**	**98%**	**74%**



Wetland species cover increased by 56% along this transect.

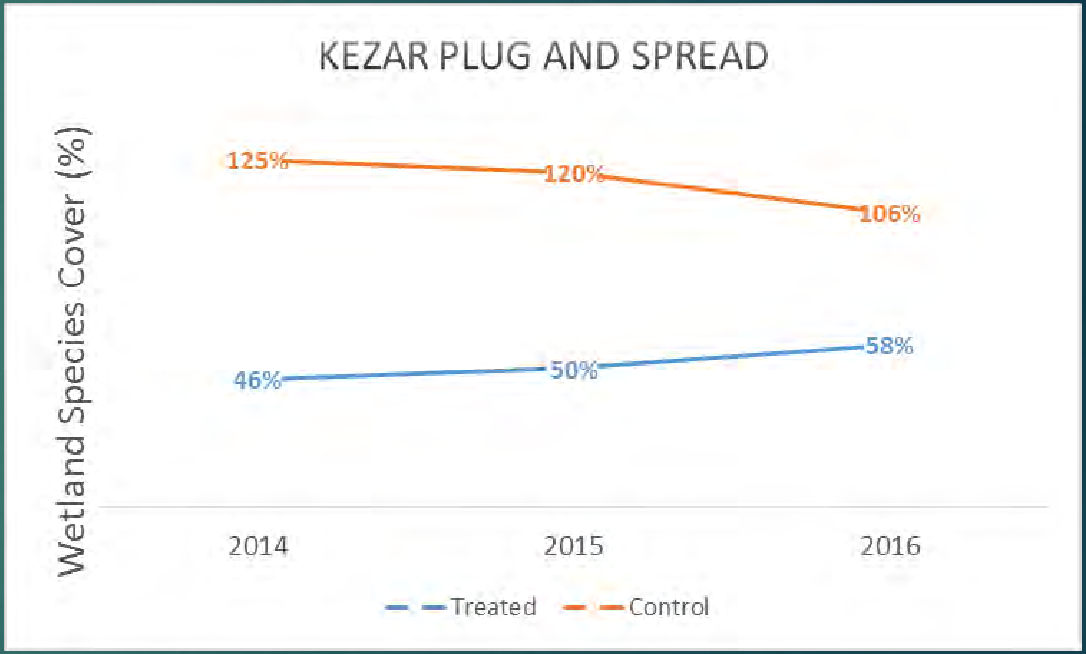
The white polygon indicates the wetland area; the red polygon represent smooth brome

Kezar Basin 2 Years Post Construction

B. Neely photo

Plug and Spreads: Wetland Species Cover

	2014	2015	2016	2014-2016 Difference
GKT01	69%	85%	82%	18%
GKT02	73%	88%	79%	9%
GKT05	12%	18%	30%	150%
GKT05 extension		43%	68%	59%
GKT07	30%	16%	33%	11%
AVERAGE	46%	50%	58%	27%



Pre-structure, September 2014

Building plug and spread in September 2014 (photo by B. Neely)

2016
The wetland species cover was 12% in 2014 and 30% in 2016, a 150% increase in wetland species cover

Slow to Respond

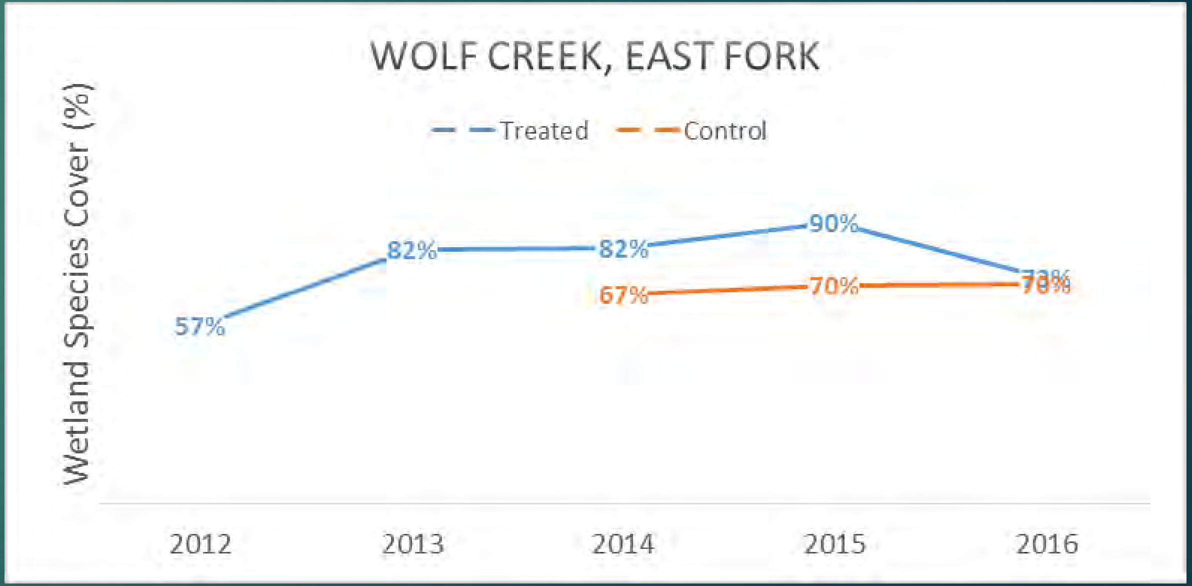
Fast Response Rate	Slow Response Rate	No Response Yet
Wolf, East Fork, Media Lunas	Wolf, East Fork (above media lunas)	Flat Top Exclosure
Redden	Flat Top, Section 36	Flat Top Above Exclosure
Wolf, Middle Fork		Above Redden
Wolf, Upper and Lower		Wolf West Fork
Kezar		Chance

Slow Response Rate

Fast Response Rate	Wetland Species Cover Increase	No. of Years Post Structure	General Characteristics
Wolf, East Fork (above media lunas)	28%	4	Mixed with some perennial water from spring and snow melt; small flood plain
Flat Top, Section 36	24%	3	Ephemeral, snow melt and storm events; medium flood plain

East Fork

	2012	2013	2014	2015	2016	2012-2016 Diff
Gwt20	75%	95%	100%	125%	105%	**40%**
Gwt24	29%	57%	57%	43%	14%	**-50%**
Gwt26	14%	14%	0%	0%	0%	**-100%**
Gwt29	20%	0%	0%	0%	0%	**-100%**
Gwt32	18%	23%	23%	50%	36%	**100%**
Gwt37	100%	161%	165%	143%	135%	**35%**
Gwt38	88%	119%	138%	163%	106%	**21%**
Gwt41	111%	183%	172%	194%	183%	**65%**
Average	**57%**	**82%**	**82%**	**90%**	**73%**	**28%**



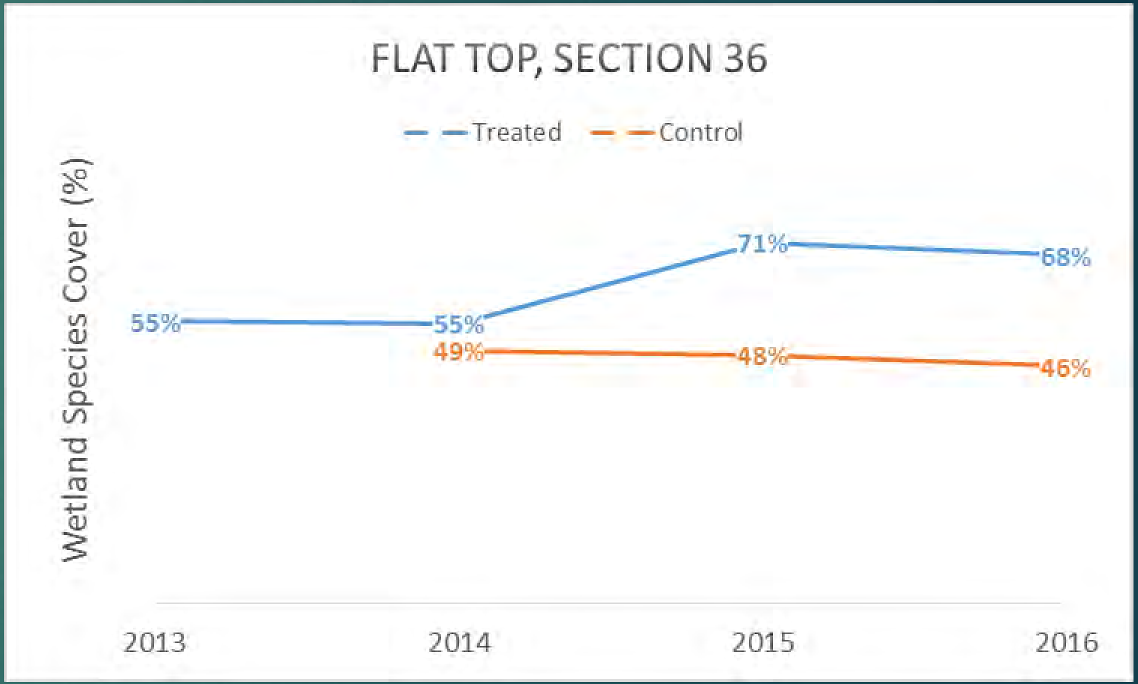
GWT20, GWT37-41 are spring fed

Note: Media Lunas had repeat photos but no transects

Flat Top, Section 36 (Henkel Road)

Wetland Species Cover

	2013	2014	2015	2016	2013-2016 Diff
Gfut03	40%	0%	40%	20%	**-50%**
Gfut06	44%	6%	69%	50%	**14%**
Gfut12	42%	75%	42%		
Gfut16	36%	36%	64%	86%	**140%**
Gfut23	110%		120%	60%	**-45%**
Gfut25	60%	120%	50%	90%	**50%**
Gfut29	39%	61%	87%	83%	**111%**
Gfut35	56%	28%	44%	50%	**-10%**
Gfut38	67%	25%	100%	108%	**63%**
Gfut41	33%	33%	56%	33%	**0%**
Gfut47	82%		112%	118%	**43%**
Gfut51	43%	35%	26%	52%	**20%**
Gfut55	60%	80%	90%	10%	**-83%**
Average	**55%**	**55%**	**71%**	**68%**	**24%**



Two drift fences stopped the cattle trailing. Up until 2016, the cattle were avoiding the valley bottom, but as of 2016 they started to graze the area.

Drift Fence

No Response Yet

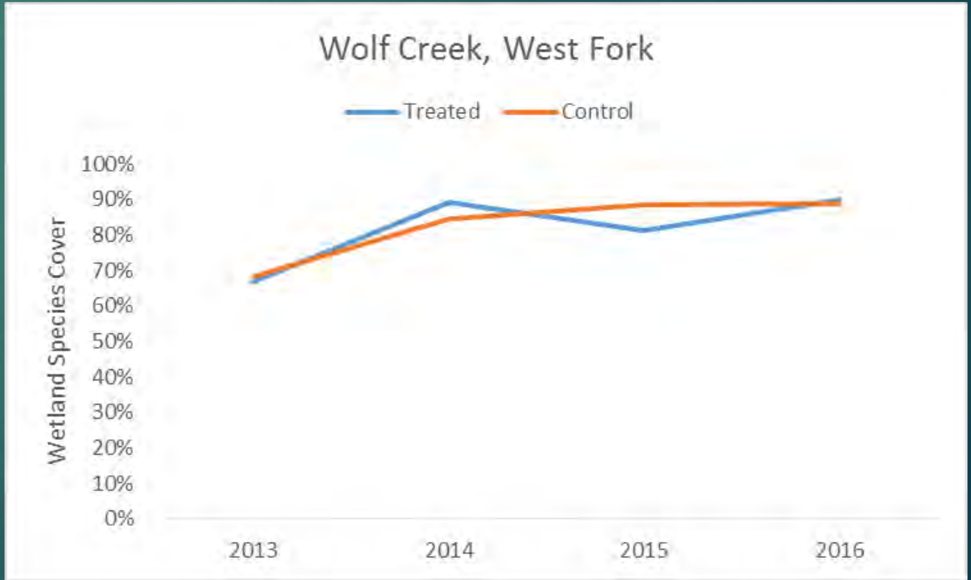
Fast Response Rate	Slow Response Rate	No Response Yet
Wolf, East Fork, Media Lunas	Wolf, East Fork (above media lunas)	Flat Top Exclosure
Redden	Flat Top, Section 36	Flat Top Above Exclosure
Wolf, Middle Fork		Above Redden
Wolf, Upper and Lower		Wolf West Fork
Kezar		Chance

Too Early?

No Response Yet	Wetland Species Cover Increase	No. of Years Post Structure	
Flat Top Exclosure	6%	3	Serious Head Cut Prevention—need more time
Flat Top Above Exclosure	0%	2	All indication that we will see a response next year
Above Redden	0%	2	Unlikely to change quickly
Wolf West Fork	5%	3	Low source of water and sediment due to ponds; issues with negative impact from low water crossing (fixed in 2016?)
Chance	0%	2	Starting with a high wetland species cover; numerous man made ponds; we expect a positive response in another one-two years.

West Fork

	2013	2014	2015	2016	2013-2016 Diff
Gwbt02	50%	60%	70%	60%	20%
Gwbt06	50%	170%	120%	140%	180%
Gwbt09	100%	95%	89%	95%	-5%
Gwbt12	67%	33%	83%	67%	0%
Gwbt14	67%	89%	44%	89%	33%
Average	**67%**	**89%**	**81%**	**90%**	**35%**



The low water crossing impeded the downstream flow and the wetland species are being negatively impacted. Note the willow vigor

Flat Top 2013-2016

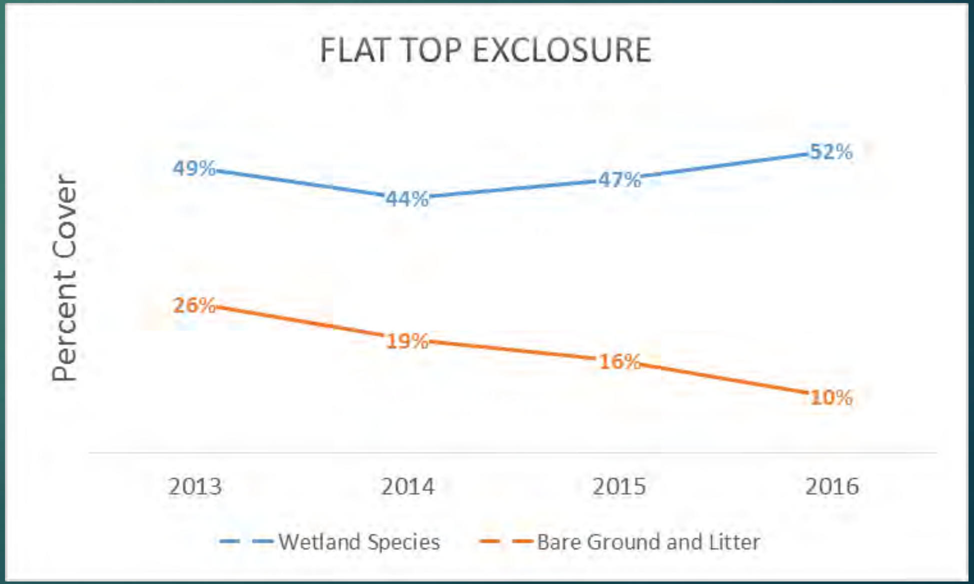
Soil, Litter, and Wetland Species in Exclosure

The total amount of bare ground and detached litter decreased by 62% between 2013-2016

	2013	2014	2015	2016	Percent Change
Bare Ground	17%	11%	12%	6%	-60%
Detached Litter	9%	9%	4%	4%	-63%
TOTAL	26%	19%	16%	10%	-62%

While the wetland species cover had a slight increase.

Many of the structures are preventing further head cutting and wetland species recovery is likely to be slow.

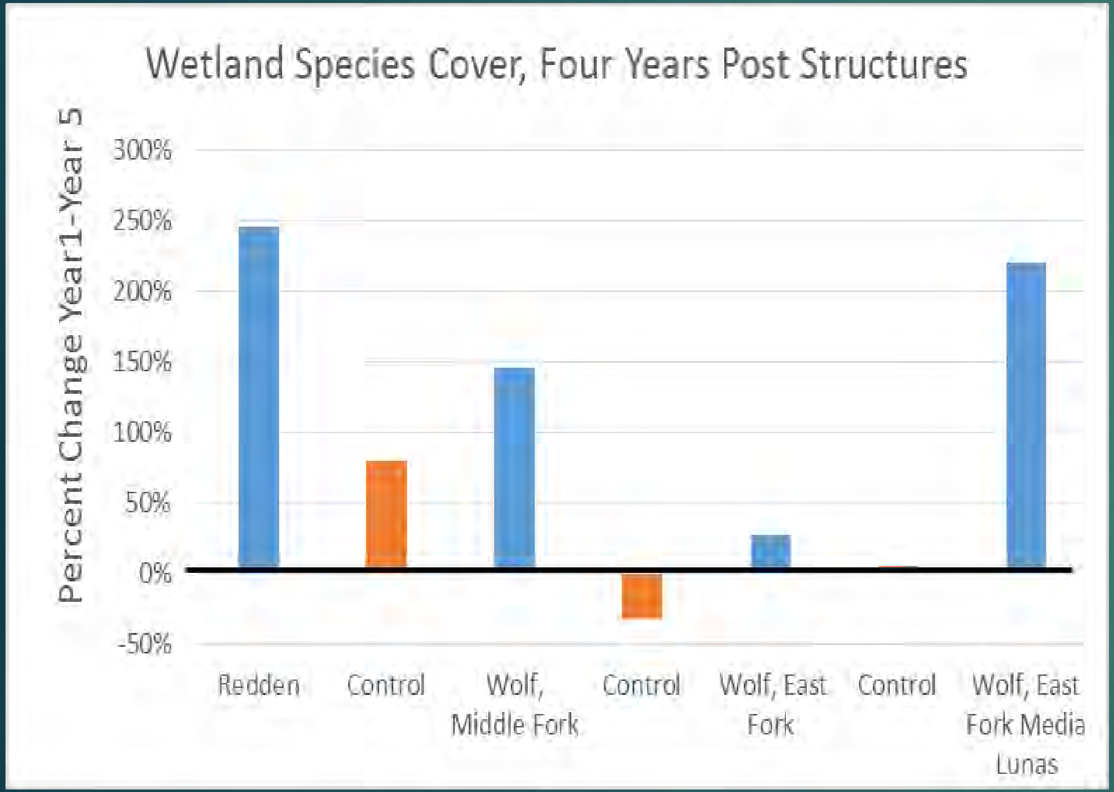


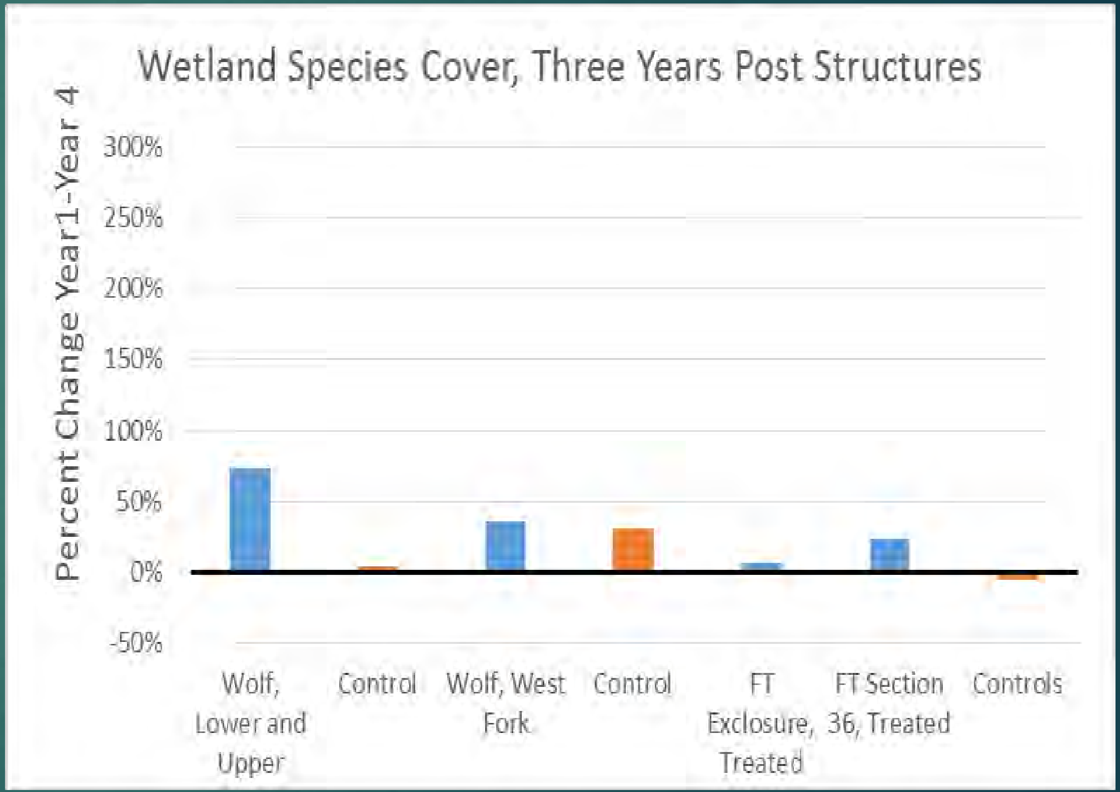
Note that the banks are stabilizing and there is less bare ground.

Abundant sediment was deposited in 2014

Notice the location of Gay's waist compared to the bank; approximately 1' of sediment was deposited, due to the log structure

Wetland Species Cover Change: a comparison across sites





There is a varied rate of response between sites, from almost 0 to 250%

Management Objectives Met

- Increase the cover of native wetland species (obligate and facultative) by at least 20% in the restored portion of the treated properties between 2012 and 2017* (as compared to the controls).

Site	Yes	No	No. of Yrs Post Construction
Redden	x		4
Wolf Creek, Media Lunas	x		4
Wolf Creek, East Fork	x	x	4
Wolf Creek, Middle Fork	x		4
Wolf Creek, Upper and Lower	x		3
Kezar	x		2
Flat Top, Section 36	x		3
Flat Top Exclosure		x	3
Flat Top, Above Exclosure		x	2
Above Redden		x	2
Wolf, West Fork		x	3
Chance		x	2

Note that we have not reached 2017 and therefore some of the "no's" are likely to turn to a "yes"

*Note that a better wording may be "within 5 years post construction"

Why the Variation in Response Rate?

Flow Rate?

Fast Response Rate	Wetland Species Cover Increase	No. of Years Post Structure	General Characteristics
Wolf, East Fork, Media Lunas	220%	4	Perennial water source from spring; wide flood plain with wetland acres approx. 25% of floodplain extent when we put structures in.
Redden	245%	4	Ephemeral, snow melt and storm events.
Wolf, Middle Fork	37%	4	Ephemeral, snow melt and storm events.
Wolf, Upper and Lower	74%	3	Perennial water source from spring; wide flood plain with wetland acres approx. 25% of floodplain extent when we put structures in.
Kezar	27%	2	Perennial water source from spring; wide flood plain with wetland acres approx. xx% of floodplain extent when we put structures in.

Flood Plain Width?

Fast Response Rate	Wetland Species Cover Increase	No. of Years Post Structure	General Characteristics
Wolf, East Fork, Media Lunas	220%	4	Perennial water source from spring; wide flood plain with wetland acres approx. 25% of floodplain extent when we put structures in.
Redden	245%	4	Ephemeral, snow melt and storm events; moderately wide flood plain.
Wolf, Middle Fork	37%	4	Ephemeral, snow melt and storm events; narrow flood plain.
Wolf, Upper and Lower	74%	3	Perennial water source from spring; wide flood plain with wetland acres approx. 25% of floodplain extent when we put structures in.
Kezar	27%	2	Perennial water source from spring; wide flood plain with wetland acres approx. xx% of floodplain extent when we put structures in.

Summary and Conclusions

- The permanent transects and line-point intercept is simple and working
- This large data set could allow additional analysis, e.g., response by structure type or response by taxonomic group, etc.
- Rate of response appears to vary among sites and years
- Generally requires 3 years post construction before an overall response is detected
- Structures that prevent head cuts from enlarging often see the least response; however they are critical structures
- Maintaining controls has been a challenge, yet they are critical to determining changes due to weather vs. structure
- Five years of monitoring a site is probably the minimum number of years to monitor; if a second layer is added, it would be useful to continue monitoring an additional 3 years.
- Restoration on new stream reaches may not require this level of monitoring
  - Photopoints are an inexpensive alternative to transect plots (controls needed) but can be challenging to analyze
  - NDVI analysis pre vs post construction may be another alternative way of assessing increase in wetland acres

Future Directions

- Our management objectives are being met at most sites, however at a different rate.
  - We need to update our objectives language.
- Other metrics, aside from wetland species cover, are changing, e.g., bare ground is reduced, sediment is building and raising the stream bed, reducing down cutting, and head cutting
- What other questions would we like to answer with the vegetation data?
- What additional management objectives, if any, should we consider?
- Any hypothesis about why we have such a range of response rates are welcome!

APPENDIX F
Prioritizing Sites for Riparian and Wet Meadow Restoration/Resilience Building Project
Site Prioritization Methods and Results
Gunnison Climate Working Group
Teresa Chapman, TNC
October 2016

Introduction

Gunnison sage-grouse in the Gunnison Basin rely on riparian and wet meadow habitats during critical life stages, especially in early summer during brood rearing season. These areas also provide important habitat for other wildlife species, e.g., deer, elk, and migratory bird species. The Gunnison Climate Working Group (GCWG), a public-private partnership preparing for change in the Gunnison Basin, is working to restore the hydrologic and ecosystem function of wet meadows and riparian areas to ensure that these species have access to necessary riparian habitat in the face of a changing climate. Both more severe, prolonged droughts and more intensive monsoonal rains are predicted under increased warming. The restoration techniques (designed by Bill Zeedyk) used in this project help to slow and disperse the water within stream channels in order to expand riparian habitat and reconnect the stream to the floodplain, ultimately increasing the stream's resilience to drought, monsoons, and storm events. The team defined four critical components of a resilient stream and riparian system: a) a properly functioning hydrology/ecology, b) a stream channel that is connected to its floodplain, c) stream banks that retain moisture and reduce erosion during flood events, and d) a native and diverse wetland and mesic species composition. In order to maximize conservation results and focus on-the-ground efforts, the team devised a site prioritization for restoration, based on a combination of ecological, climate-informed, and topographic GIS variables.

The methods and results presented here are intended to provide a landscape-scale model of the restoration need and potential of stream reaches in the entire Gunnison Basin. As in many restoration projects, narrowing down the best places to work is a critical step. This prioritization model can be used to identify those stream reaches within critically important Gunnison sage-grouse habitat that offer the greatest potential to respond favorably to our restoration techniques. Once reaches with the highest potential are identified using this GIS method, on-the-ground investigations can further refine opportunities and constraints for restoration at each site.

Methods

We used four main criteria to select and prioritize stream reaches for restoration within the Gunnison Basin:

1. Location within potential Gunnison sage-grouse brood rearing habitat
2. Close proximity to lek locations (<= 2 miles)
3. Restoration Potential Index (measuring difference in greenness between a wet year and a dry year)
4. Riparian Condition Index (measuring the extent of the floodplain and the current extent of riparian vegetation).

We used two ecological layers, Gunnison sage-grouse brood rearing habitat and proximity to leks, to narrow priority streams to those most essential for Gunnison sage-grouse habitat. The Gunnison sage-grouse brood rearing habitat was mapped by the Gunnison Basin Gunnison sage-grouse Strategic Committee in its Habitat Prioritization Tool, specifically created for the grouse. The layer was created from the SSURGO soil database, a vegetation layer, an elevation-derived stream flow model, and numerous potential threats to sage-grouse (such as roads). Although this data layer is not available for other basins, we used it as the foundation of our analysis and only included stream reaches within mapped brood rearing habitat. We used a two-mile buffer surrounding current active Gunnison sage-grouse leks in order to prioritize areas where the highest percentage of hens are predicted to raise their young (~85% nest and brood rear within two miles of leks).

We created a climate-informed layer, the *Restoration Potential Index*, to identify areas that currently 'green up' during wetter years and also maintain some functionality during drought years, implying that the riparian corridor is not too deeply incised and that the area has some source of water during the summer months, including snow melt, seeps and springs, and/or a perennial stream. This layer was generated from a NASA Landsat satellite image vegetation index of greenness. The riparian areas that do not green up sufficiently during drought years (but do during wet years) provide an opportunity to slow down and spread the available water in these stream reaches with the goal of providing needed riparian and mesic habitats during drought.

We created a topographically based layer, the *Riparian Condition index*, to indicate areas that showed the most promise for improvement based on the floodplain extent and current extent of the riparian area. Stream reaches with little available floodplain due to topography are not ideal candidates for these restoration structures. This layer was generated from a fine resolution elevation model and fine scale aerial imagery. Riparian Condition Index marks areas with topography conducive to spreading out the water and have little current riparian vegetation, indicating channel incision or lack of water. Combining the Restoration Potential index with the Riparian Condition Index allowed the team to estimate which stream reaches have access to water, are not excessively degraded beyond the ability of these structures to repair, and have topography favoring a more expansive floodplain.

The unit of analysis is a stream reach as identified by the National Hydrography Dataset. We used stream miles as measured in the NHD to estimate the number of stream miles within the criteria. We used Colorado Parks and Wildlife riparian polygons generated from aerial image interpretation to estimate the area of riparian acreage within the criteria.

Criteria 1: Location within potential Gunnison sage-grouse brood rearing habitat

Select stream reaches from the high resolution 1:24,000 scale National Hydrography Database (NHD) that intersect the potential for Gunnison sage-grouse brood rearing habitat developed by the Gunnison Basin Gunnison sage-grouse Strategic Committee's Habitat Prioritization Tool (HPT; Figure 1).

a. Select unique stream reaches from the high resolution NHD within the basin that intersect the Gunnison County Habitat Prioritization Tool (HPT) Gunnison sage-grouse brood rearing habitat polygons (potential for brood rearing habitat >=1).
b. Convert the NHD stream reach (flowline type = Stream or River) to a raster (grid) at a 30 m resolution and buffer the stream reaches by 60 m using the expand ArcGIS tool to address issues of inaccuracy in the NHD flowlines. Snap the raster to a Landsat image to assure that all pixels in stream reaches align with Landsat imagery (Figure 2).

Figure 1. Stream Reaches with Gunnison sage-grouse Brood rearing habitat (from the Habitat Prioritization Tool). There are 4,410 stream reaches in the Gunnison Basin that contain Gunnison sage-grouse brood rearing habitat.

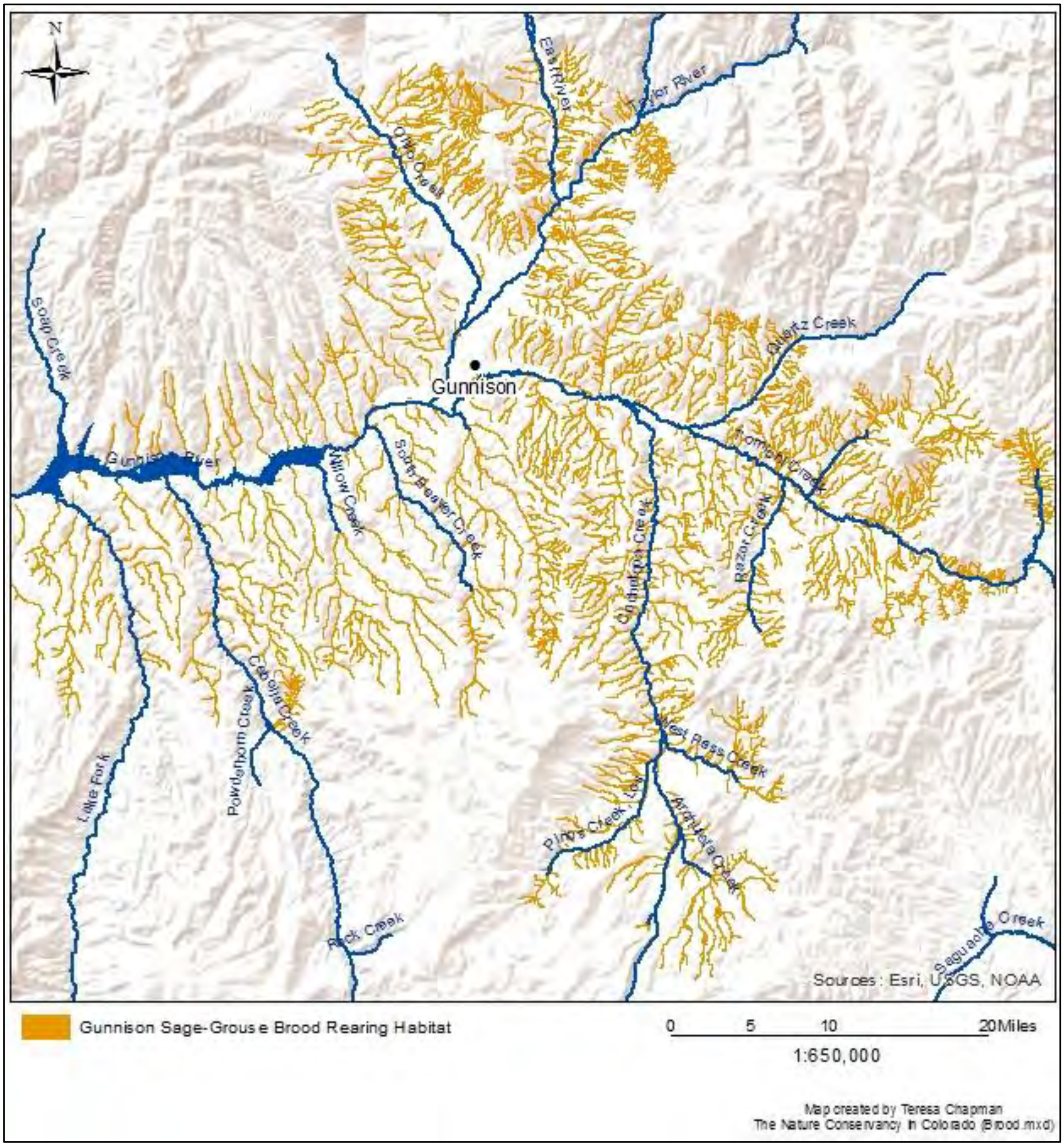
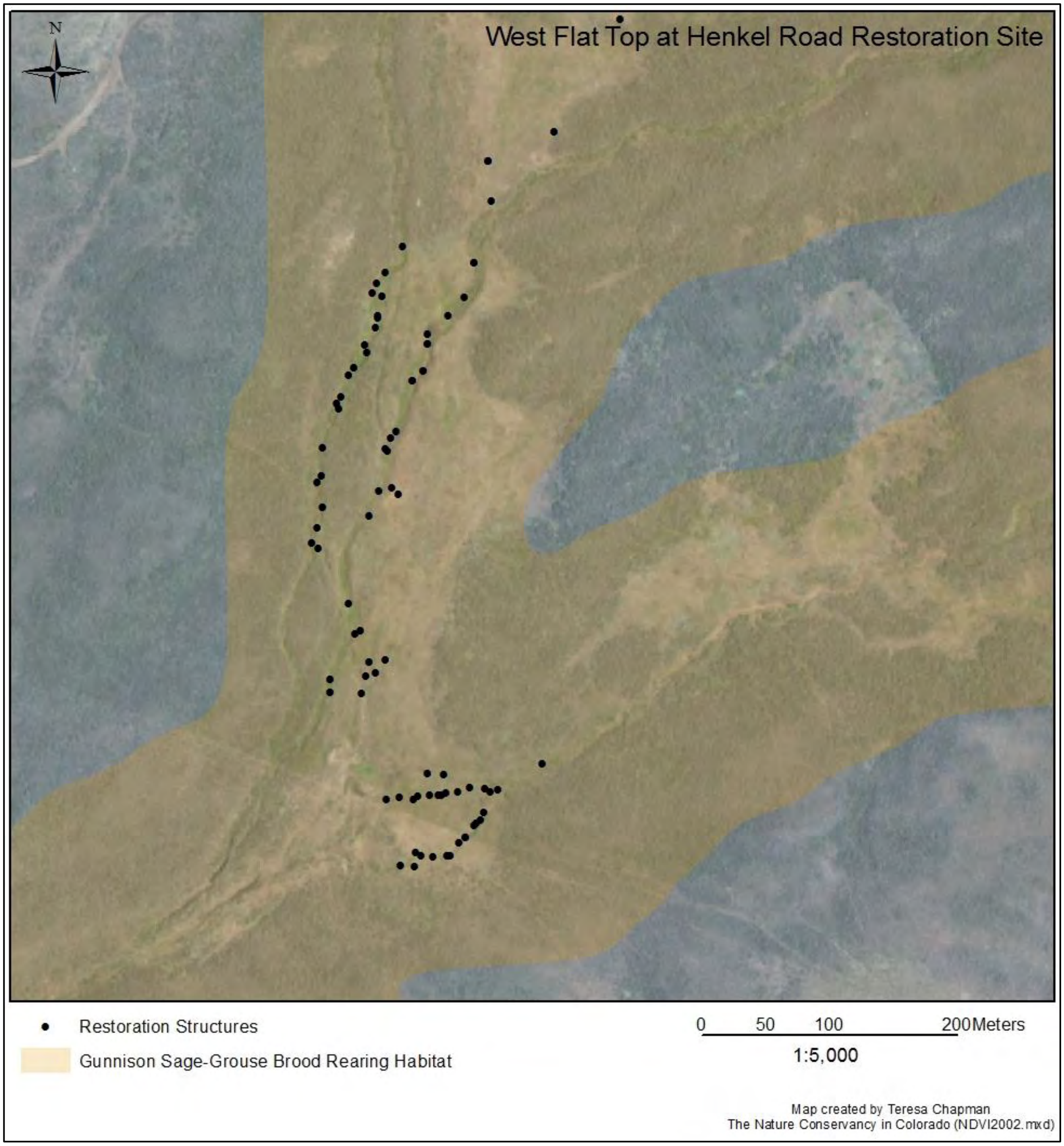


Figure 2. The Gunnison sage-grouse Brood rearing habitat at West Flat Top at Henkel Road restoration site.

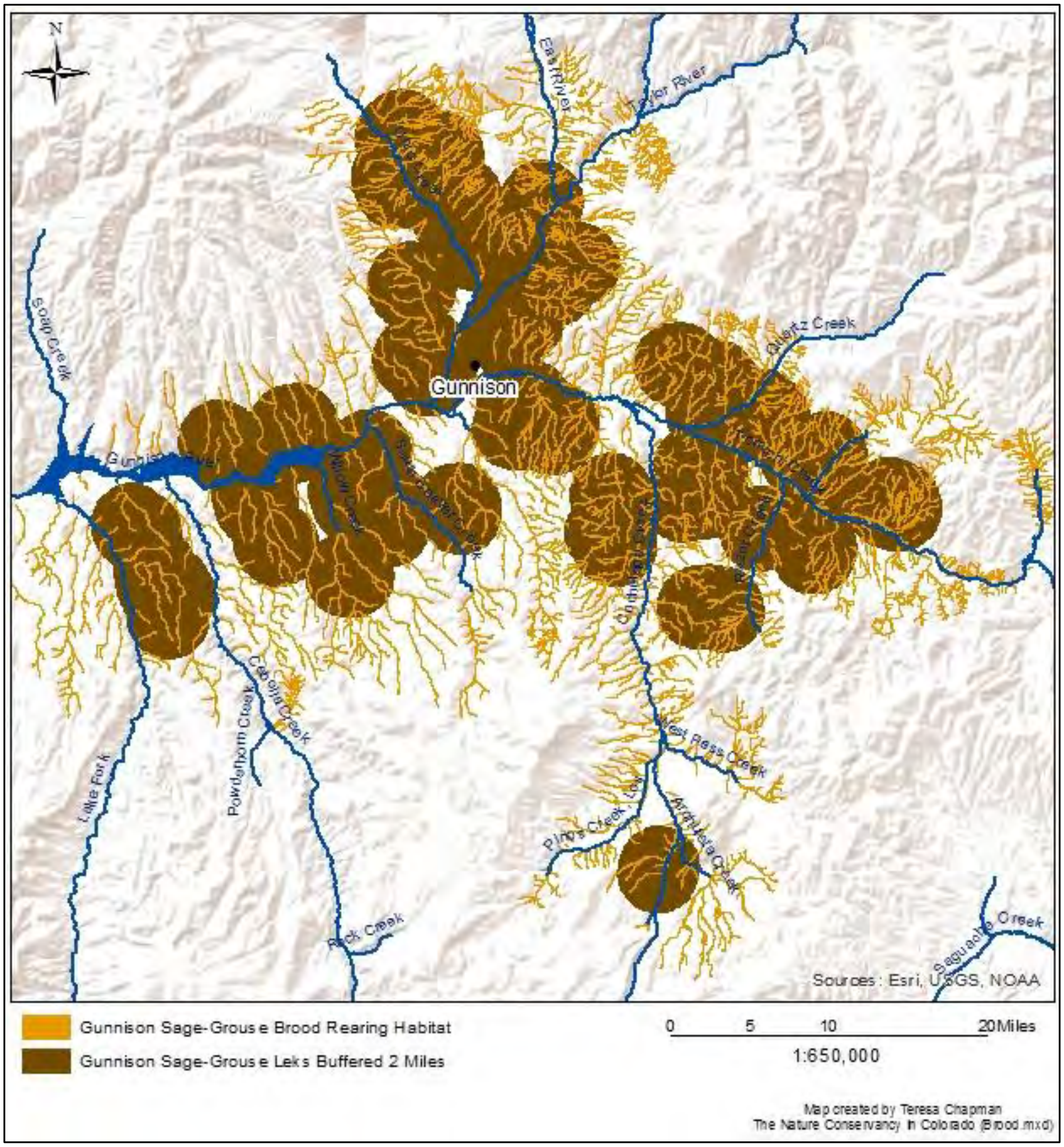


Criteria 2: Close proximity to lek locations (<= 2 miles)

Determine stream reaches within a specified distance of Gunnison sage-grouse leks (Figure 3).

a. Buffer known active Colorado Parks and Wildlife (CPW) lek locations to two miles.
b. Calculate areas of overlap between lek buffers.
c. Determine number of leks within two miles of a stream reach.

Figure 3. Stream reaches within 2 miles of an active Gunnison sage-grouse lek. There are 1,883 stream reaches within 2 miles of Gunnison sage-grouse leks, totaling 927 miles of perennial, intermittent, and ephemeral streams and approximately 5,540 acres of current riparian vegetation, as mapped by CPW riparian polygons.



Criteria 3: Restoration Potential Index (difference in greenness between a wet year and a dry year)

Determine Restoration Potential Index of stream reaches using a time series of a climate-related vegetation index (NDVI: Normalized Differenced Vegetation Index). NDVI is a proximate for productivity of vegetation. Very productive and green vegetation has higher NDVI values than drier, browner, less productive vegetation. The index directly gives the percentage of decreased riparian area between a drought and a wet year.

a. Obtain NDVI values from peak growing season and drought months (July and August) in a time series between 2000-2011 from USGS Landsat Climate data records (http://landsat.usgs.gov/CDR_ECV.php) to determine years with very high and very low NDVI values.
b. Remove water and clouds from all images. NDVI values range from -10000 to 10000 (scaled by .0001).
c. Determine the wettest and driest years between 2000-2012. The year 2002 was the driest and 2009 was the wettest (Figures 5-7).
d. Use the CPW Riparian polygons, the National Wetlands Inventory dataset, and the BLM Gunnison basin seeps and springs layer to calculate the mean NDVI values of riparian plants and spring fed systems during a wet year and estimate a threshold value for NDVI values in riparian areas. The mean of riparian vegetation had a NDVI value of approximately 4000.
e. Classify area of stream reaches above 4000 NDVI for the Landsat time series.
f. Calculate an index based on the difference in riparian area above the threshold 4000 NDVI in a wet year versus a dry year. Standardize the ratio by the area above 4000 NDVI in the wet year.

$$\text{Restoration Potential Index} = \frac{([\text{NDVI} >= 4000 \text{ wet year}] - [\text{NDVI} >= 4000 \text{ dry year}])}{[\text{NDVI} >= 4000 \text{ wet year}]} * 100$$

An area which lost half of the area above 4000 NDVI between 2009 and 2002 would have a value of 50 (or .5). A value of 100 indicates that the stream reach did not green up above the NDVI threshold of 4000 and therefore decreased the riparian vegetation by 100%. A score of zero indicates that the area never greened above the threshold and is too dry, lower elevation or very highly degraded (Figure 4).

Interpretation of Restoration Potential Index values:

0: very dry (due to either low elevation, steep/rocky topography, lack of consistent water source). Not prime areas for restoration.

1-60: very high elevations, or very wet high flowing creeks/springs (also possibly forested areas and/or errors in database). These areas are well-functioning riparian habitats in terms of maintaining green areas during drought. Not prime areas for restoration.

60-99: potentially spring fed system and maintained at least a small area of green riparian habitat during the 2002 drought. Areas where restoration efforts would likely show fast response because there is water moving in system during droughts.

100: area has ability to green up but did not hit threshold value in 2002. Areas where restoration efforts would likely show a slower response because there is less water moving through system during dry years.

We considered all streams with a Restoration Potential Index >= 60 as areas with potential for improvement with these restoration techniques. Streams with values greater than 60 have potential to add resilience to these systems through stream restoration.

Figure 4. NDVI values for 2009 (wet year) across the Gunnison Basin. Green areas on the map are above the 4000 value for NDVI indicating green riparian vegetation. Brown areas are very dry.

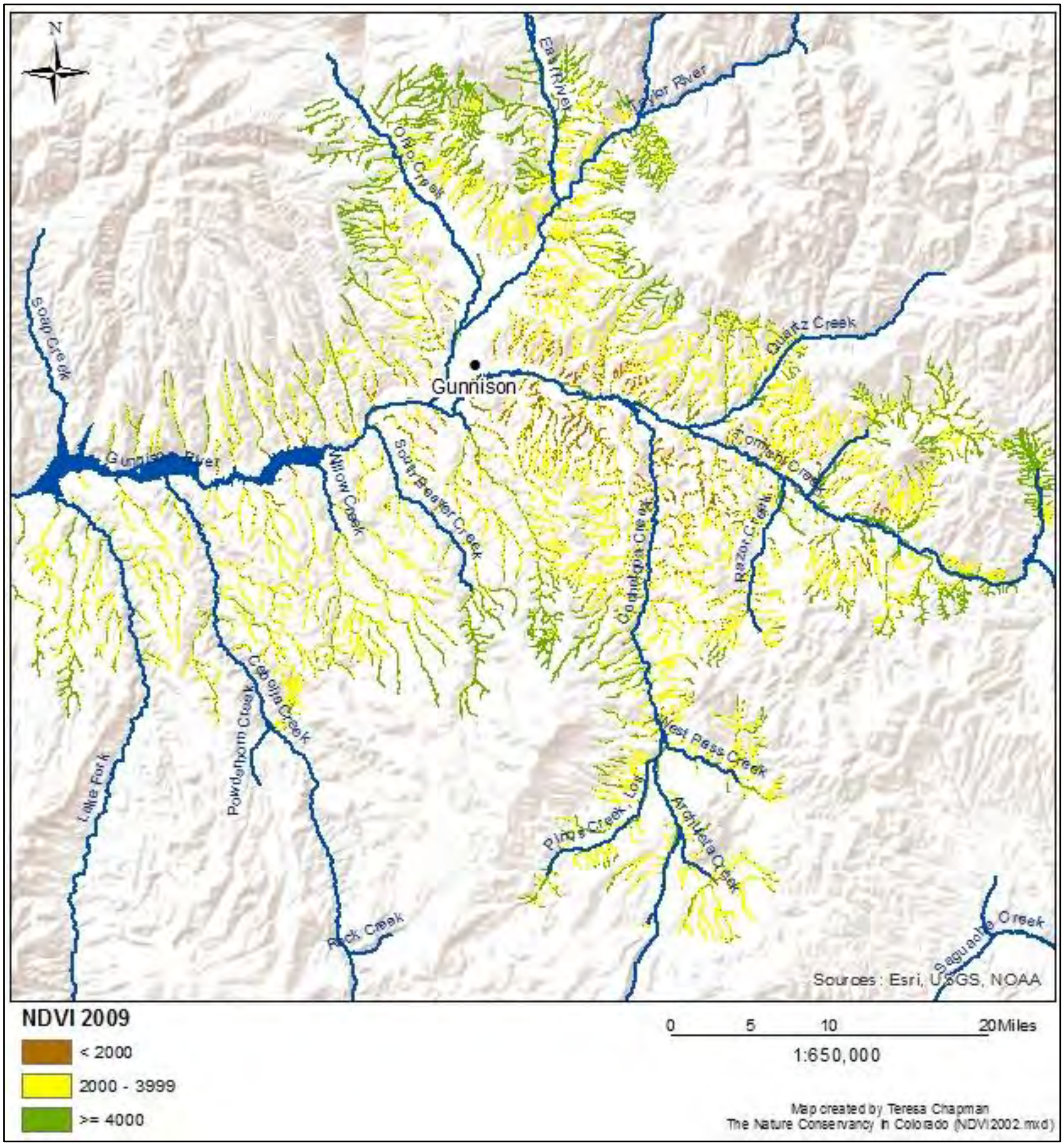


Figure 5. NDVI values for 2009 (wet year) at West Flat Top at Henkel Road restoration site. Many areas within the stream reach were above the NDVI threshold of 4000, indicating very green riparian vegetation.

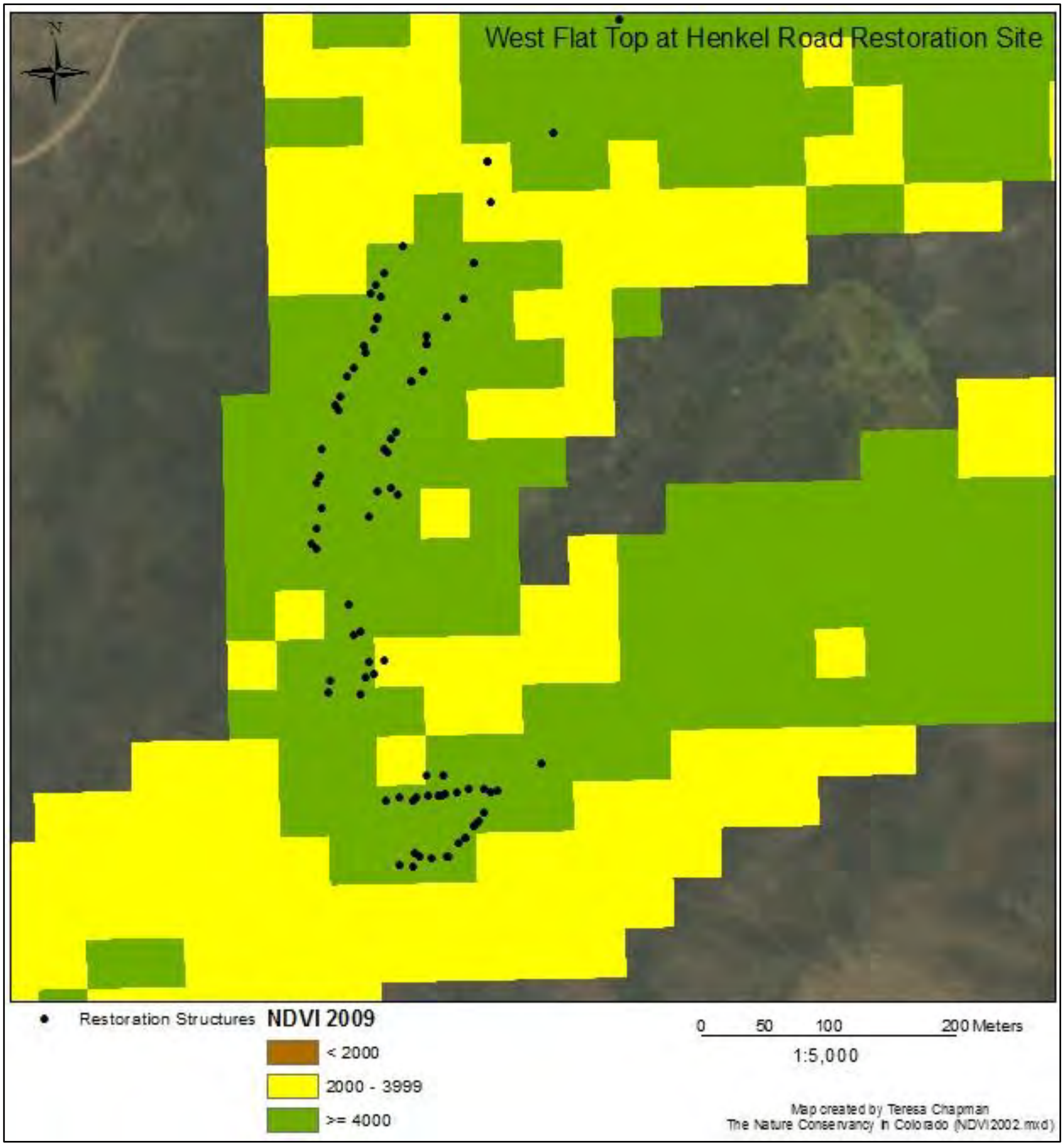


Figure 6. NDVI values for 2002 (drought year) across the Gunnison Basin. The area of vegetation that is less green, less productive, and less moist is shown in brown and covers a greater area compared to a wet year. Less vegetated area reached the NDVI threshold of 4000, shown in green below, during the drought of 2002, indicating the severity of the drought and the negative impact on riparian habitat.

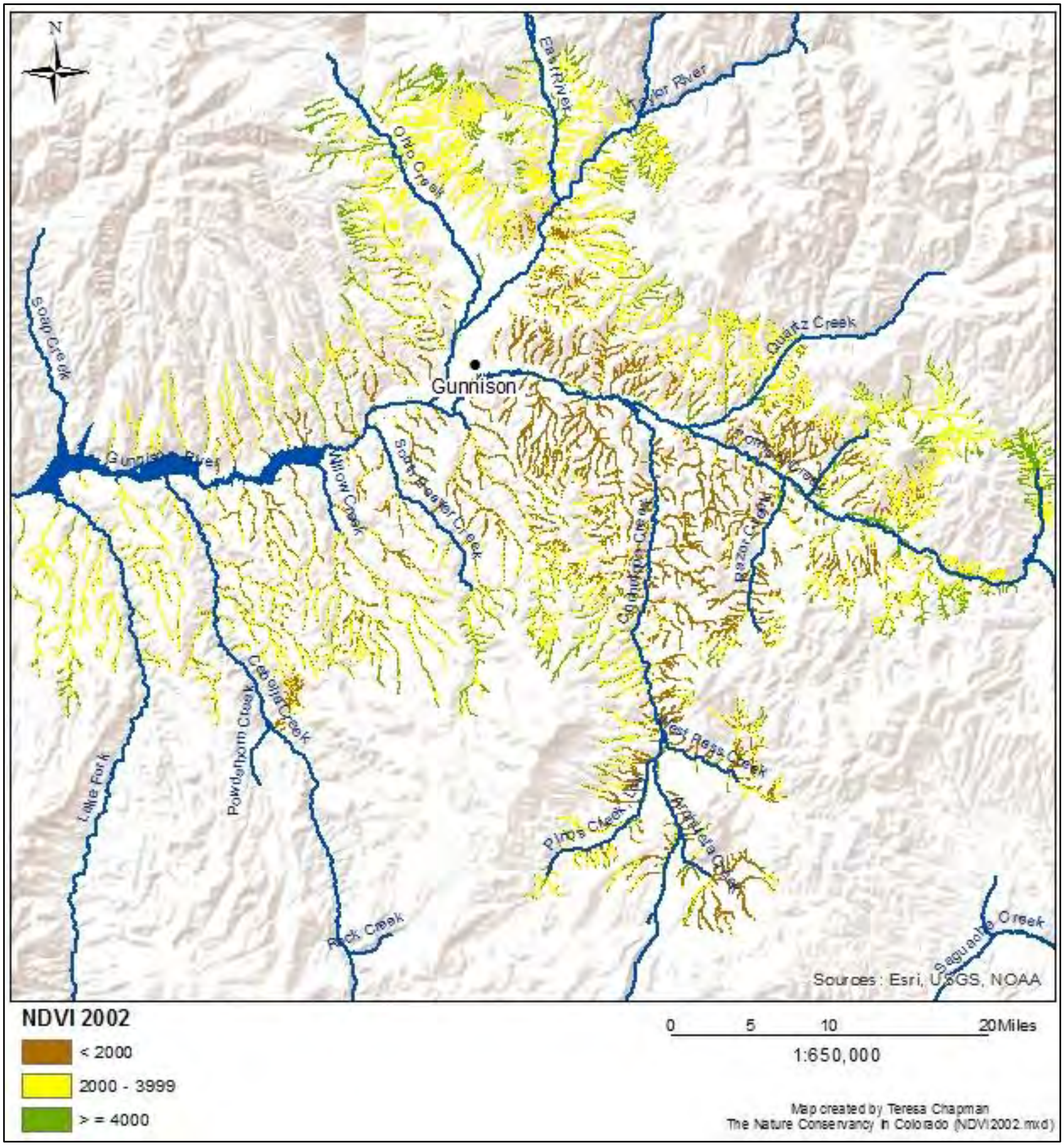


Figure 7. NDVI values for 2002 (drought year) at West Flat Top at Henkel Road restoration site. The stream reach did not have any riparian areas that crossed the NDVI threshold of 4000.

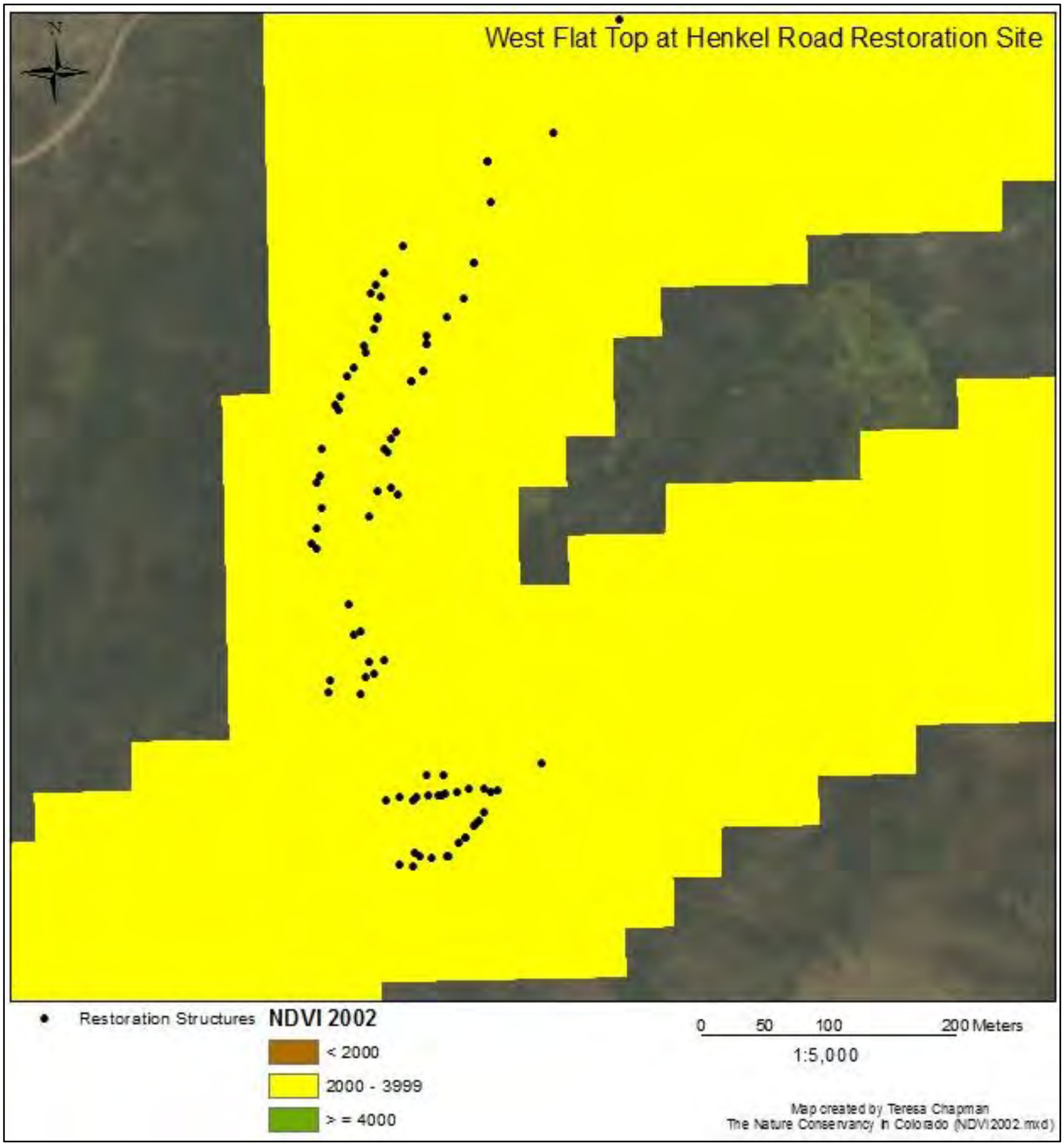
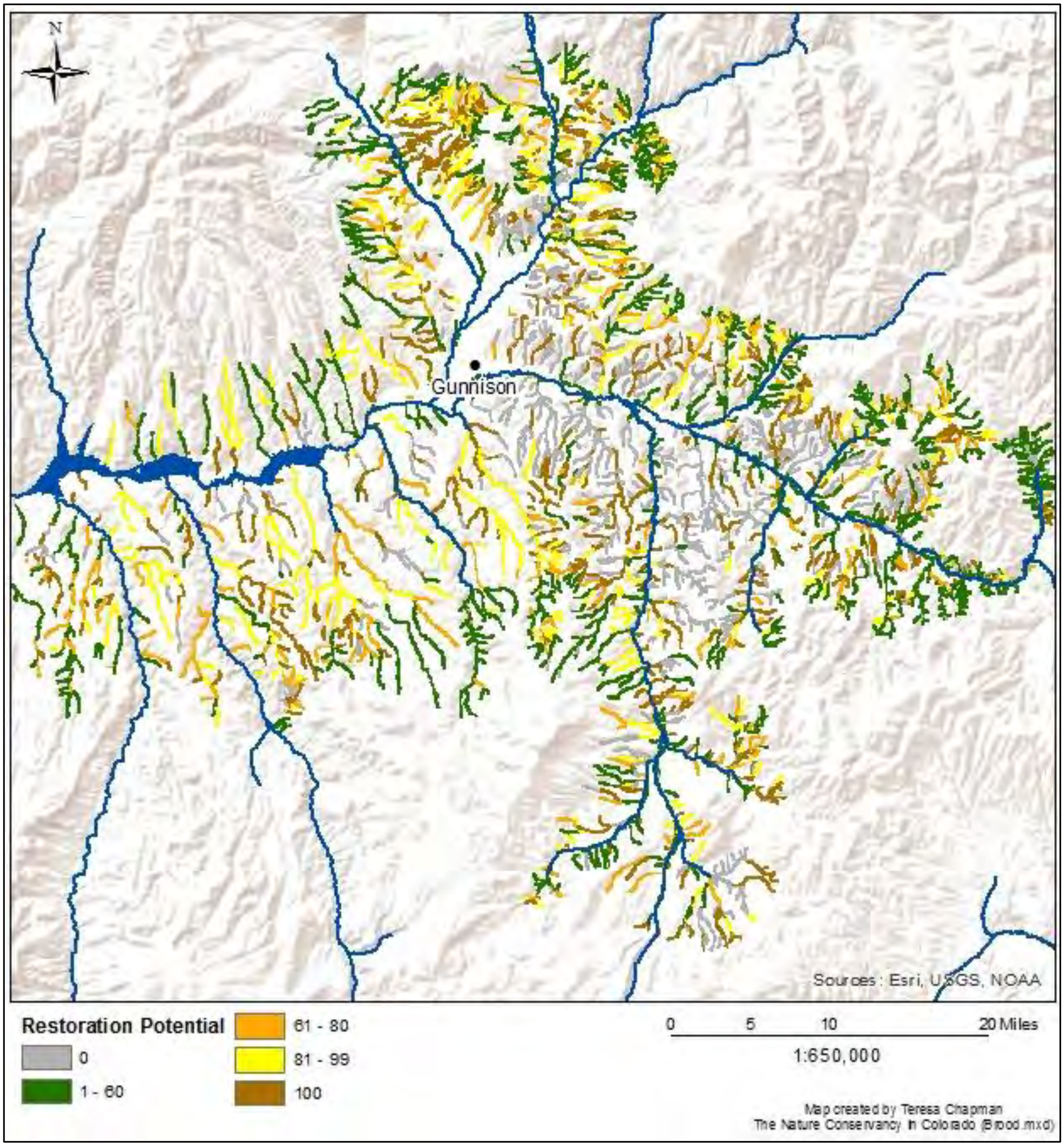


Figure 8. Restoration Potential Index across the Gunnison Basin stream reaches. The West Flat Top at Henkel Road restoration site scored 100 on the Restoration Potential Index since the stream reach did not have riparian area that greened up above NDVI 4000 in year 2002. Of the total stream reaches near leks, 847 streams measured with Restoration Potential Index above 60, meaning they lost 60-100% of very green riparian area during the drought and indicating they could benefit from current restoration treatments. These streams total 421 miles and approximately 1732 acres of current riparian vegetation.



Criteria 4: Riparian Condition Index (comparing the extent of the floodplain and the current extent of riparian vegetation).

a. Create a topographic floodplain for every stream reach by generating the cost of travelling from the stream centerline across a slope layer from a 10 m digital elevation model. This process creates a floodplain based on the slopes and natural topography and estimates the potential riparian area if the floodplain were connected to the stream (Figure 9).
b. Calculate the extent of current riparian vegetation within the floodplain by classifying 1 m aerial imagery with a supervised maximum likelihood classification algorithm in ArcGIS. We 2011 NAIP imagery with four bands, including near infrared. We estimated the accuracy of the classification with 700 randomly generated points. The total accuracy of the riparian class was 86% (Figure 10).
c. Generate the Riparian Condition Index by dividing current riparian extent by the total floodplain area (Figure 11).

$$\text{Riparian Condition Index} = \frac{\text{Current Riparian vegetation (m2)}}{\text{Total Floodplain (m2)}} * 100$$

We used a threshold between 1and 25 on the Riparian Condition Index to prioritize wetlands where we could significantly increase riparian acreage. Since we do not know how much of the modelled floodplain a well-functioning stream occupies, we placed the threshold for riparian vegetation extent to below 25% of the floodplain. We aim to determine an approximate value for restored streams from areas in our restored areas once they have responded fully to the treatments.

Figure 9. Topography based modeled floodplain at West Flat Top at Henkel Road restoration site.

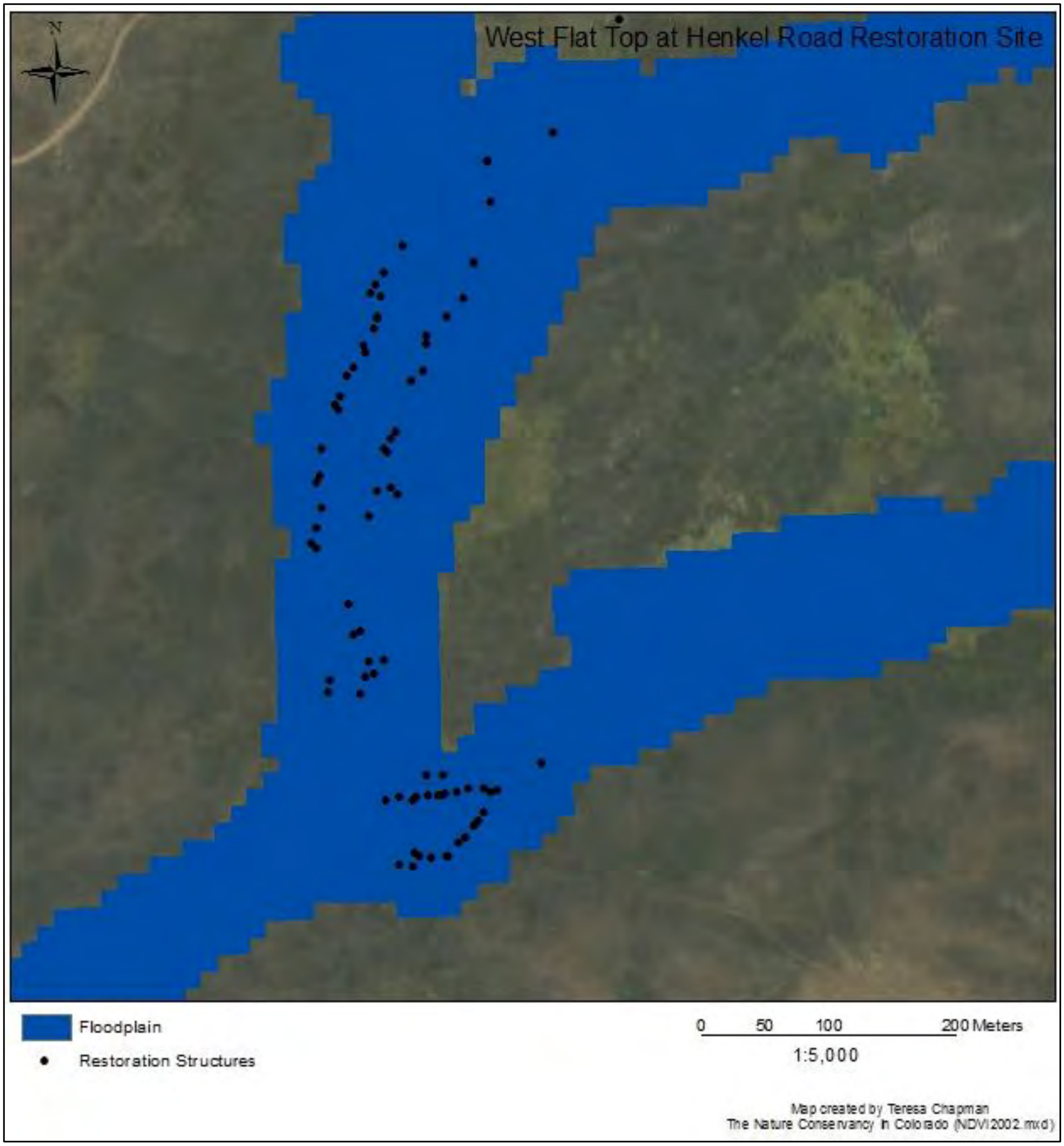


Figure 10. Extent of riparian vegetation in 2011 prior to restoration overlaid with topography based modeled floodplain at West Flat Top at Henkel Road restoration site. The ratio of 2011 riparian vegetation to the area of the floodplain creates the Riparian Condition Index and estimates the potential for expansion of the wetland.

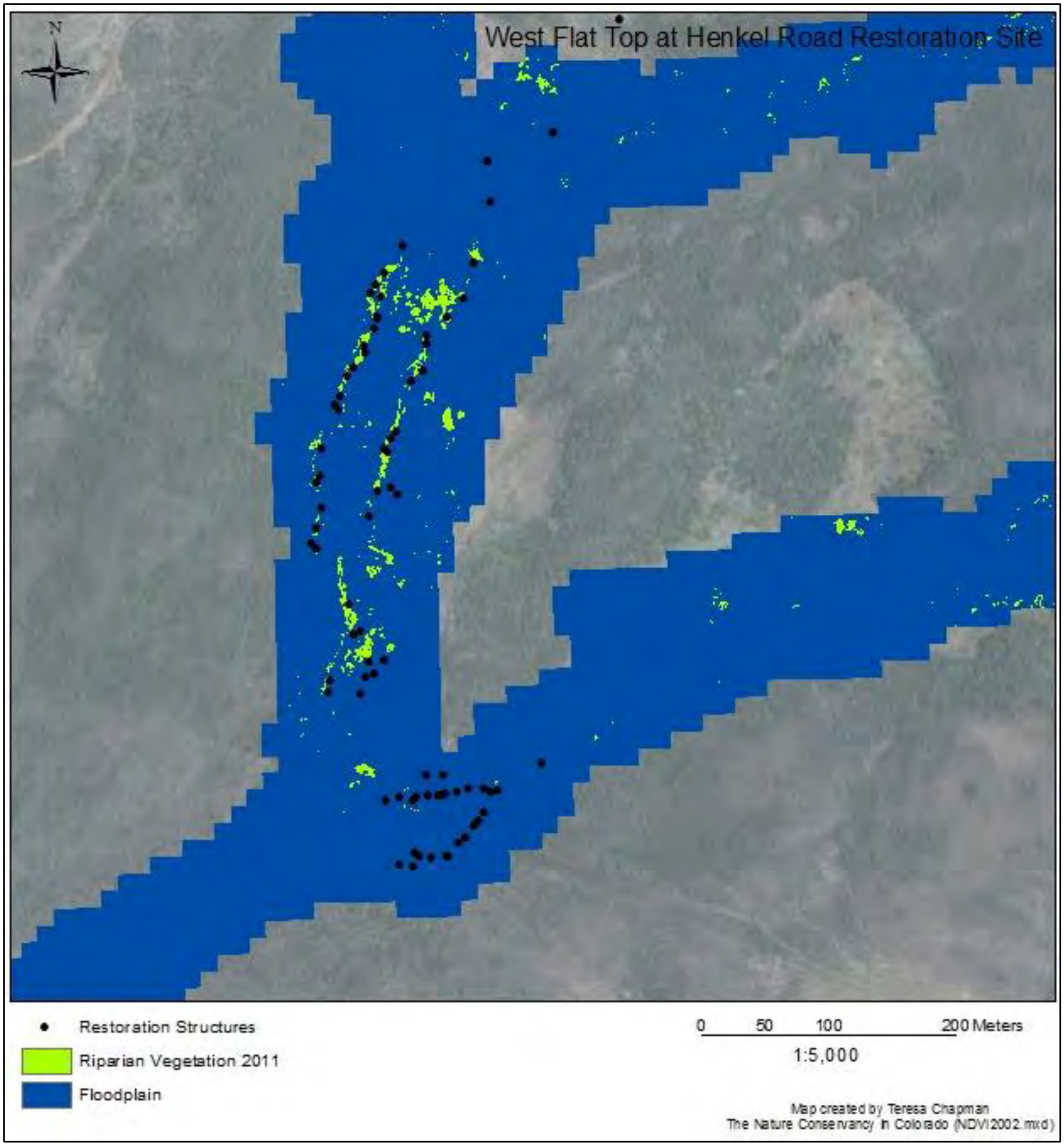


Figure 11. Riparian Condition Index at West Flat Top at Henkel Road restoration site. The site scored a 3 for this index, indicating that riparian vegetation in 2011 only occupied a small fraction of the potential floodplain and there is opportunity to expand the riparian vegetation here.

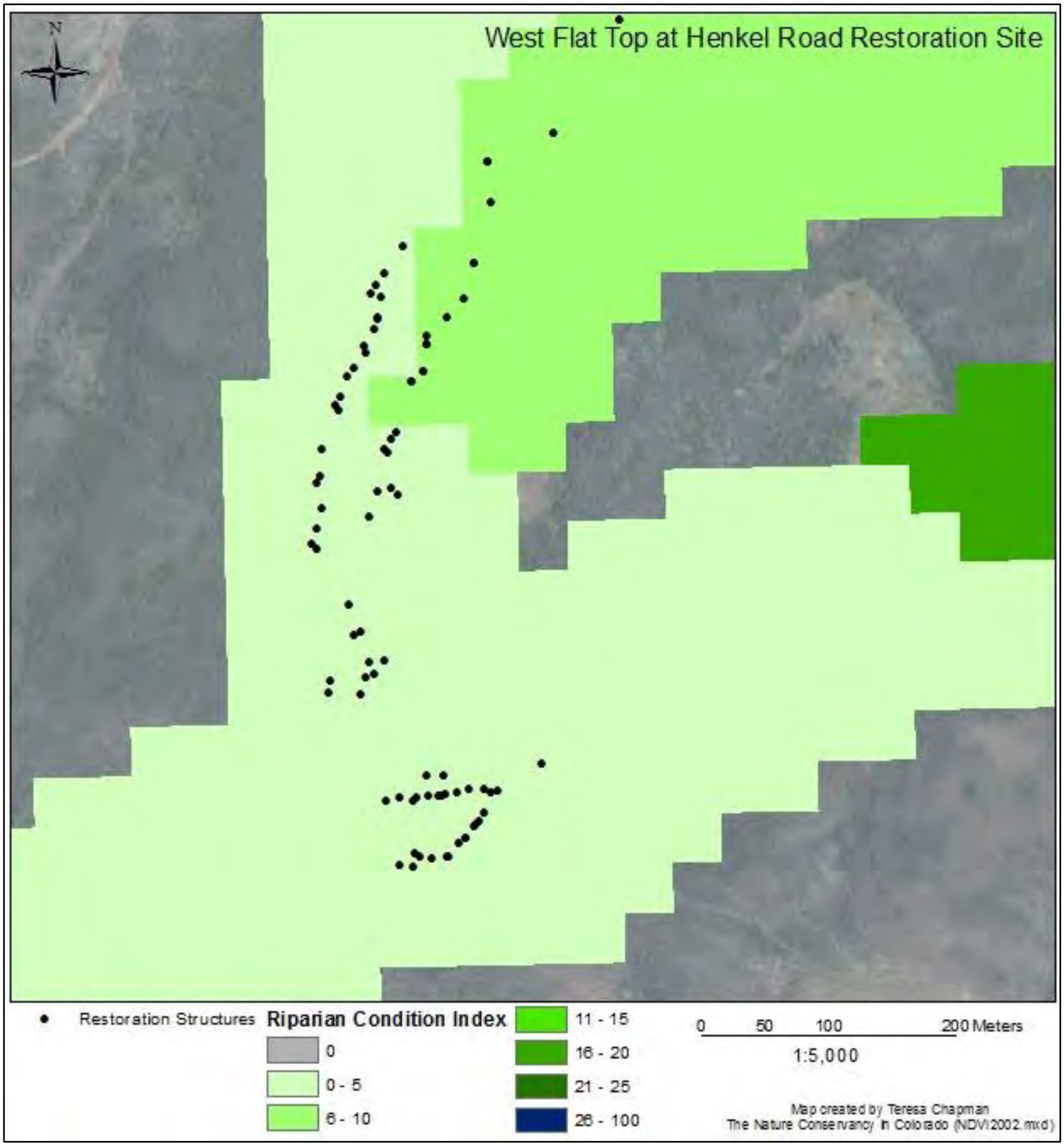
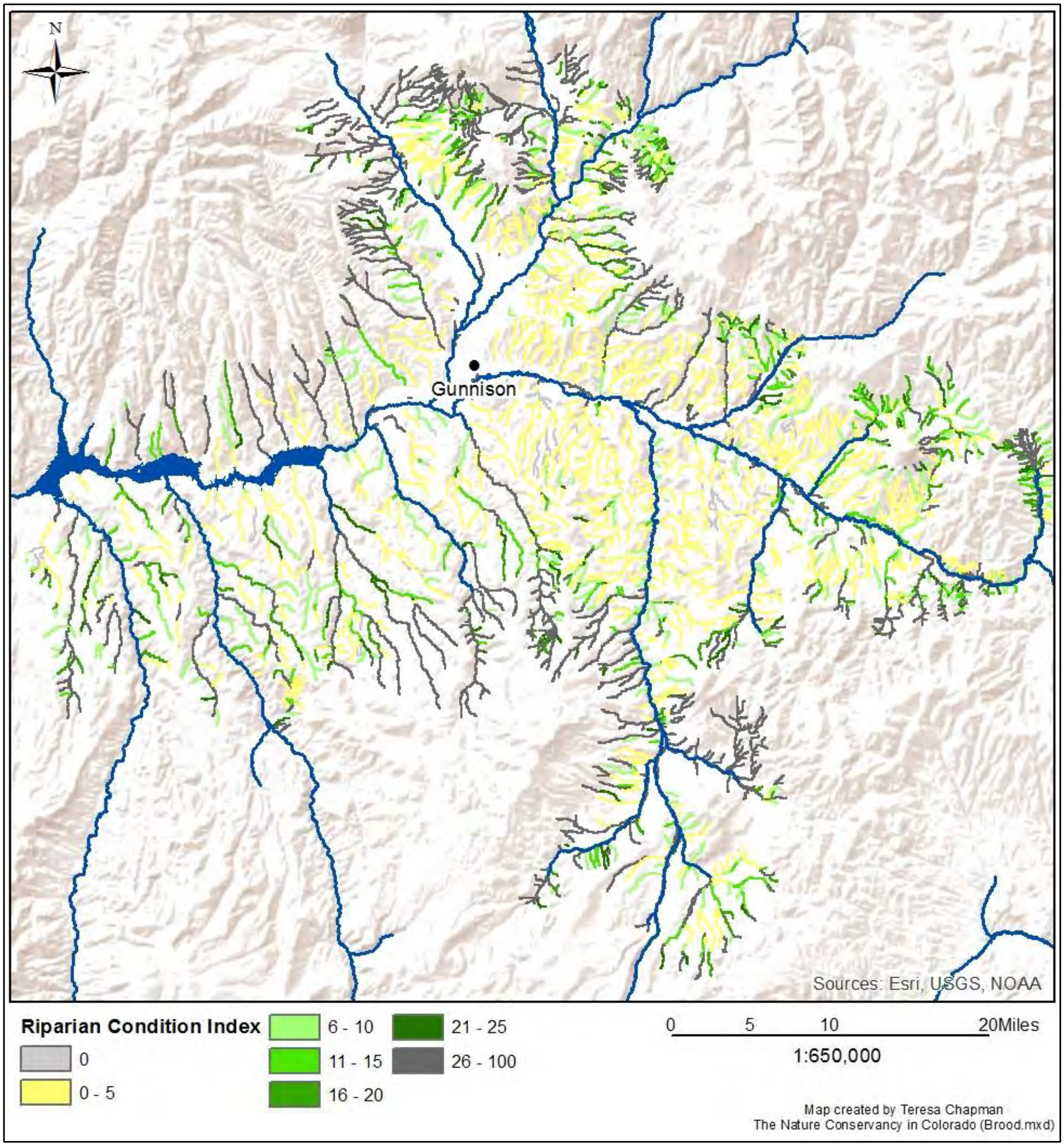


Figure 12. Riparian Condition Index across the Gunnison Basin. Within the streams that scored high for Restoration Potential Index and in close proximity to leks, we estimate that approximately 529 streams show promise to greatly improve the extent of riparian vegetation based on the Riparian Condition Index (scored between 1-25). We used a threshold between 1and 25 on the Riparian Condition Index to prioritize wetlands where we could significantly increase riparian acreage. These streams total 265 stream miles and 750 acres of current riparian vegetation.



Results

The results of these four criteria result in 529 high priority stream reaches within 32 sub-watersheds in the Gunnison Basin. These streams total 272 stream miles and 765 acres of current riparian vegetation. Not all of the stream miles will require or be feasible to restoration (Figure 13). Field assessments will determine the number of stream miles within each stream reach that will need restoration. The area of riparian acreage is most likely a more appropriate metric for restoration need. To arrive at this result, we reduced the number of stream reaches at each of the four criteria.

There are 4,410 stream reaches in the Gunnison Basin that contain Gunnison sage-grouse brood rearing habitat.

There are 1,883 stream reaches within 2 miles of Gunnison sage-grouse leks, totaling 927 miles of perennial, intermittent, and ephemeral streams and approximately 5,540 acres of current riparian vegetation.

Of the total stream reaches near leks, 847 streams measured with Restoration Potential Index above 60, meaning they lost 60-100% of very green riparian area during the drought and indicating they could benefit from current restoration treatments. These streams total 421 miles and approximately 1732 acres of current riparian vegetation.

Within the streams that contained brood rearing habitat, were in close proximity to leks, and scored high for Restoration Potential Index, we estimate that approximately 529 streams show promise to greatly improve the extent of riparian vegetation based on the Riparian Condition Index scored between 1-25. Table 1 summarizes the stream priorities and their metrics within the sub-watersheds.

To put these values into perspective, between 2012 and 2015 the team installed 750 new structures across 32 stream reaches totaling 20 miles and treated 61 acres of riparian vegetation (Figure 14). The team did not work across every mile within those reaches. We prioritized areas within those reaches based on restoration need determined during field assessments.

We estimate that this riparian vegetation extent could potentially double with restoration treatments. Within this estimated stream mileage are smaller areas surrounding the existing riparian vegetation where the work is located. Stream miles are a very rough estimate of the work needed, since restoration happens intermittently between degraded areas.

Figure 13. Map of priority stream reaches identified by the GIS analysis within the Gunnison Basin. High Priority stream reaches are defined as: 1) intersecting brood rearing habitat, 2) within two miles of a lek, 3) with a Restoration Potential Index between 60 and 100 (indicating riparian areas that significantly dried during the drought but maintain greenness during wet years), and 4) with a Riparian Condition Index between 1 and 25 (indicating that the current riparian vegetation occupies a small percentage of the floodplain). Combining these metrics results in stream reaches with high potential to improve by our restoration techniques and to increase resilience to the impacts of climate change, including drought and monsoons.

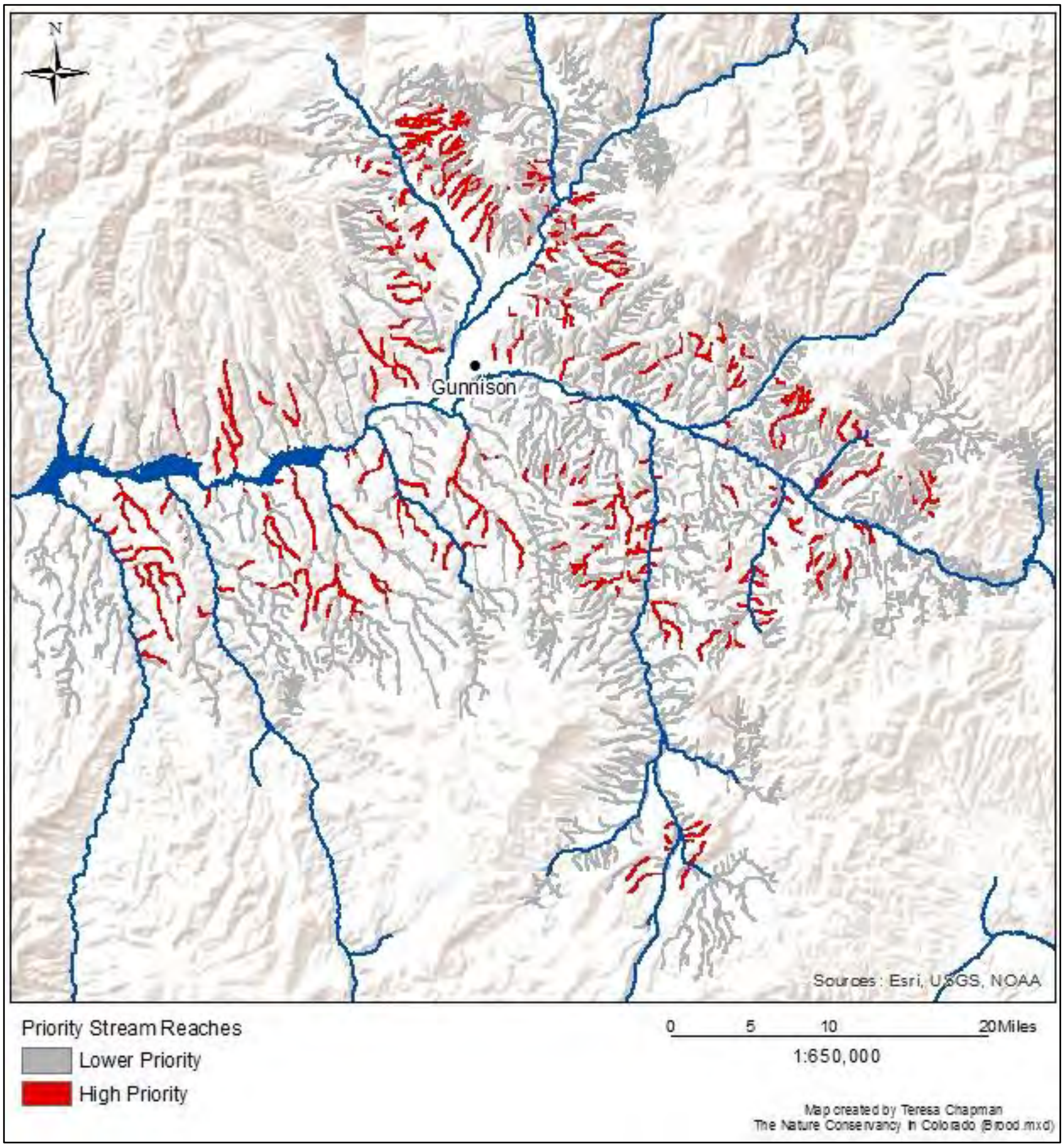


Figure 14. Map of priority stream reaches identified by the GIS analysis within the Gunnison Basin, Priority catchments where restoration structures were constructed and maintained between 2012 and 2016, and potential sites under current review for upcoming seasons.

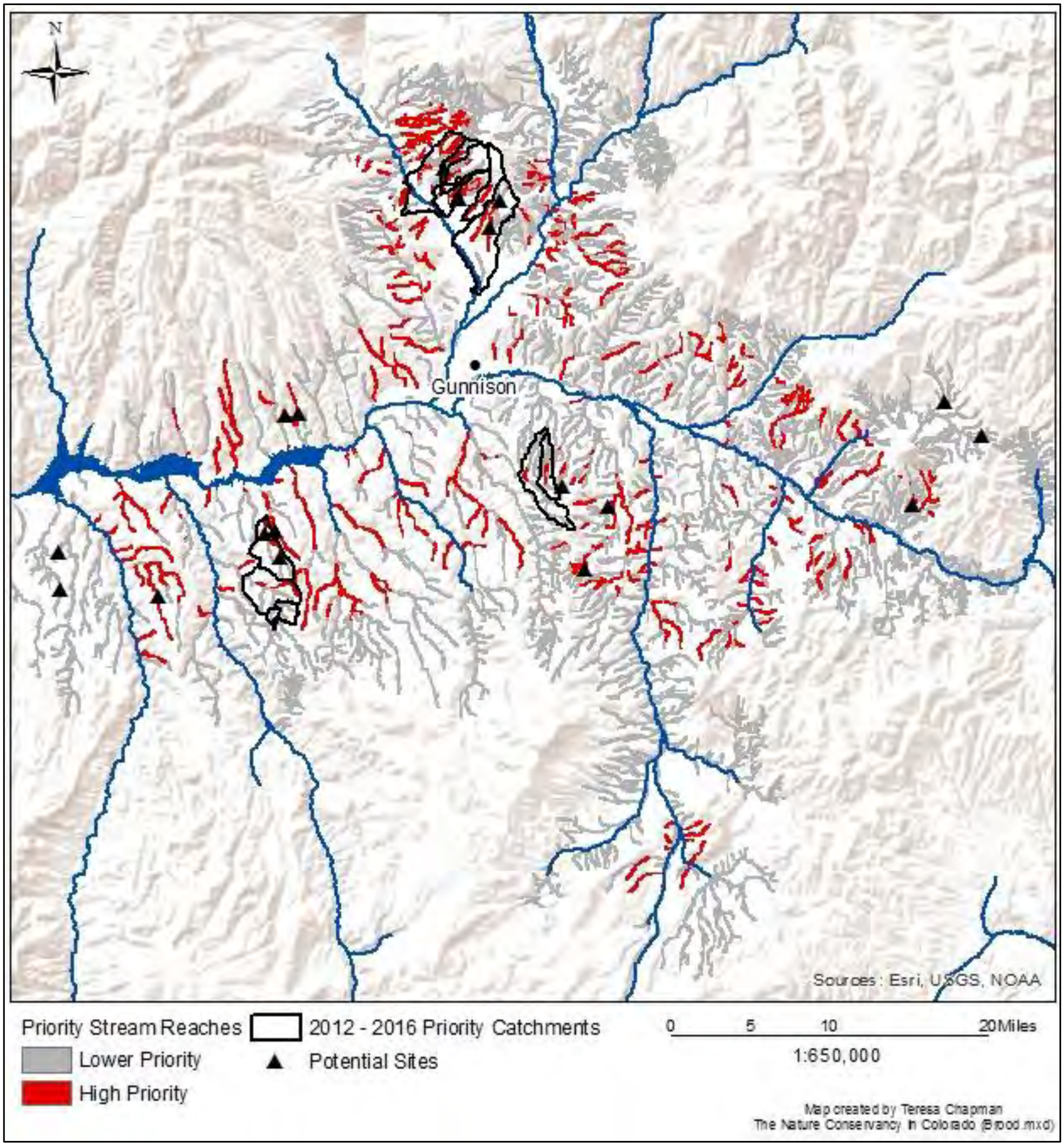


Table 1. Summary of Priority Stream Reaches in the Gunnison Basin by Sub-watershed. An estimated 765 acres of riparian habitat within 32 sub-watersheds would benefit from the restoration techniques in this project.

	Subwatershed Name (Hydrologic Unit 12)	Number of Priority Stream Reaches	Number of Leks within 2 miles Mean (+-SD)	Restoration Potential Index Mean(+-SD)	Riparian Condition Index Mean (+-SD)	Acres of Riparin Vegetation in 2011	Miles of Priority Stream Reach
1	140200030506	5	1 (+-0)	84.6 (+-16.7)	6.4 (+-4.4)	10.7	3.4
2	Alder Creek	8	1.9 (+-1)	91.5 (+-8.9)	5.2 (+-6.8)	3.9	3.2
3	Alkali Creek	21	1.1 (+-0.3)	93.5 (+-9.9)	15.6 (+-7.2)	16	8.1
4	Antelope Creek	24	1.5 (+-0.9)	92.2 (+-12.4)	11.8 (+-8.8)	50.3	9.4
5	Archuleta Creek	8	1 (+-0)	87.4 (+-14.1)	7.2 (+-5.3)	11	3.7
6	Barret Creek-Tomichi Creek	33	1.2 (+-0.5)	86.6 (+-14.3)	7 (+-6.6)	50.3	19
7	Cabin Creek	1	1 (+-0)	98 (+-0)	3 (+-0)	1.4	1
8	Chance Gulch-Tomichi Creek	11	2 (+-1.3)	93.3 (+-14.3)	3.2 (+-1.8)	8.4	6.1
9	Goose Creek-Cebolla Creek	1	3 (+-0)	75 (+-0)	12 (+-0)	1.7	0.7
10	Headwaters Razor Creek	2	1 (+-0)	100 (+-0)	9.5 (+-10.7)	1.4	3.3
11	Headwaters Willow Creek	8	1 (+-0)	93.8 (+-9.7)	12.2 (+-8.8)	13.5	5.3
12	Hot Springs Creek	17	2.3 (+-1)	89.5 (+-12.7)	5.6 (+-4.7)	21.3	11.1
13	Long Gulch	30	2.5 (+-1.3)	95.2 (+-9.8)	6.6 (+-6.5)	31	13.2
14	Long Gulch-South Beaver Creek	11	1.9 (+-0.9)	88.2 (+-13)	7.6 (+-5.7)	21.4	7.4
15	Lower East River	11	1.3 (+-0.5)	90.5 (+-12.8)	7.9 (+-6.8)	7.6	4.6
16	Lower Ohio Creek	79	6.6 (+-2)	92.7 (+-10.3)	8.3 (+-6.8)	100.8	37.3
17	Lower Quartz Creek	6	1.5 (+-1.3)	90.5 (+-14.6)	11.9 (+-8.5)	8.4	2.4
18	Lower Taylor River	5	1 (+-0)	85 (+-15.6)	8.4 (+-8.7)	2.7	1.8
19	Middle Ohio Creek	29	4.4 (+-1.7)	99.3 (+-2.4)	9.3 (+-6.7)	24.9	17.2
20	Mill Creek	1	1 (+-0)	95 (+-0)	4 (+-0)	0.6	0.4
21	Outlet Cebolla Creek	7	1 (+-0)	83.2 (+-16.3)	11.9 (+-6.2)	13.2	3.9
22	Outlet Cochetopa Creek	37	1.6 (+-0.9)	92.2 (+-11.7)	7.9 (+-6.5)	32	14.3
23	Outlet Lake Fork	18	3.2 (+-1.3)	89.4 (+-13.1)	10.9 (+-7)	44.1	6.6
24	Outlet Razor Creek	19	1.4 (+-0.9)	89.7 (+-13.2)	8.6 (+-7.6)	46.8	7.8
25	Pine Creek Mesa-Blue Mesa Reservoir	9	1.4 (+-0.5)	93.6 (+-6.9)	10.5 (+-6.2)	16.9	3.5
26	Sewell Gulch-Tomichi Creek	11	1.7 (+-0.6)	95 (+-10.2)	6.8 (+-8.3)	7.6	5.6
27	Sheep Gulch-Gunnison River	52	2.3 (+-1.3)	86.6 (+-14.2)	7.6 (+-7.2)	48.6	28.4
28	Steers Gulch-Gunnison River	6	1.7 (+-1.1)	91.4 (+-13.5)	6 (+-5.9)	16	4.5
29	Stubbs Gulch	11	1 (+-0)	94.6 (+-8.1)	5.7 (+-6.2)	25	6.2
30	Sugar Creek-Willow Creek	10	1.3 (+-0.5)	86.2 (+-10.7)	14.5 (+-8.3)	46.7	6.1
31	Willow Creek-Blue Mesa Reservoir	23	2.1 (+-0.7)	96 (+-5.2)	6.8 (+-6.2)	61.4	13
32	Wood Gulch-Tomichi Creek	27	1.8 (+-0.7)	92.9 (+-10.3)	6.3 (+-4.8)	19.9	13.9
	Total					765.5	272.4

Once the GIS analyses were completed, the team filtered the resulting stream reaches by feasibility, land-ownership, and local knowledge, conducted rapid field assessments to verify restoration need, and revisited the sites to design specific restoration treatments. We consider the following criteria for feasibility and restoration need:

1. Landownership and willingness of landowners,
2. Status of NEPA process,
3. Accessibility (first cut),
4. Proximity to other sites to increase efficiencies,
5. Opportunities for scaling up more efficiently, and
6. Geographic representation across the basin.

We also conduct rapid field assessments to determine specific restoration needs and treatments. This assessment includes completion of a field form developed by CNHP which aims to evaluate:

1. Restoration potential problems, e.g., head cuts, compaction, roads, etc.,
2. Level of work needed,
3. Accessibility,
4. Potential for significantly increasing stream miles,
5. Importance for Gunnison sage-grouse,
6. Opportunity for increasing efficiency,
7. Adjacent sagebrush habitat condition, and
8. Overall rank and refine priorities

We also consider other factors to consider for determining where to work:

1. Upstream supply of sediment
2. Ease of access for delivery of materials
3. Complete repair and maintenance work started when needed Priority sites identified for pilot
4. No regrets sites
5. Potential for significantly expanding miles or acres
6. High potential for success
7. Opportunity to increase efficiency in scaling up
8. Opportunity to demonstrate a new tool, e.g., plug and pond
9. Importance for Gunnison sage-grouse
10. Willing landowner/land manager

Updated October 26, 2016. With input and review by Gay Austin, Andrew Breibart, Jonathan Coop, Betsy Neely, Shawn Conner, Chris Pague. Renee Rondeau, Nathan Seward, Mike Pelletier, Imtiaz Rangwala, and Meg White.

APPENDIX G

PRE AND POST RESTORATION TREATMENT PHOTOGRAPHS

WEST FLAT TOP MOUNTAIN, US FOREST SERVICE

(Photography by Matt Vasquez, US Forest Service)

USFS South Cottonwood Upper

2016 - Pre (May) and Post (August) Treatment Photos, Page 1

➢ *Arrow indicates direction of water flow and matches pre and post photo positions*

2016 - Pre (May) and Post (August) Treatment Photos, Page 2

- *Arrow indicates direction of water flow and matches pre and post photo positions*

Enhancing Ecosystem Resilience of Riparian/Wetland Habitats in the Upper Gunnison Basin
Site Location: GMUG National Forests, Gunnison Ranger District - Flat Top Mountain

2016 - Pre (May) and Post (August) Treatment Photos, Page 3

➢ *Arrow indicates direction of water flow and matches pre and post photo positions*

2016 - Pre (May) and Post (August) Treatment Photos, Page 4

- *Arrow indicates direction of water flow and matches pre and post photo positions*

South Cottonwood Private

Top Photo: August 20, 2015 (structure completion date); Bottom Photo: May 26, 2016,

- *Arrows indicates direction of water flow and matches 2015 and 2016 photo positions*

Bebb's Willow

- *Arrow indicates direction of water flow and matches pre and post photo positions*

Bebb's Willow

2016 - Pre (May) and Post (September) Treatment Photos, Page 7

- *Arrow indicates direction of water flow and matches pre and post photo positions*