APPENDIX D

Gunnison Basin Wetland Restoration Vegetation Monitoring

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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 Wolf and Redden Creek properties between 2012 and 2014.
>
> **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 Wolf and Redden Creek properties between 2012 and 2014.
>
> **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).

Methods:

Redden Restoration site. We used a stratified random sample design by splitting the site into four subsections and randomly choosing one of the first four structures and then choosing every fourth structure thereafter (Table 1). Photos were only taken at the first randomly selected structure of each section. For other chosen structures we collected vegetation data by laying out transects just upstream of the structure (marked with wooden stakes at the beginning and end of the transect). At chosen media luna structures we layed out transects just below the structure. Most transects crossed a drainage (bank to bank) and the length was determined by estimating the sphere of influence that a structure will likely have; generally it included the expected new wetted area. Most transects were between 5 and 10 m long. We used 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 and density were collected at every meter. Density was measured in a 10 cm x 10 cm quadrat placed on the right side of the tape. We counted number of graminoid and forb stems arising from the ground/quadrat. Height was collected by measuring the height of the tallest plant (we measured absolute height, not droop height) in the density square. 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. All 2012 data was collected on September 10 and 11th prior to any structures being built. All 2013 data was collected on August 19 and 20th. The 0 m mark was always on river left. Additional photos (labeled as photopoints) 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, weather, camera height, compass bearing were recorded for each photo.

Table 1. Redden Restoration Site had 54 structures. A stratified random sample design was used by dividing the site into four sections and randomly choosing four structures from each section. We

collected vegetation data and photos at randomly selected structures. Two control transects were placed above Section 1.

Section number	Structure Numbers	Randomly selected structure
1	1-15	3*,7,11,15
2	16-31	16*, 20, 24, 28
3	32-42	32*, 36, 39, 42
4	43-54	43* 46, 49, 53
Control	2 control transects	

*Photos only

Wolf Creek Middle and East Forks Restoration Site (all on private land). There were a total of 46 structures, 1-19 along an ephemeral creek (Middle Fork) and 20-46 along a spring-fed creek (East Fork). We randomly chose 7 structures on the Middle Fork and 10 on the East Fork (Table 2). Data collection was identical to that used at Redden (see above) and was collected in 2012 on September 12 and 18th prior to any structures being built, and August 27 and 28th in 2013.

Table 2. The Middle Fork and East Forks of Wolf Creek Restoration Site had 19 structures and 26 structures on the East Fork. Seven structures were randomly chosen from the Middle Fork and 10 from the East Fork. We collected vegetation data and photos at randomly selected structures. One control transect was placed above structure 20.

Creek Section	Structure Numbers	Randomly selected structure
Middle Fork	1-19	1, 4, 8, 9, 13, 15, 18
East Fork	20-46	20, 24, 26, 29, 32, 34, 37, 38, 41,46*
Control	1 control transects	Placed above structure 20 in a section above restored area and most similar to the Middle Fork portion

*Photos only

Wolf Creek West Fork, Upper Wolf, and Lower Wolf Restoration Site (all on BLM): There were a total of 45 structures, 17 along the West Fork, 19 along the Upper Wolf, and 10 along the Lower Wolf. We randomly chose one structure out of every three structures for each of the sections, with a total of 13 transects of which two were controls. See Table 3 for details. Data collection was identical to that used at Redden, Middle Fork, and East Forks (see above) and was collected in 2013 on August 1-3 either prior to any structures being built or with 1-2 days after a structure was built.

Table 3. Wolf Creek BLM Restoration Site had 45 structures on three sections. Eleven structures were randomly chosen. We collected vegetation data and photos at randomly selected structures. Two control transects were placed in Upper Wolf below the low water crossing.

Creek Section	Structure Numbers	Randomly selected structure
West Fork	1-17	2, 6, 9, 12, 14
Upper Wolf	0-18	2, 7, 13, 16,
Lower Wolf	1-10	6, 7
Control	2 control transects	Placed in Upper Wolf below low water crossing

Flat Top Restoration Site (all on USFS): There were a total of 82 structures, 23 within the exclosure unit and 59 in Section 36. We randomly chose one structure out of every three structures for the exclosure section and one out of every four structures for Section 36, with a total of 24 transects of which two were controls. See Table 4 for details. Data collection was identical to that used at Redden, Middle, East, and West Forks of Wolf Creek, Upper Wolf, and Lower Wolf (see above) and was collected in 2013 on August 1-3 either prior to any structures being built or with 1-2 days after a structure was built.

Table 4. Flat Top Restoration Site had 82 structures. A stratified random sample design was used by choosing one out of every three structures at the exclosure site and one out of every four structures at Section 36. The two drift fences had photopoints established. We collected vegetation data and photos at randomly selected structures. Two control transects were placed in Section 36 above the first structure.

Creek Section	Structure Numbers	Randomly selected structure
Exclosure	1-23	1, 5, 7, 10, 15, 16, 17, 19, 21
Section 36	1-57	3, 6, 12, 16, 23, 25, 29, 35, 38, 41, 47, 51, 55
Drift fences	58-59	Four photopoints
Control	2 control transects	Placed in Section 36 above the first structure

Table 5. Summary of vegetation transects and photopoints at all of the 2012 and 2013 restoration sites.

Site	No. of vegetation transects	No. of photopoints
Redden	12	16
Redden, control	2	2
Wolf Creek, Middle Fork	7	7
Wolf Creek, Middle Fork-Control	1	1
Wolf Creek, East Fork	9	12
Wolf Creek, West Fork	4	4
Wolf Creek, West Fork-Control	2	2
Wolf Creek, Upper Wolf	4	4
Wolf Creek, Lower Wolf	2	2
West Flat Top ,Section 36	13	17
West Flat Top ,Section 36-Control	2	2
West Flat Top, Exclosure	9	9
Moncrief Ranch	0	7
Total	67	78

Data Analysis

Data analysis could only be conducted on the sites with two years worth of data (Redden and Wolf Creek, private land). In order to assess meeting the management objectives, we pooled all wetland species and analyzed differences in cover between 2012 and 2013. Data was analyzed by stream reach. We conducted a normality test to determine if the data were normally distributed. If the data were normally distributed then we conducted a one-tailed paired T-Test to detect significant changes between 2012 and 2013. If the data were not normally distributed we conducted a Sign Ranked test. Height and density data was not species specific thus we could not analyze by wetland species; we conducted one-tailed paired T-test to detect significant differences between years.

Results

We identified over 100 species collectively, ranging from wetland obligates to upland species and natives to non-natives. Twenty-one species were considered wetland species and all others were considered upland species.

Wetland species cover. Wetland species cover at Redden significantly increased (P=0.025) between 2012 and 2013, increasing from 13 to 26%, while the wetland species cover in the control did not change between 2012 and 2013 (Figure 1). The wetland species cover on the Middle Fork of Wolf Creek exhibited an increase in cover between years however it was not significant (Figure 1b). The East Fork of Wolf Creek had a significant increase in cover (P=0.009) between years, from 53% in 2012 to 83% in 2013 while the control increased from 0 to 7% (Figure 1).

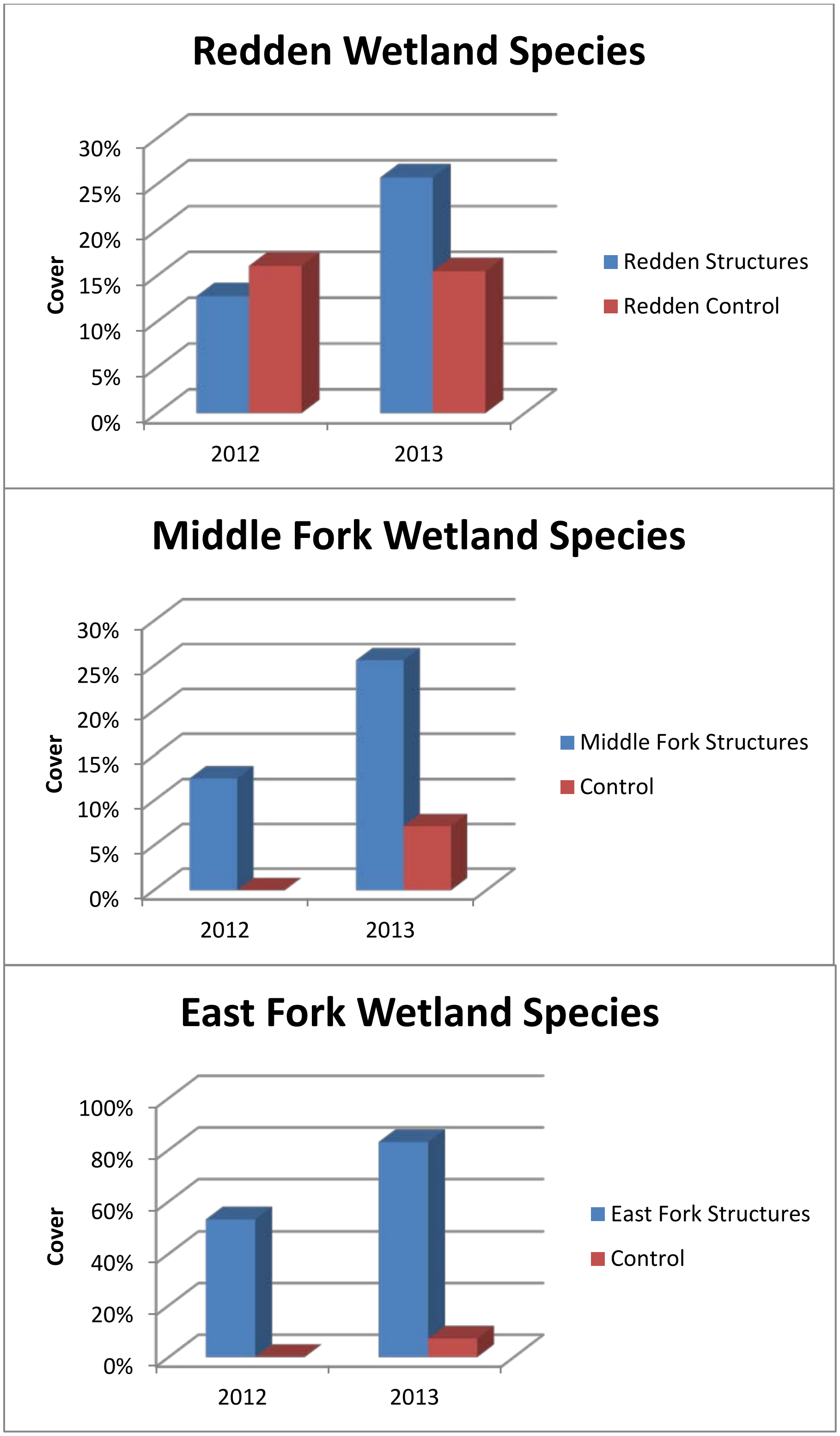

Figure 1. Wetland species cover from transects associated with the structures compared to control (no structures) for 2012 and 2013. Sample size: Redden n=12, control =2; Middle Fork n = 7, control = 1; East Fork n=8, control =1. Redden and East Fork structures had significant increases in wetland species between years ($P \leq 0.05$).

Height, Forb and Graminoid Density. The height was significantly taller in 2013 compared to 2012 regardless of treatment or site, i.e., no difference between structures and control (Table 6). Forb density is relatively low at all of the sites and significantly increased in 2013 regardless of treatment at Redden's and Middle Fork of Wolf Creek. At East Fork of Wolf Creek there was a significant increase in the forb density as it more than doubled in 2013 (P=0.02; Table 6). Graminoid density followed the same pattern as height as both the treated and controls increased (Table 6). The increases in 2013 were most likely due to an increase in precipitation rather than due to the structures as the control sites exhibited the same pattern.

Upland shrub species. We did not analyze our dataset for a decrease in shrub species as there were no apparent changes. We expect changes to occur over a three to five year period rather than a one year period. We did observe some dead sagebrush at the media luna sites at East Fork of Wolf Creek but this was an exception compared to other transects.

Table 6. Mean differences (2013-2012) by site for height, forb density, and graminoid density. Although there were significant increases in 2013, this was most likely due to an increase in precipitation since the same pattern was observed in the controls. Bolded numbers indicate a significant difference between years ($P \leq 0.05$) compared to the control.

Site	Height (cm)		Forb Density		Graminoid Density	
	2012	**2013**	**2012**	**2013**	**2012**	**2013**
Redden	9	16	0.7	1.2	5.4	8.6
Redden Control	7	14	0.3	0.6	3.5	7.5
Middle Fork, Wolf	9	15	1.5	1.5	3.1	10.1
East Fork, Wolf	22	28	**1.5**	**3.5**	6.7	13.2
Wolf Control	14	23	0.1	0.0	5.3	13.9

<u>Photopoints.</u> Photos provided additional evidence of changes due to the rock structures, including increase in sediments and vegetation cover. A sample of these is included in Attachment 1).

Conclusions

Wetland species composition significantly increased between 2012 and 2013 at two of the three reaches and the probability of this being the result of the structures rather than precipitation is quite high. Although the controls saw some change it was minor compared to the structure transects. The East Fork of Wolf Creek had the largest changes of any of the sites and is a reflection of the two active springs along this reach, whereas the other sites do not have active springs nor are they perennial. We did not detect significant differences between the treated and control areas when we analyzed the height and density data except for the forbs at East Fork of Wolf Creek. We expect this is due to the spring-fed nature of the creek and that given enough time we may see the same response at the other two sites. Given that the structures were in place just slightly less than one year, we find it quite promising that we were able to detect a positive response from building the structures and we expect this trend to continue and the changes to be even more distinct over the next few years.

<u>Precipitation</u>. Differences in monthly and annual precipitation between 2012 and 2013 were quite evident in that 2012 was a drier year than 2013 (Figure 2). No doubt that the higher rainfall in 2013 assisted with the rate of restoration that we observed at many of the structures, however there was ample evidence that the structures aided the restoration process more than the additional precipitation. This evidence is seen by comparing the control sites to the treated areas as well as reviewing the repeat photographs. The repeat photography backs up the data analysis. Many of the repeat photographs detected increases in sediments behind the structures, especially on the Redden property and the media lunas on the East Fork

(see photos in Attachment 1), whereas the control photopoints did not detect any additional sediment loading nor significant changes in the vegetation cover.

Monitoring Comments. The methods developed for monitoring the structures were designed to be repeatable, rapid, and meaningful and we believe we achieved this. We suggest that these transects be monitored again in subsequent years as we expect the changes to be even more evident than reported in this report. The height and density data is fairly laborious to collect and has a high observer bias and may not be critical to repeat as long as species cover data is detecting a change. This would reduce the amount of time needed to collect and analyze data. Collecting forb density data may be worthwhile given that we were able to detect a change within one year and forbs are critical for sage grouse. The photopoints provided photographic evidence that can assist with interpretation of the data analysis and should be conducted as close to the same time (month and hour) as the original photos were taken.

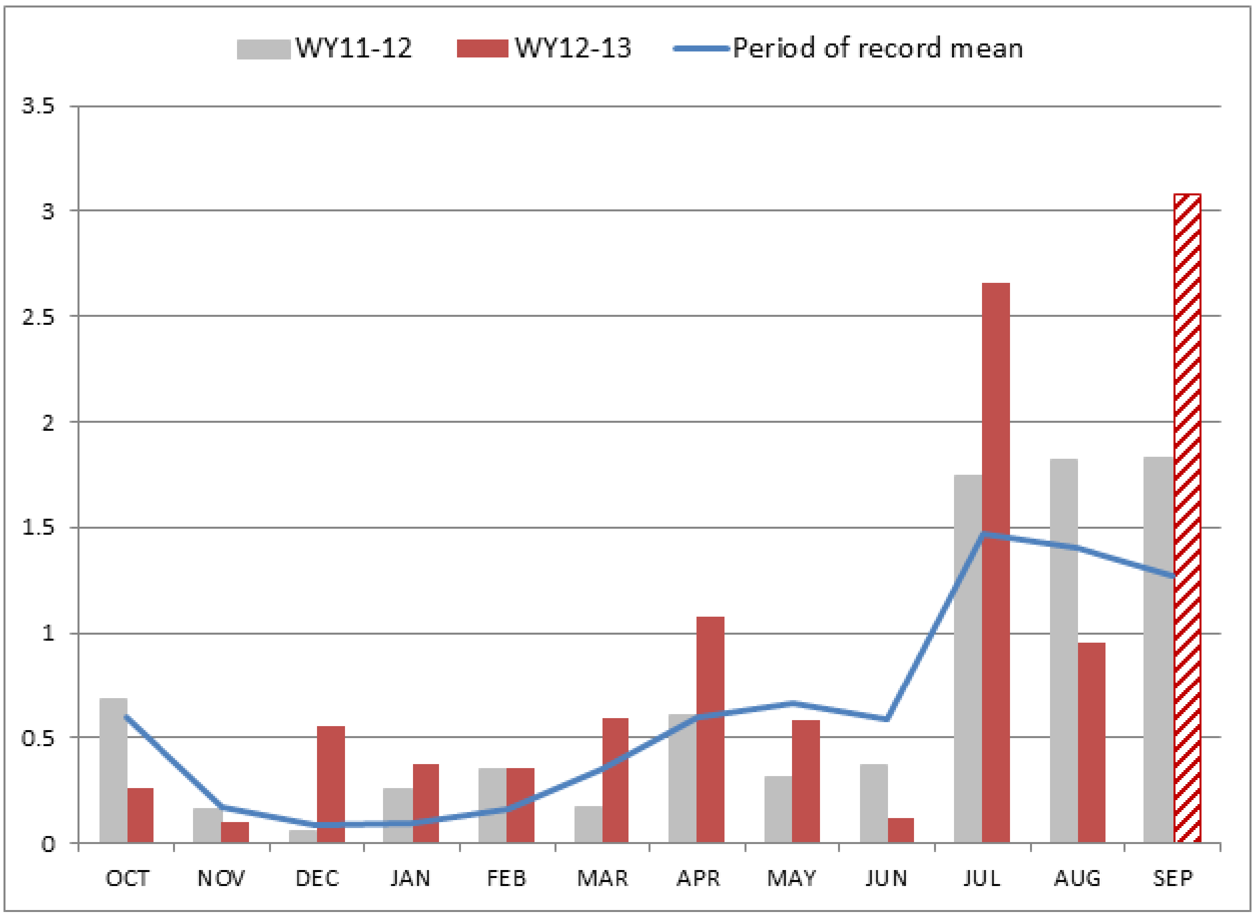

Figure 2. Monthly precipitation for water year's 2011-2012 and 2012-2013. Data from Huntsman Mesa weather station. The period of record mean is from June 1991 to September 2013.