Burro Cienaga Grasslands Restoration Plan & Progress: Pitchfork Ranch – DRAFT

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The Nature Conservancy in New Mexico

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Mission:

Improve grassland habitat for Aplomado falcon, pronghorn and other grassland dependent species on over 2700 acres of A.T. and Cinda Cole's Pitchfork Ranch, a part of the Hachita – Burro Cienega grassland complex priority Sky Island grassland assessment (Gori et al. 2012).

Goals:

1. Reduce shrub encroachment through herbicide treatment and re-establishment of fire regimes to restore and maintain open grassland conditions.
2. Install erosion control structures to prevent continued movement of headcuts and reduce sheet erosion and gullying in five drainages in order to reduce soil erosion, and increase water retention and grass cover.
3. Repair and prevent damage caused by improperly installed dirt stock tanks to reduce soil erosion and water loss through evaporation, and increase infiltration and overall watershed health

4. Establish a long term monitoring plan to document erosion control success, changes in plant diversity and cover, changes in mesquite encroachment, rainfall patterns and groundwater level

Introduction

The Pitchfork Ranch is located within the Burro Cienaga – Hachita Priority Grassland area (Gori SIGA ref), identified in the Sky Island Grassland Assessment as one of 12 priority valley grassland landscapes where the potential for restoring intact grasslands and recovering grassland-dependent wildlife has the greatest probability of success across the region. The ranch is located 60 miles south of Silver City and northeast of Lordsburg, New Mexico. Owners Tom and Cinda Cole are committed to the conservation and restoration of a significant riparian area and surrounding grasslands on their ranch, and have placed all private deeded land in a restrictive conservation easement. This grassland restoration project adds to a long list of restoration projects that began in 2005, including those funded by the US Fish and Wildlife Service, Natural Resources Conservation Service, and Bureau of Land Management.

The Pitchfork historically contained over 4,600 acres of desert grasslands, and is adjacent to over 50,000 acres of relatively intact desert grassland. Desert grasslands such as these have undergone dramatic vegetation changes over the last 130 years including encroachment by shrubs and loss of perennial grass cover (Humphrey 1958, Bahre 1991). Historically, frequent wildfires maintained open, shrub-free grasslands, but with over 100+ years of fire suppression, shrubs have increased causing the degradation and loss of grasslands regionally (McPherson 1995). In southern New Mexico, southern Arizona and northern Mexico, an estimated 35% of historic borderland grasslands have been lost due to shrub encroachment (Gori and Enquist 2003; Yanoff et al. 2008). Shrub encroachment and conversion alters watershed hydrological function including water capture, infiltration and recharge (Wilcox et al. 1988; Woolhiser et al. 1990). It also reduces perennial grass cover and available forage and seed and eliminates the low and open structure necessary for grassland-dependent species.

To improve grassland condition we have taken a systematic approach to map ecological sites & states across the entire ranch, and identified 2,700 acres as the most cost-effective, contiguous, restorable grasslands in which to focus our efforts. We have applied treatments on the ground including herbicide shrub treatment and erosion control structures to increase grass cover and improve the hydrologic function of these grasslands. We have also prepared a fire management plan and prescribed burn plan for the entire ranch. We feel that by reducing shrub encroachment and stabilizing soils, we will be prepared to return fire to this landscape, and to manage shrub encroachment and maintain open grassland at a large scale within the Burro Cienaga grasslands.

Figure 1. Pitchfork Ranch, located within the Burro Cienaga Hachita Priority Grassland Landscape.

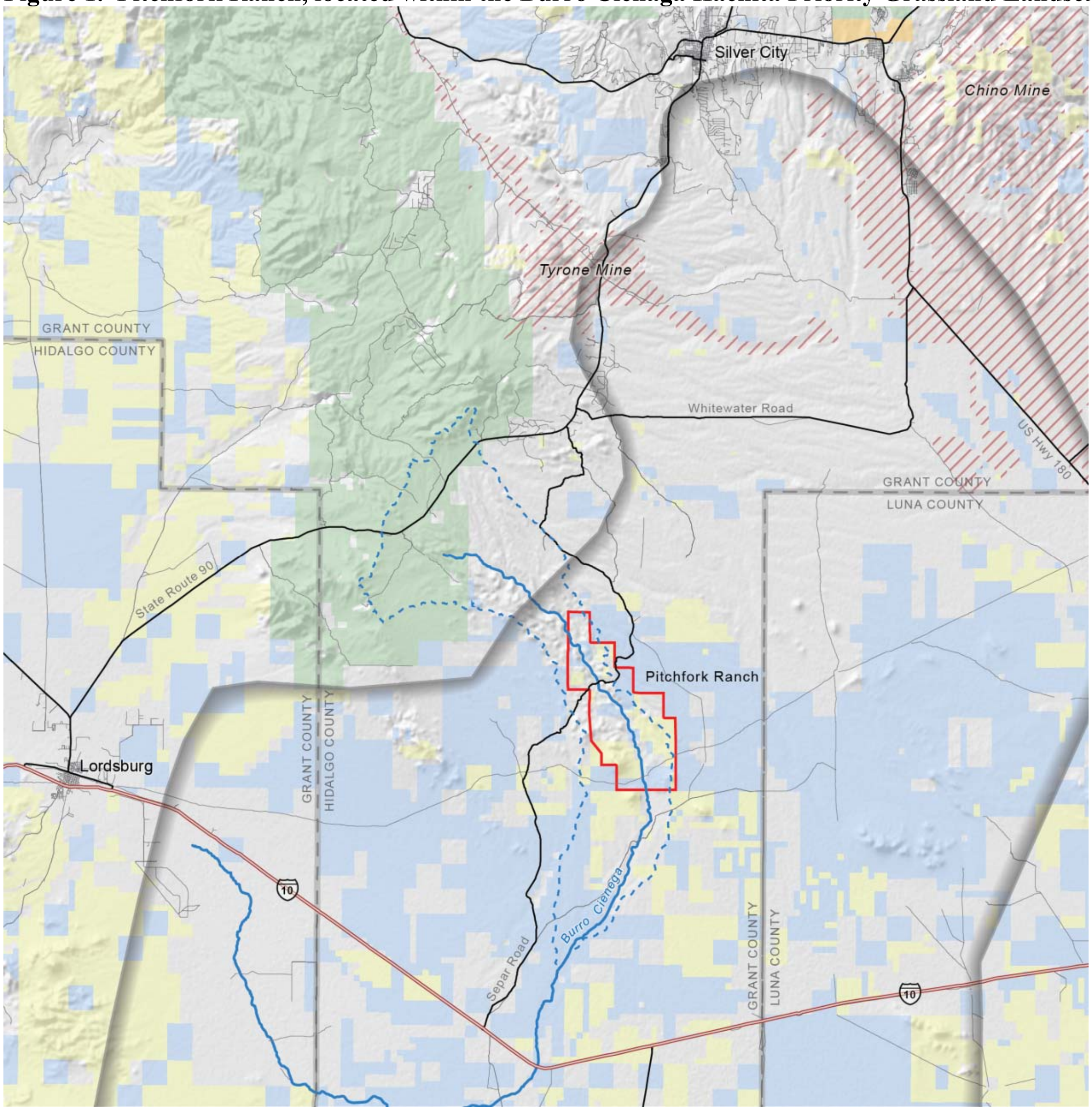

Table 1. Project Milestones

Date	Description
December 2010	Interdisciplinary team from BLM, JER and TNC met at the Pitchfork to identify suitable restoration sites on BLM land and begin preparing NEPA
June/July 2010	Field visits to plan treatment locations
April/May 2011	Karla Sartor began as project manager
	Identified project outcomes within the Pitchfork Ranch and identified specific treatments along drainages with subcontractor Joseph Franklin-Owens
June 2011	Measured erosion features prior installation of erosion controls structures (e.g. headcut & gully size & position)
	Installed permanent erosion and photo point monitoring locations and captured pre-treatment photos
	Updated plant species list for seeding
July 2011	Identified potential Phase II restoration sites
	Mike Marshall completed archeological clearance for Phase II
	Prepared TNC – Coles contract for Phase I
	Bill Zeedyk prepared restoration plan for dirt tanks & surrounding reaches
August 2011	TNC & JER field visit to prepare for Ecological State Mapping & NMSU student erosion control modeling
	Completed fence integrity check and smooth bottom wire replacement
September 2011	TNC & JER completed state mapping of ranch
	TNC & NMSU installed vegetation monitoring plots
	Received BLM Notice to Proceed September 26th
Oct./Nov. 2011	Completed installation of Phase I erosion control structures
December 2011/ Jan 2012	Coordinated site visit and information exchange event with neighboring ranchers
	Interpreted JER ecological site maps & prepared initial shrub control restoration
February 2012	Consulted with hydrologist Ellen Soles to monitor erosion control structures
	Completed cooperative agreement for Phase II, including all subcontractor estimates
April 2012	Met with neighboring landowner to discuss future restoration opportunities in the Burro Cienaga grasslands
	Installed groundwater, rainfall, and channel cross section monitoring
	Site visit with fire management contractor Steve Bumgarner

May 2012	TNC presented ecological state mapping decision support tool at Madrean Archipelago Conference in Tucson, AZ
	Completed installation of Phase II erosion control structures
Jun-12	Seeded Phase II erosion control structures & installed mulching and soil pitting trials
	Installed monitoring plots for mesquite encroachment & Phase II erosion control structure monitoring
	Coordinated second information exchange event with neighboring landowners
	Established a shrub herbicide treatment trial
Jul-12	Submitted proposal to fund expanded restoration work in the Burro Cienaga Grasslands
	Finalized & approved Pitchfork Ranch Fire Management Plan and Prescribed Burn Plans
September/October 2012	Visually survey structures for integrity, repair as needed
	Evaluate monitoring plot statistical power, add additional plots as needed, and perform measurements
	Download rainfall & ground water data loggers

Erosion control

Project Planning

The Pitchfork Ranch was identified as a potential partner with BLM land in 2010. Owners A.T. and Cinda Cole were agreeable to grassland restoration, and had already initiated riparian restoration within the Burro Cienaga watershed. In December 2010, Steven Yanoff and Dave Gori (TNC), Ray Lister, Jack Barnitz and Corey Durr (BLM), and Brandon Bestelmeyer (JER) met to identify restoration and mapping opportunities on BLM land at the Pitchfork Ranch. Two drainages with severe erosion (photo) were identified as the best restoration opportunity to test small rock dams to slow runoff and increase infiltration. In addition, these treatments would arrest progression of a large headcut, threatening the most intact portions of a high quality tobosa swale. Mapping ecological states across the ranch was agreed upon as a decision support tool for identifying specific areas for shrub control.

Staff turnover at TNC in the spring of 2011 (Karla Sartor was hired to replace Steven Yanoff) led to some delays in implementation. There were several delays in the NEPA process, including scheduling BLM resources experts, and a severe fire season in the summer of 2011 further straining BLM resources.

Description of Treatments

Rock erosion control structures

Erosion control structures were installed in five sub-watersheds, and along two ranch road sections (Table 2). Installation occurred in two phases; the first was in October and November of 2011, and the second was in March and April of 2012. A total of 38 rock structures were installed within two gentle grassland drainages in Phase I, and an additional 67 structures were installed in Phase II within four separate drainages, and along 800m of ranch roads (Figure 2). Upon final notice to proceed from the BLM, the first structures were installed in October 2011. We had delivered over 500 tons of rock for this project. These rocks were first from a staging area to each the drainages, and any leftover rock material was left onsite for use in future maintenance of rock structures.

The structures we built were inspired by Bill Zeedyk, and include media lunas, one rock dams, boulder filter dams, cross-vanes, Zuni bowls, rock rundowns and boulder baffles (Zeedyk reference). All of these structures but boulder baffles are used for vertical control, or lessening the grade of a reach, and are used to repair incised channels by slowing flow velocity and capturing sediment to raise the bed, and allow flood events to reach the floodplain. Below is a short description of all types rock structure installed.

Low grade sheet erosion control

Media luna structures or spreaders are used in low grade areas with low vegetation cover where sheet erosion is occurring. These are a long, slightly curved line of rocks designed to slow and spread flow, prevent gully formation, and increase water retention.

Gully stabilization

One rock dams are so named because they are only one rock tall, but can be several rocks wide and deep. Rocks are placed tightly together across a channel, flaring up toward the banks, and several rocks deep (photo). These structures act as a rock mulch to slow flow and trap sediment

Boulder filter dam structures are used for slightly larger gullies, with larger 'footer' rocks secured in a trench at the base, then successively smaller rocks above, which will shift into the interstices of the boulders as water flows across the structure.

Cross-vane structures are designed in an arch, with the downstream 'arms' at a higher elevation than the pour over, to concentrate flow in the center of the channel and reduce stress along the banks (photo). A scour pool will develop below the structure, which is a natural grade control where water loses energy when it comes in contact with pooled water. Cross-vane structures are used where the grade drop relatively low.

Headcut stabilization

Zuni bowls are used where a larger drop, or more vertical wall exists (a headcut), and are used to develop drops to two plunge pool, and therefore a more gradual overall grade. This is a term adopted by Bill Zeedyk, after he observed people from the Zuni pueblo in New Mexico building this type of structure to control headcuts (Zeedyk ref). For very large headcuts, such as our 'large headcut' (see location in Figure 5) a double Zuni bowl, or two consecutive Zuni bowls can be designed. See Figure 7 inset map in the Monitoring section for a fine scale contour map of the double Zuni bowls designed for the large headcut area.

Rock rundown structures are used for shallow headcuts only, or in conjunction with Zuni bowls to arrest larger headcut progression. First the steepness of the headcut must be laid back, and then rocks will line this new, shallower gradient to stabilize soil and encourage vegetation colonization.

Induced meandering

Boulder baffles were the only Bill Zeedyk designed 'induced meandering' approach for lateral control of a reach that has lost sinuosity. Rocks are placed at the side of a channel in a triangular shape to deflect water from one side, and erode the opposite bank to create a meander in the reach. Baffles are carefully designed to be an appropriate size and distance from each other, as calculated on the size of the gully and watershed. This approach was used above the small Butterfield dirt tank (described below).

Table 2. Erosion control sites (sub-watersheds). Aplomdo Rd. is within Aplomado Drainage sub-watershed.

Phase	Site Name	Land Ownership	Map Section	~ Acres	Treated Reach length (m)	Description
Phase I	Aplomado Drainage	BLM	20 & 21	310	1500	Broad, shallow drainage near Aplomado hack site, contains good condition tobosa swales with severe headcuts, and is adjacent to best condition grassland on the Pitchfork and neighboring ranch
	A.T. Cross Drainage	BLM	29 & 28	220	880	Low grade drainage with many small erosion features
Phase II	Small Butterfield Dirt Tank	Cole	29	200	490	Failed stock tank was decommissioned and erosion control structures installed upstream & downstream
	Large Butterfield Dirt Tank	Cole	29	350	70	Intact dirt tank with severe erosion upstream, downstream, and sideslope. Re-engineered to armor new spillway and stabilize soils
	Alligator Juniper Drainage	BLM	29	130	100	Low grade drainage with small headcutting, installed grade control structures
	Left Drainage	Cole	29	30	150	Small drainage with small erosion features to control
	Mine road	BLM	29	100	450	Main road to South-eastern quadrant of ranch, installed one-rock side channels
	Aplomado road	BLM	20 & 21	*	350	Road to Aplomado hack site, installed water diversion contours across road

Figure 2. Erosion control structures & Herbicide trial area

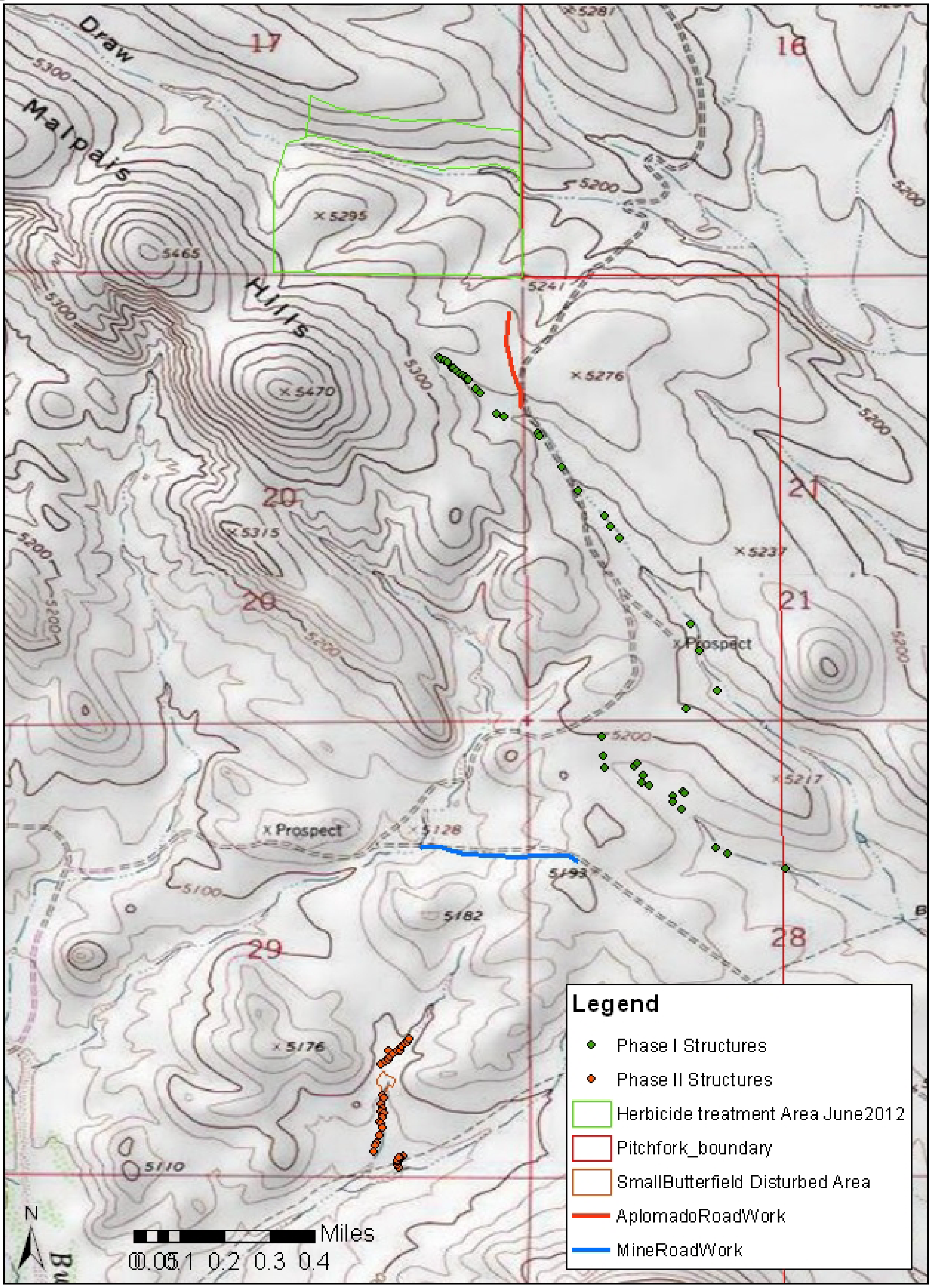

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Table 3. Number and type of rock structures installed in each drainage/sub-watershed and quantity of materials required. Aplo. = Aplomado drainage, Butfld. = Butterfield drainage, Allig. = Alligator drainage.

Rock structure name	**Phase I Drainages**		**Phase II Drainages**						**Total**
	Aplo.	AT Cross	Small Butfld.	Large Butfld.	Left	Allig.	Aplo. Road	Mine Road	
media luna	2	5					5		***19***
one rock dam	7	8		5	3		5	2	***45***
cross vane			6			5			***18***
filter dam			7						
Zuni bowl	4		3		2			2	***15***
rock run down	4	6	1	1		10			***32***
rock run down	2								***4***
rock baffles			10						***10***
Total	***19***	***19***	***27***	***6***	***5***	***15***	***10***	***4***	**143**
Materials (tons)									
Small rock (4 - 8" diameter)	120	100		100		35	5		
Large rock (up to 20" diameter)			100		10	40		30	**540**

Seeding

All rock structures were seeded with native seed after completion. Nearby soil was spread overtop to limit granivory, and rock structures were swept with a broom to move seeds and soil into inter-rock spaces. Species were selected from a plant list developed during a planning field visit in 2011, and purchased from Curtis & Curtis, in Clovis, NM (Table 4). We selected varieties grown as close to the Pitchfork as possible.

Table 4. Native seed mix used.

grass species	**Phase I**		**Phase II**	
	PLS lbs.	% of mix	PLS lbs.	% of mix
sideoats grama	14.4	30%	13.5	30%
black grama	6.2	13%	2.25	5%
blue grama	16.8	35%	15.75	35%
galleta	10.6	22%	4.5	10%
plains bristlegrass	n/a	n/a	9	20%
Total	48 lbs PLS, 77lbs total		45 lbs PLS, 76 lbs total	

Photo monitoring points were installed near all unique style of structures in the Phase I drainages, and in representative locations in Phase Two (Figure ref). For a full description of the ranch-wide monitoring plan, see the monitoring section below.

The total sub-watershed area treated is over 1300 acres, and is already being used as a demonstration site for outreach and to understand rock structure effectiveness.

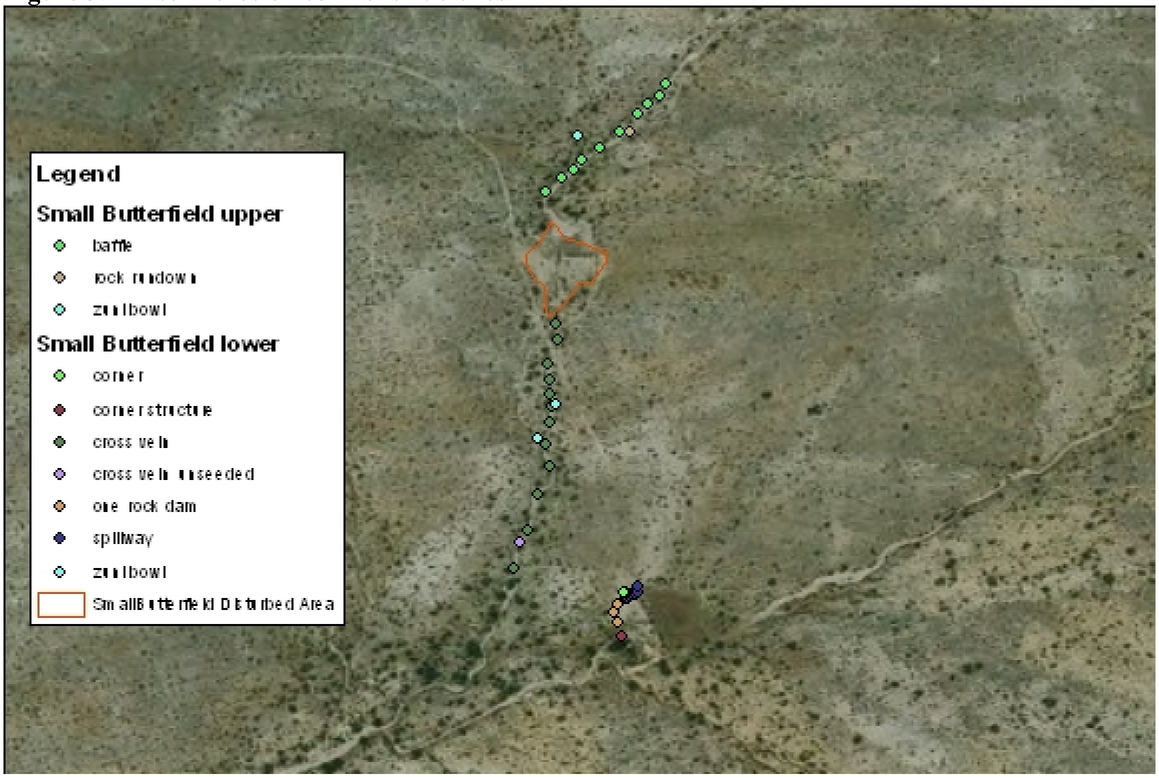
Dirt stock tanks

The second phase of erosion control structures also included stabilization of a failed dirt tank (Small Butterfield) (photo) and the erosion problems created by it both up and downstream of the tank (photo). When these tanks cause channel incision, this often leads to side-slope erosion as well, which is what we have observed with the Butterfield tanks, and why we felt it was important to repair these channels before they put the entire sub-watershed at risk. This work also included restoration of an intact but failing dirt tank (Large Butterfield) that was designed to reduce further channel erosion, decrease evaporative water loss, and allow more water to recharge the alluvial floodplain aquifer downstream of the tank. Consultant Bill Zeedyk was hired as a sub-contractor to design the most ecologically beneficial restoration for the tanks and areas surrounding these tanks, because channel incision was more severe in these drainages and tank engineering more complex than in the work in Phase I.

It is clear that left unchecked, improperly designed stock tanks alter drainage flow such that soil erosion is a big problem. Prior to treatment, the Small Butterfield Tank had a breached dam in one small section of the center, which likely concentrated large flows and accelerated downstream erosion. Channel incision (4-6 feet upstream and downstream of the impoundment) results in reduced flow available to the surrounding floodplain vegetation. We now see an increase in mesquite encroachment in these former floodplain areas, as deep rooted mesquite were able to access water better than grasses.

The recommendation for the failed dirt tank was to use a bulldozer to level the existing dam, and re-contour the drainage to reintroduce the natural meander this reach had previously. Above the Small Butterfield Tank we used an 'induced meandering' approach, using rock baffles to increase sinuosity of the channel, which will eventually return flow to the floodplain (Figure 3).

Figure 3. Phase II erosion control structures



The Large Butterfield Tank was intact, but inefficient, in that it was designed to capture 100% of the runoff from the watershed, "robbing" water from downstream reaches. It was recommended that a smaller tank would provide suitable water for livestock and allow more water to move below the tank during runoff events, reducing water lost to evaporation. Additionally, the current spillway was poorly constructed (no rock armoring) and had severe erosion occurring (headcuts greater than 10 feet tall). To resolve these problems, we relocated the spillway from river left to river right, redirecting the flow away from erosion prone areas that would be difficult and costly to repair, and reducing the height of the spillway by five feet, to impound less water and lose less to evaporation.

We originally obtained proposals for redesigning of four tanks (one failed and one intact), but chose to leave those tanks as is to serve as both a comparison to what we have done with the Butterfield tanks, and because the risks and benefits were less compelling to implement costly remediations. One failed tank is located far from any accessible roads, and both tanks did not have the excessive erosion problems that the Butterfield tanks had. An unintended consequence of decommissioning the Small Butterfield tank was the large bare ground area (~ 1 acre) left after recontouring. We used this opportunity to perform a trial of seeding, mulching and soil pitting treatments to revegetate and stabilize soils.

Revegetation trial

Broadcast seeding with the same native seed mix used within rock structures was applied with a small, hand push broadcast seeder to the upslope half of all treatment plots. The lower half of all plots was left unseeded as a control. The seed was then integrated into the soil with an old harrow (pic ref), and the harrow was also used to break up soil in the unseeded areas.

We applied four different treatments to improve seedling establishment (Table 5). One treatment was applied within each of four strip plots installed on the shallow slope (~60' X 15' plots) (Figure 4 and Table 5) and three treatments were applied within six plots on the steeper slope (~40' X 10' plots, not shown). The soil was too shallow for vertical mulch to be installed.

Figure 4. Small Butterfield area revegetation trial

Table 5. Soil stabilization & moisture retention treatments. Each plot also included a sub-plot where half of the plot was seeded, and half was left unseeded.

Treatment	Description
Soil pitting	seeding by hand into hand dug 'soil pits' (Bainbridge ref)
Vertical mulch	Sticks & brush 'planted' into the soil by hand to encourage infiltration and provide shade for seedlings (Sky Island Alliance ref)
Woodchip mulch	80% cover of Gila Wood Products woodchips
Control	no mulch, no pitting

'Zerosion'

As a part of our soil stabilization & revegetation trial, we included an experimental product developed by Gordon West of Gila Wood Products. This product is a non-toxic, bonded wood chip material designed to adhere firmly to bare soil, increasing soil moisture retention, and to prevent rill development on steep slopes. To make this a cost effective approach, we used Zerosion in a similar manner that straw wattles would be applied along the contour of steep slopes rather than bonded woodchip mulch across the entire study area, which would not be cost effective to scale up. Two long berms (~250' long, 3" high & 8" wide, tapered to ground) were installed in contour to the low slope area of the restoration study area (picture/figure ref), and two shorter (~80' long) berms were installed in the steeper slope portion of the restoration area.

Zerosion is applied using a blower to distribute the woodchip material from a dump truck pile to the restoration site, at a maximum of 200(?) ft. The bonding agent (a non-toxic salt based chemical) is mixed with water and applied from a separate hose simultaneously with the wood chips (photo?).

The potential advantage of 'zerosion berms' to straw wattles is that they have a larger surface area in contact with the soil, where straw wattles are round and do not have much product to soil surface contact, often resulting in catastrophic failure. Zerosion berms are significantly more expensive than straw wattles, but if they work this may be a worthwhile investment for difficult to restore areas, rather than smaller investments in products that do not perform. An additional problem that we faced with a few trial straw wattles installed in the Phase I drainages, was that the plastic netting enclosing the straw was chewed through and straw removed by pack rats, which will significantly reduce the life of this treatment. In hindsight there was a packrat (?) mound nearby, and other straw wattles further from mounds were untouched.

In addition to Zerosion berms, Zerosion was applied to one headcut area in a side drainage near the Small Butterfield Tank. In this trial bonded mulch was applied directly to the headcut area in an even coating (pic ref). If this material holds up to a heavy rain flow, the approach may be more cost effective than using small rock structures. The downside to the Zerosion approach is that it must be applied fairly close to a road; otherwise the several pieces of heavy equipment necessary (wood chip truck, water truck, & Zerosion blower flatbed truck) cause their own disturbance.

Ecological state mapping & restoration planning

Working with the Jornada Experimental Range (JER), we completed a fine-scale condition map of ecological sites, states and erosion risk for the Pitchfork Ranch. The mapping methods are described in detail in Steele et al. (2012), Burkett et al. (2011) and on the JER website http://jornada.nmsu.edu/esd/state-mapping6. There are currently very few people trained to perform ecological state mapping. In September 2011, Karla Sartor and Laura Burkett performed two days of field traverse and ecological inventory to verify uncertain aspects of the maps. In consultation with JER staff, we developed a draft "rule set" for interpreting the maps and translating them into management recommendations that identify areas with the highest potential for grass recovery following treatment. These recommendations were presented to BLM staff, and aided in communication about priorities with the Pitchfork Ranch owners, and were presented at the Madrean Conference in Tucson, AZ in May 2012.

At the Pitchfork Ranch, we used the map to identify 3 sub-watersheds where we would apply erosion and brush control treatments. These treatments are described in the following section. Because of the shortened project duration (see above), we began restoration planning with BLM and the Pitchfork owner on two other sub-watersheds (e.g. BLM land) before the state map was completed. The mapping results, however, confirmed the priority of these two sub-watersheds for erosion and shrub control treatments. The state map was also used to plan future shrub control and prescribed burn treatments on the Pitchfork Ranch; for these treatments, we targeted patches of shrub-invaded grassland that were adjacent to high-quality, open grassland, thereby improving grassland condition, directly or indirectly, over a much larger area. These treatments were incorporated into a recent proposal to the NM Natural Resources Trustee Office for grassland restoration on the Pitchfork Ranch and three neighboring ranches in this landscape (see below) covering over 90,000 acres.

Shrub Treatment

This grassland project has always included a shrub treatment component, but these treatments were delayed due to inadequate rainfall in the winter of 2011. With low winter precipitation, mesquite are not biologically active enough to absorb the herbicide and have an effective kill. In spring 2012 we implemented a trial of two different herbicide treatments to test effectiveness, and gather data on cost to more accurately assess funding requirements for future herbicide treatment projects. Under the guidance of a USFS herbicide specialist, we treated over 100 acres in a low density mesquite invasion. These treatments were Pronone Power Pellets (hand application, toss 1 pellet per 1m^3 mesquite canopy) and Velpar DF granulated powder (mixed with water and applied with a backpack sprayer). The pellets were applied to approximately 70 acres in the southern part of the study area, and the spray was applied to approximately 30 acres in the northern portion of the study area. The powder is an attractive alternative, because it is lower cost, and a dye can be mixed with it to ensure that all plants are treated. Pellets are widely used by ranchers because application is very simple. In planning these treatments, we discovered that there is very little documented knowledge about the response to herbicide treatments in the Pitchfork Ranch area. There is no general consensus for how much shrub encroachment and how much erosion potential is too much to have the desired response? It is clear, however that some remaining grass cover is necessary in order to have a positive response to treatment. We feel that this area has the strongest cost/benefit for maintaining open grassland.

Monitoring

We have integrated disparate existing monitoring efforts with new grassland monitoring to implement a ranch-wide monitoring plan. This monitoring program is designed to evaluate the results of grassland restoration described here, as well as riparian restoration along the upper Burro Cienaga, and the combined effect on the Burro Cienaga watershed. This monitoring plan includes photo point monitoring, channel profile descriptions, fine-scale geomorphology mapping, permanent vegetation transects, rain gauges, piezometers, wet/dry mapping, and bird monitoring transects (Figure 5).

Restoration Objectives

1. Headcut position does not move following two strong monsoon seasons
2. Erosion control structures remain as build following monsoons, and are accumulating sediment and are being secured by vegetation
3. Grass cover near erosion control structures increases over five years as measured visually through repeat photo monitoring
4. Mesquite encroachment in grasslands does not increase more rapidly within erosion control drainages as it does outside of treated drainages
5. Measure the success of soil stabilization and revegetation treatments to identify most successful methods for this site

Figure 5. Monitoring overview.

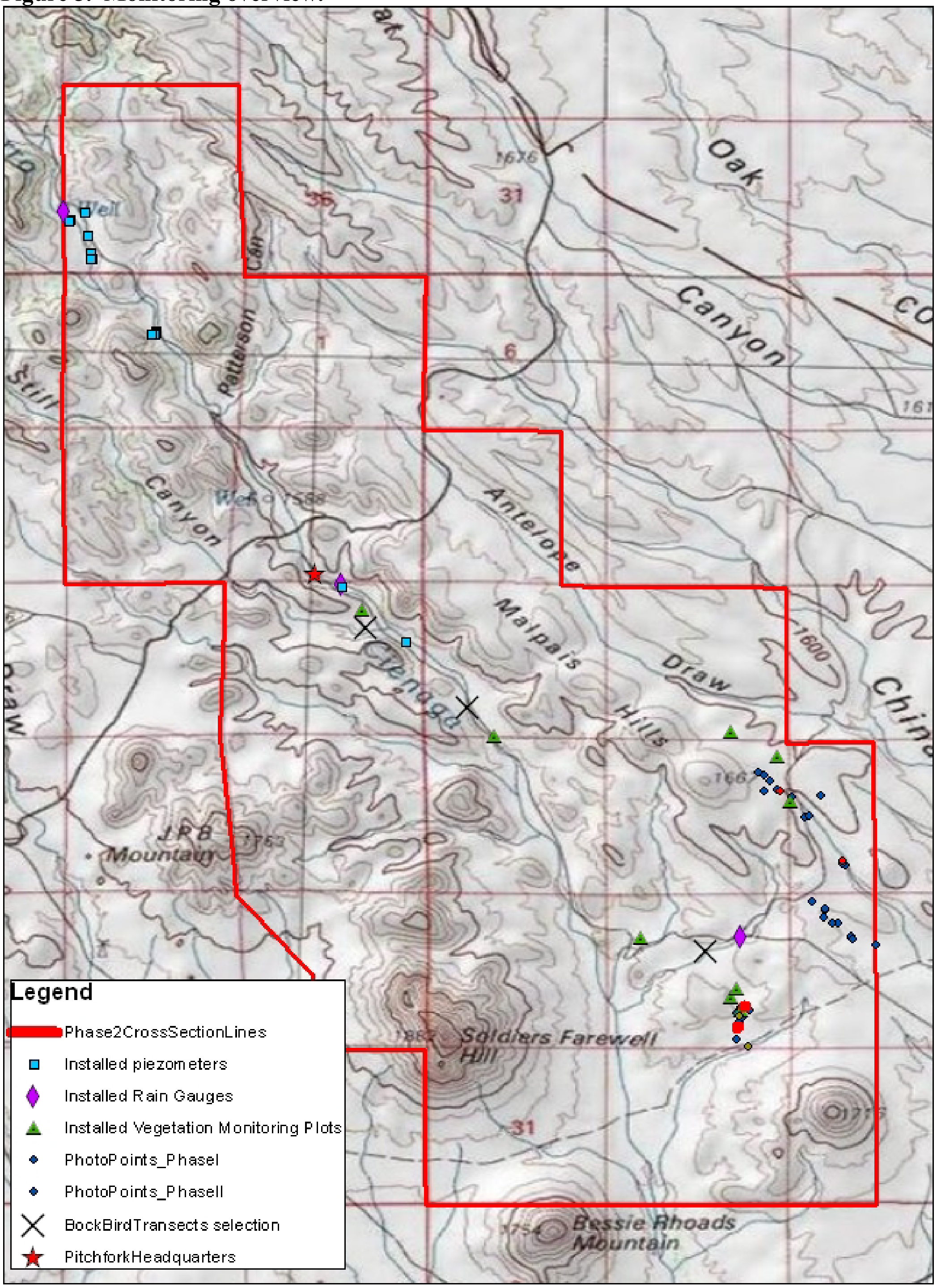


Figure 6. Monitoring in erosion control treatment areas

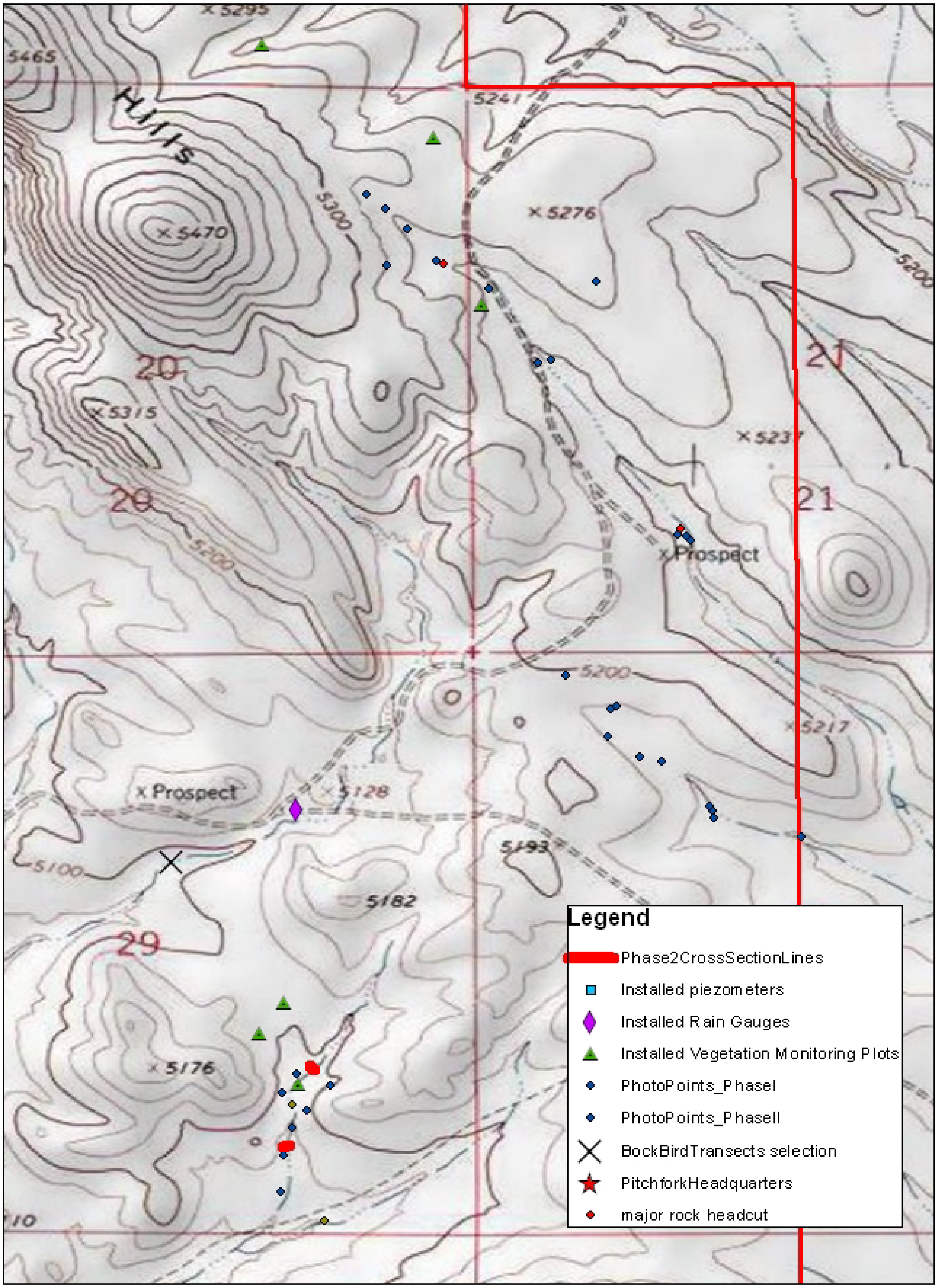


Photo Points

Photo point monitoring included locations at all unique structure types before and after installation, and representative structures in all drainages (Figure 6). A total of x photo points… All photo points were permanently marked with a four foot section of rebar pounded into the ground, and topped with a PVC pipe and adapter which encloses a water tight canister containing pre-treatment photos to ensure continuity of documentation into the future (photo ref). Photos will be taken after each succeeding monsoon season.

Soil Erosion

A number of methods were evaluated for monitoring erosion control structure effectiveness in terms of reducing soil erosion, such as soil moisture retention using soil moisture probes, soil aggradation using soil pins. These were discarded due to recommendations that they were time consuming and expensive, with little valuable data provided, since it is difficult to predict *a priori* how soil and sediment will move, making it difficult to locate these monitoring tools. We have settled on photo point monitoring, visual inspection of structures post flow event, and a trial fine scale geomorphology mapping technique described below.

Broad scale visual indicators of the integrity of one rock dams & Zuni bowls include: 1) All rocks remain in place as designed 2) No evidence of scour holes below or cutting above structures 3) Sediment and debris catchment visible between rocks, 4) Vegetation colonizing the surface of the structures, and 5) headcutting is halted (Zeedyk ref)

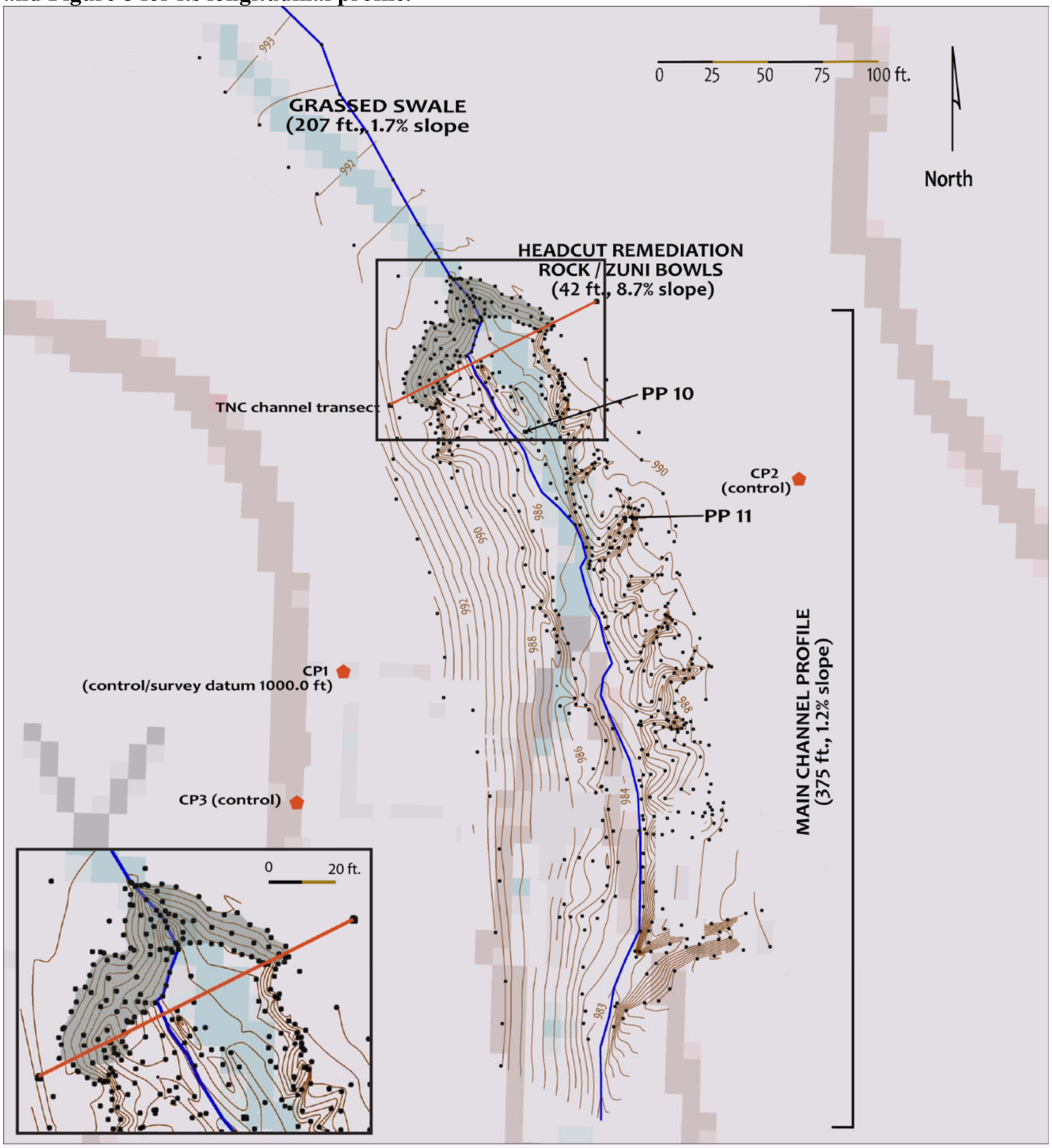
Headcut position & channel cross section

Prior to the installation of headcut remediation structures, we measured the headcut position and rough channel cross section for the large and small headcut areas (Figure 6). We installed permanent monuments on both banks, and measured the position of each headcut from a line between these monuments (Weaver 2005). We also measured channel profile (depth) at 5m intervals along this channel cross section.

The erosion control structures installed in the Antelope & AT Cross drainages were in a broad drainage, with very flat channel cross sections, aside from an area around the large headcut, which will be addressed below. In the Small Butterfield drainage, the gullies formed are much deeper (up to 3m deep), so we installed two channel cross section profiles, to detect changes in channel position and soil aggradation . One profile was located in the upper reach where baffles were installed, and we expect the channel to move. The second profile was installed downstream of the recontoured dirt tank, where several one rock dams were installed and we expect there to be soil aggradation in the long term. We installed permanent monuments on either bank as for the headcut position measurement above, but depth measurements were recorded every two feet across the channels (total length?). Measurements will be repeated after a significant flow event, and every five years thereafter.

We conducted a fine-scale geomorphological assessment of the large headcut area (Figure 6) with the assistance of a Hydrologist from Northern Arizona University, Ellen Soles. We determined that this would best account for soil movement surrounding the rock rundown and Zuni bowl structures, with a complete picture of where soil was moving from and to. A total station (ref) survey of the large headcut area was performed in February 2012, including almost 400ft upstream and downstream of the remediated headcut. This survey method results in a two-foot contour map of the entire area (Figure 7), which reveals double Zuni bowl position, and overall rock rundown slope within the context of the slope of the entire drainage (Figure 8). The survey will be repeated upon visual inspection of soil movement to document exactly where and how much soil has moved around this structure. While more time consuming, and requiring specialized equipment that we contracted with Ellen Soles to use, this method may give a better result than a channel profile or cross section alone could do. With our initial channel cross section measurements, and cross section measurements that can be extracted from this survey data, we will be able to compare the two methods and make a recommendation as to what is the best method to use for monitoring erosion control structures in the future.

Figure 7. Fine-scale contour map of the large headcut area for monitoring success of remediation. Inset map shows contours of rock structure (gray), including Zuni bowls. See Figure 6 for location of the large headcut, and Figure 8 for its longitudinal profile.



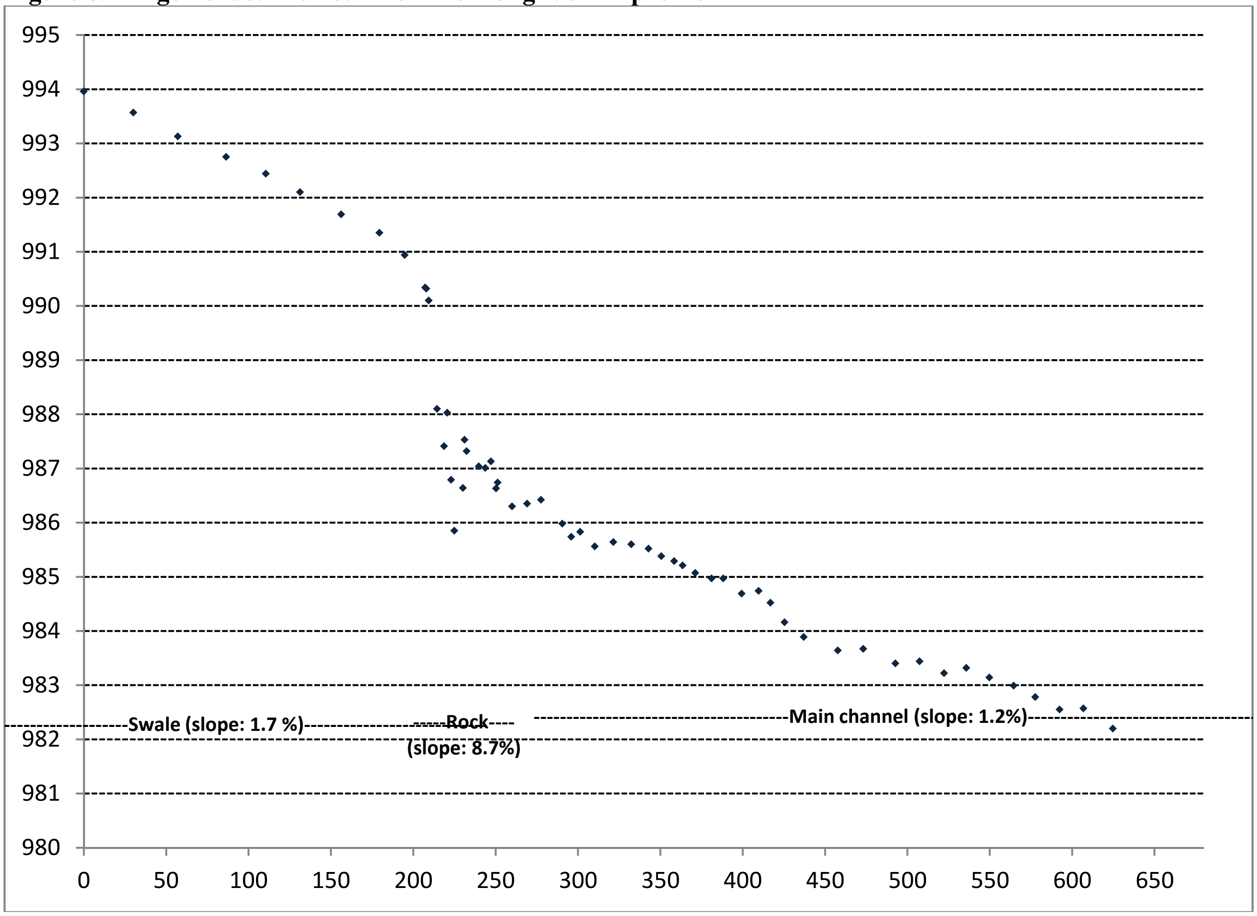
"As-built" map of the surveyed remediation area on the "Aplomado drainage" of the Pitchfork Ranch (see Map 1 for location). Contour interval = 0.5 ft., except where data resolution provides only 1-ft. contour data. All contour elevations are relative to the arbitrary survey datum of 1000.0 ft.

Flow is ephemeral, from north to south. Black dots are surveyed points; monumented survey controls are red polygons. The blue line connects points surveyed on the channel thalweg. "PP10" and "PP11" are monumented repeat photo points. Rock work and constructed Zuni bowls at the main channel headcut are in the gray shaded area immediately upstream of the cross-channel transect established by TNC (red line).

Three subareas were mapped: a grassy unincised swale (207 ft. length) upstream of the rock remediation area; the rock remediation through the active main channel headcut (42 ft. length); and the main channel downstream of the rock work (375 ft. length). Note that channel slope through the swale is steeper than in the main channel downstream, and the numerous side gullies through the east bank of the main channel .

Base imagery is a portion of the *Soldiers Farehill Hill* 7.5-min quad, US Geological Survey.

Figure 8. Large headcut remediation area longitudinal profile



Vegetation

Vegetation monitoring of this project includes photo point monitoring, line point intercept (LPI) transects, and basal gap transects, as described by JER (Herrick ref, weblink).

In collaboration with NMSU master's student Sarah Burnett, we installed five LPI transects located within the Aplomado Drainage to monitor plant species diversity, cover and percent bare ground. Three of these plots were located mid-drainage, at a site randomly selected for Sarah's graduate research, and at the large and small headcut photo points # x & x. Additionally, two control LPI transects were installed outside the Aplomado Drainage, but nearby as a reference. Each transect consisted of two 25m transects in an L shape, with 50 points per transect. One transect was in a contour with the slope at each site, and the other was perpendicular to the slope. These plots offer a small quantitative sample of changes in vegetation with changes in water availability due to erosion control structures, but vegetation monitoring will be conducted primarily through interpretation of repeat photographs collected at photo points.

To monitor mesquite shrub encroachment across the ranch, we installed a set of 10 belt transects to measure the density and cover of mesquite in June 2012. Each plot was 100m x 6m. The number of mesquite shrubs was recorded within each plot by one of three size classes (<1m, 1-2m and >2m diameter at largest diameter). Additionally, basal gap intercept was performed along the same transect, to monitor percentage bare ground and perennial cover, by recording the start and stop of each bare ground patch greater than 15cm). One of these plots was co-located with the vegetation LPI plots described above, but the primary objective of these plots was for long term monitoring of shrub encroachment, and the effects of herbicide treatments on shrub cover, grass cover, and bare ground.

Rainfall, hydrology and surface water

The success or failure of erosion control structures can be dependent on the timing and intensity of rainfall events post installation. For this reason, we installed two data logging rain gauges at the Pitchfork Ranch to better understand what sort of rainfall events the installed structures were able to withstand. These rain gauges add to an existing rain gauge at the top of the Burro Cienaga watershed within the ranch boundaries, and data over x years, collected by the Coles at ranch headquarters (Figure 5). We will also use this information to document actual rainfall patterns in this remote region far from standard weather stations. This is important information for interpreting patterns of vegetation response to restoration activities, which can be used as a proxy for changes in soil moisture. This will also aid in documentation of restoration activities along the main Burro Cienaga channel.

Ultimately grassland restoration is tied to hydrologic function and watershed health, in that grass cover aids in rainwater infiltration and reduce reduces runoff, increasing groundwater recharge. The main channel of the Burro Cienaga is currently being restored through installation of grade control structures, including post vanes and woven weirs (Zeedyk ref). These structures will capture sediment; raise the incised channel, and increase surface and groundwater. This is a novel approach and is not well documented. Casual observation indicates that groundwater levels and extent of surface flow may have increased over the past seven years of restoration, due to evidence such as trees thought dead which are now leafing out again. Hydrologist Ellen Soles installed in ? (year) three piezometers arrays or groundwater monitoring wells in the upper reach of the Burro Cienaga within the Pitchfork Ranch. We have now installed two additional piezometers, downstream from the headquarters, closer to the grassland restoration projects (Figure 5 & photo).

Surface water is necessary for many grassland species. To assess change in the extent of surface flow resulting from grassland and riparian restoration, we implemented in 2012 a 'wet/dry' mapping program with the use of volunteers. This is a method that is accessible to the lay person, provides valuable information about long term hydrologic patterns and is an excellent outreach tool. This monitoring activity will create a GIS/GPS period of record that shows where surface water is present and where it is not. Mapping activities take place during the driest time of year, commonly on or near the Summer Solstice. A full protocol for this monitoring is in

Grassland Birds

Changes in the abundance and diversity of grassland bird species in response to restoration treatments will be documented using a field-tested methodology developed by the Rocky Mountain Bird Observatory for grasslands. Approximately twelve 1,000-m transects will be established in and adjacent to herbicide and prescribed burn treatment polygons on the Pitchfork and AT Cross Ranches; two observers will slowly walk along these transects, counting the number and species of birds seen, heard, and flying over. Bird counts will be conducted along these transects in winter (January/February) and spring (May) each year, before (2013) and after vegetation treatments (2014, 2015). Two of the transect locations on the Pitchfork Ranch have been monitored since 2008 by Dr. Carl Bock, providing excellent baseline data. Finally, our monitoring transects will be included in a larger study that is being initiated by the Rocky Mountain Bird Observatory to measure the effects of restoration activities on wintering bird populations in Chihuahuan Desert grasslands (G. Levandoski, RMBO, pers. comm.).

Fire Management Plan

A Fire Management Plan was completed for the ranch in July 2012 by Steve Bumgarner, retired BLM Las Cruces District Fire Manager. Full text of this plan and the accompanying Prescribed Burn Plan can be found in Appendix. Ref). The plan was prepared according to guidelines of the TNC Fire Management Manual http://www.tncfiremanual.org/. This management plan is a living document that identifies fire management tools to address specific ecological concerns at the Pitchfork Ranch, such as shrub encroachment. The plan also describes management and/or suppression of wildfires on the ranch, and lays out wildfire response guidelines that consider the management objectives of the Pitchfork Ranch as well as proximity of neighbors, structures, and other assets.

Site visits to prepare this plan began in April 2012. We used ecological state maps to prioritize the visit and to view potential burn areas where past erosion was low, shrub encroachment was likely limiting grass establishment, and in proximity to good condition grassland. Planning included contacting all neighboring ranches to inform them of the planning process, and ask for their views on burning. Only one neighboring ranch owner was opposed to prescribed burning at the Pitchfork Ranch and a number of neighbors were interested in conducting burns on their ranches. Due to the relatively small size of this ranch on a landscape fire management scale, we determined that in order to achieve large scale grassland restoration, it will be necessary to involve neighboring landowners in the planning process, and to define fire management units continuously across a larger landscape and across ranch boundaries.

Working within the Pitchfork Ranch only, this plan identifies three prescribed burn units that are the lowest risk and cost while providing the greatest ecological benefits. By achieving successful prescribed burns we will inspire neighboring landowners to join the process. The first burn unit is a sacaton bottomland grassland, which will be burned to reduce an abundance of dead grass, recycle nutrients, and reduce shrub encroachment. This unit's relatively small size (152 acres), and roads bordering two sides of the unit, which act as natural fire add to its potential advantage as a priority burn on the Pitchfork Ranch. The largest of these burn units (622 acres) is completely enclosed by ranch roads. A third burn is an ecological restoration burn of an old field area (17 acres) to reduce weeds and prevent shrub establishment. These plans, including weather conditions necessary for a successful burn, and all necessary contact information are described in full within the Pitchfork Ranch Management Plan (Bumgarner 2012) and Pitchfork Ranch Prescribed Burn Plan (Bumgarner 2012b)

These plans have been approved by TNC Arizona & New Mexico Fire Manager Bob Rogers and Regional Fire Manager Jeremy Bailey. The prescribed burn plans include all documentation necessary to execute all three burns, including documentation necessary for the BLM to assist with these burns. While the three fully described burns are not on BLM land, there is a good chance that BLM will assist with these burns; an Environmental Assessment will be completed prior to the end of the year which would clear the way for prescribed burns in the drainages on BLM land where erosion control structures were installed. The three burns described in the Prescribed Burn Plan are ‘ready to go’, and we plan to conduct these prescribed burns using a TNC fire crew next spring with the goal of reducing shrubs and improving grassland condition on over 1,100 acres.

Plans have also been distributed to neighboring landowners to start a dialog on an expanded fire management program in the landscape.

Ecological Management

We have recommended and offered technical support to ranch owners for general ecological management at the ranch. For example, when we noticed during site visits that there was very early invasion of tamarisk in the riparian area, we recommended that ranch owners respond as quickly as possible by cutting all stems, and painting the cut surfaces with herbicide, which they completed in June 2012, and plan to monitor for return.

When it came to our attention that there was a large herd of antelope in a neighboring ranch, and to fulfill the requirements of the BLM cooperative agreement for grazing rest following erosion control treatment installation, we performed a fence integrity check and replaced bottom wire with smooth wire in locations where antelope were observed to occasionally cross the fence. This was completed in

Project status and preliminary results

Structures installed in phase I withstood a large (~2”) December 2011 rainfall event without severe damage or movement of rocks. By spring 2012 there were forbs and grasses growing up through the rock structures, which is a good sign for reinforcing them prior to a the next major flow event. As of this writing, there has not been a significant rainfall event localized in the Phase I or Phase II drainages, so we cannot evaluate their effectiveness yet. This is good news, however, in that small amounts of rainfall may help get vegetation established prior to a large storm that would be more likely to damage erosion control structures or younger plants.

References Cited

Appendix A: Photos

(there will be many more!)

Photo 1. Boulder filter dam

Appendix C

Wet/Dry Walk Protocols
Adapted from TNC AZ San Pedro Wet/Dry mapping protocol

The main objective of this monitoring is to create a GIS/GPS period of record that shows where surface water is present and where it is not. Mapping activities ideally take place during the driest time of year, commonly on or near the Summer Solstice. Depending on drought and other factors, annual mapping of perennial surface waters helps managers understand effects of these factors on stream systems and the wildlife that depends upon them.
GPS, or Global Positioning Systems, is a worldwide radio-navigation system developed by the U.S. Department of Defense. GPS units receive signals from multiple satellites, and record your position. Once the unit is initialized, you will be using primarily the '**Mark**' and '**Enter**' functions. The **Track Log** setting is optional, not necessary.

The gist: to record data, travel along the river/drainage on foot or horseback using GPS units to mark the location and length of all surface water.

What to bring:
A GPS unit, small compass, hat, sunscreen, plenty of water, snacks or a lunch, and sturdy walking shoes that can get wet; wear a backpack to keep your hands free. Long pants and shirt are recommended for extra protection. You might also want a camera, binoculars, field guides etc. and a map from the previous year--if available. Also bring a field notebook or proper data sheets to record additional observations.

Procedure:
Note that you record data in two forms – hand-written on data sheets and recorded in the GPS unit. Record BOTH the Wet/Dry observations and other observations on the hand-written data sheets to minimize confusion when downloading the points later.
-If breaking the river into several team survey segments, first place a flag at the starting point of your monitoring segment.
-Take a GPS reading at this flag, press **Mark** and then **Enter** to record the waypoint (this is your location, or data point) on the GPS, and write down the waypoint number and UTM readings.
-Record the compass reading of the direction you will be walking.
-As you walk along the river, Mark **wherever the water starts and stops on the river**, taking into account the 30 foot rule (see below and attachment). Record the GPS coordinates (if doing this), accuracy number, waypoint number, time, and whether the water starts or stops, on your data sheet or comparable notebook. Collect data for both ponded water (stagnant pools) and flowing/running water.

-The final GPS measurement will be taken at the point where your segment ends, which may be marked by a flag placed by the team down-stream from your segment. Record the last GPS measurements in the unit and in writing.

The 30 foot Rule
Record both the **starting and stopping points** for water bodies that are MORE than 30 feet in length. You can determine this distance in the field by pacing it off.
If there is a break in the water (dry stretch) that is 30 feet or less, ignore it. For example, if the river flowed 60 feet then stopped for 10 feet, and then flowed for 100 feet, we would ignore that 10 foot break.
We do not map both the start and stop points for any wet length less than 30 feet because the accuracy of GPS receiving in small areas is less than 30 feet.

Special Cases:
(1) For a small water body like a **small isolated pool** between 5 and 30 feet long, record only one point at the middle of the pool in the GPS and in writing taking care to note "Isolated Pool".
(2) ***Fish Frogs or Rare aquatic life of interest:** Record the location of **fish** regardless of the size of the pool. If the pool is less than 5 feet long and fish are present, take one GPS reading at the middle of the pool, note the approximate size of the pool and the presence of fish. If fish are present in wet reaches greater than 5 feet long, simply note that fish are present in the surface flow.

Note that we are measuring along the length of the channel, not width across the channel. For example, if a pool is 30 feet wide, and 15 feet long it is considered to be an isolated pool and only the mid-point is recorded (see Isolated Pool example on "30 Foot Rule" sheet).

Be sure to check out all of the river's channels. Sometimes the flow of the river will be braided (divided, with islands in the middle). Your group may spread out as you move along the river to make sure you don't miss a parallel channel.

Safety Reminders for new or additional volunteers:
Be sure to bring water, more water, a hat, sunscreen, and some food. Although it may be shady along the river, depending on the length of your hike, bring at least two quarts of water per person, and remember to drink frequently, BEFORE you get really thirsty.
Wear shoes that you won't mind getting wet and muddy.
No participant should ever be traveling alone. Keep track of the location of other team members at all times.
Keep an eye out for rattlesnakes. Never step into vegetation where you cannot see exactly what you are stepping on.
Keep an eye out for quicksand in wet areas. Quicksand is often found near the edge of cut banks.
Watch for snags and dead limbs overhead. If taking a reading under a snag, have a spotter watch for possible falling limbs.
If it is overcast, be aware of the possibility of flash floods. If the water level starts rising, **get out** of the river channel.