Rocky Mountain Field Institute

Pilot Willow Propagation Program to Facilitate Resiliency in Critical Riparian Areas – Final Report

Number: POGG1 PDAA 2016 00628

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Dedicated to the conservation and stewardship of public lands in Southern Colorado

Executive Summary of Project

Through three phases comprised of six total tasks, this project sought to pilot a willow propagation and planting program in a high priority riparian area within the Waldo Canyon burn scar where post-fire vegetation recovery using traditional willow staking and other methods have not been successful to improve watershed health and stream function. An additional component of this project was to continue hillslope stabilization and erosion control treatments to complement riparian plantings. Overall, work objectives included increasing the composition of native riparian plants, vegetative cover, structural diversity, and promoting bank and channel stability.

In May 2016, approximately 900, 4-month old willows were planted along an estimated 1,624 linear feet of riparian area located within the Upper Camp Creek drainage of the Waldo Canyon burn scar. In addition, RMFI and a Mile High Youth Corps Crew completed complementary erosion control and stabilization work primarily aimed at stabilizing headcuts and minimizing downstream sedimentation. Observations from a monitoring site visit conducted in May 2017 revealed 90-95% survival rates for the willows that were planted in the Upper Camp Creek drainage. Furthermore, all headcut and erosion control treatments were still intact and functioning to promote bank and channel stability.

The survival rates observed in the planted willows were significantly higher than the estimated 10% survival rates observed in the same and other severely burned drainages using traditional willow staking methods. Signs of elk browsing were high, but no mortality was observed among the planted willows. This indicates little to no uprooting of the planted willows by animals or water/debris moving through the channel. In addition, very limited downstream movement of sediment and larger material was observed along the reach. Also noted was a growing population of macroinvertebrates in the stream including stoneflies and caddisflies, which are indicators of good water quality, and a health population of sedges that had developed in the floodplain. Macroinvertebrates had not been observed within this section of stream after the Waldo Canyon Fire in 2012.

Results from this initial pilot project are very encouraging and are helping to inform Phase 2 of the project, which seeks to triple the number of willows propagated and planted within the Waldo Canyon burn scar. Challenges noted in the pilot phase of the project included the unexpected difficulty that was encountered in trying to distinguish the planted willows from the other native vegetation growing on-site. However, project success can be measured by quantifying mortality rates. It is too difficult to count and calculate all of the live willows within a particular stream reach. Instead, it is much more effective to look for dead willows and impaired reaches due to channel degradation, lack of water, over grazing, etc. In Phase 2 of the project, we will continue to utilize this method of monitoring mortality rates.

Project Phases and Tasks

This project was comprised of 3 distinct phases linked to 6 total tasks. Phase 1 sought to identify high priority riparian areas that were currently contributing sediment and continuing to pose downstream risks to life and safety; complete project planning, site visits, logistics, and youth corps contracting; and complete the harvesting of 300 willow whips suitable for propagation at the Charles E. Bessey Nursery located in Halsey, Nebraska.

Throughout December 2015 and January 2016, RMFI worked with Leah Lessard, Hydrologist for the U.S. Forest Service (USFS) Pikes Peak Ranger District to identify and prioritize high priority riparian areas within the Waldo Canyon burn scar. Several parameters were utilized to identify potential planting areas including access, prior work, level of recovery, water table/water source, and sediment contribution. The Upper Camp Creek drainage within Queens Canyon was identified as the priority location to pilot the project (Figure 1a, 1b – Please Note: all photos and maps are at the end of the document). RMFI had previously worked in Upper Camp Creek to decommission and stabilize a road utilized by USFS contractors to construct sediment detention basins in 2013. RMFI had also used willow stakes to revegetate the perimeters of the basins, and had also completed other restoration work within the drainage. In addition, the riparian area draining Camp Creek was still contributing downstream sediment and lacked diverse composition of native riparian plants as well as structural diversity.

On January 12, 2016, RMFI and USFS staff harvested dormant willow cuttings along the Pikes Peak Highway north and south of the Crow Gulch Picnic Area (Figure 2). Approximately 300 whips measuring approximately 3 feet long were harvested. Species included narrowleaf willow (*Salix exigua*), scouler willow (*Salix scouleriana*), bebb willow (*Salix bebbiana*), and Rocky Mountain willow (*Salix monticola* Bebb). Willows were tied together in bundles and prepped for overnight shipping to the Charles E. Bessey Nursery located in Halsey, Nebraska. The willows arrived at the nursery the next day where they were cut from 3-foot segments to approximately 1-foot segments and placed in potting containers (Figure 3). On March 4, 2016, the willows were transplanted into individual pots (Figure 4) to continue growth and root maturation.

Between February and May 2016, RMFI continued project planning and coordination. Additional site visits were held to scope out areas suitable for restoration and stabilization work by the Mile High Youth Corps (MHYC) crews and RMFI staff.

Phase 2 of the project involved planting the propagated willows, completing erosion control and stabilization work to complement the willow plantings, and developing a replicable monitoring protocol to determine success of the revegetation efforts.

On May 31, 2016, RMFI, the USFS, a Mile High Youth Corps (MHYC) crew, and 6 community volunteers transported approximately 900 willows from the staging area off of Rampart Range Road down into the Camp Creek drainage (Figure 5). The drainage was divided into 10 planting zones across an estimated 1,624 linear feet to facilitate future monitoring efforts measuring willow survivability (see map in Figure 6). Average elevation along the reach measured 8,949 feet with a maximum elevation of 9,035 feet (see terrain statistics for the reach in Figure 6). The average slope of the reach was 17 degrees with a predominantly east/east-southeast aspect. The start and end of each segment was recorded with GPS waypoints and photos looking upstream and downstream were taken at the time of planting as well as during the monitoring site visit conducted on May 25, 2017 (please see photos 14-23 for up/down photos at each planting zone). Leah Lessard, USFS Hydrologist, completed a willow planting demonstration with all on-hand to ensure adequate planting depth and contact with the water table (Figure 7). The group then split up and began planting the willows within each of the 10 planting zones. Approximately 200 plants were planted on May 31; the MHYC completed the willow planting that same week.

Based on data recorded from the U.S. Geological Survey (USGS) gage at Camp Creek (USGS 07103702 Camp Creek Above Glen Eyrie), precipitation between May 31 and June 4, 2016 (the week of planting) averaged 0.55 inches, and the average daily discharge in cubic feet per second (cfs) averaged 7.3 cfs (Figure 8). The average maximum, mean, and minimum temperatures recorded between May 31 and June 16 (total duration of work) were 78°F, 63°F, and 48°F, respectively, and average wind speeds for the duration were 9 miles per hour.

In addition, RMFI contracted 3 weeks of MHYC beginning on May 31 and ending on June 16, 2016. In addition to planting willows in the Camp Creek drainage, the crews restored approximately 3,672 ft^2 of burned landscape by spreading 7 pounds of native seed, constructing 14 log erosion barriers, and constructing 12 other drainage and erosion control structures including sills, step falls, and cross veins (Figures 9-12). In total, 13 MHYC crew members and 7 RMFI staff were engaged in the project during the 3 weeks of contracting. The MHYC crew spent a total of 1,196 hours on the project over the course of 12 workdays.

In March 2017, RMFI, with input from the USFS, developed a monitoring protocol and datasheet that was tested during a monitoring site visit to the planting area on May 25, 2017. Please see Appendix A and B for the monitoring protocol and data from the site visit.

Phase 3 of the project involved post-project evaluation, assessment, and reporting. Project updates were presented at the El Paso County Regional Resiliency Collaborative Meeting on August 1, 2016, September 19, 2016, October 3, 2016, November 7, 2016, December 19, 2016, February 21, 2017 and May 1, 2017. A presentation on the project was also given with representatives from the USFS at the Pikes Peak Environmental Forum on April 28, 2017 and 2 television interviews about the project were given on April 25, 2017 (with Scott Erickson from Channel 13 News) and on June 6, 2017 (with Eric Singer from the Gazette).

Project Results

A monitoring site visit was held on May 25, 2017 to test the monitoring protocol, observe the status of the willow plantings, and observe the status of the erosion control and stabilization treatments that were completed in May/June 2016. Observations from the site visit were very encouraging. Data suggest survival rates were at 90-95% for the willows that were planted within the Upper Camp Creek drainage (see Appendix B for scan of datasheet) after incorporating a 5-10% error rate to account for observer error and conditions. This is significantly higher than the 10% survival rates we had seen in the same and other severely burned drainages using traditional willow staking methods. Signs of elk browsing were high, but no mortality was observed among the planted willows. This indicates little to no uprooting of the planted willows by animals or water/debris moving through the channel. In addition, very limited downstream movement of sediment and larger material was observed along the reach. Also noted was a growing population of macroinvertebrates in the stream including stoneflies and caddisflies, which are indicators of good water quality, and a health population of sedges that had developed in the floodplain. Macroinvertebrates had not been observed within this section of stream after the Waldo Canyon Fire in 2012.

The erosion control and stabilization treatments that were constructed within the Upper Camp Creek drainage were all functioning properly. There were no failures observed in the structures

and a 4-year photo series (see Figure 13) visually demonstrates the successful stabilization of slopes, increase in native vegetation, and natural regeneration of aspen trees within the watershed.

An unanticipated challenge encountered during the project involved the difficulty in distinguishing the planted willows from the other native vegetation growing on-site. When the willows were planted in May 2016, substantial vegetation growth within the riparian area was not observed. However, 1-year post-planting, other vegetation had continued to establish within the riparian corridor making observation of the willows difficult. In Phase 2 of the project, we will continue to utilize adapted monitoring methods including measuring mortality rates and observations of channel degradation.

Final work and volunteer statistics include:

- 6 volunteers
- 54 volunteer hours
- $1,272 volunteer value (per independentsector.org)
- 13 Mile High Youth Corps members
- 1,196 youth corps hours
- 189.75 RMFI staff hours
- 3,367 feet^2 restored
- 7 pounds of native seed utilized in restoration efforts
- 900 transplants utilized in restoration efforts
- 26 stabilization and erosion control structures built (log erosion barriers, log stepfalls, sills)
- 8 erosion control structures maintained

Project Conclusion

Results from this initial pilot project are very encouraging and demonstrate the potential for increasing survival rates through the propagation of ecotypic species that have had time to develop more mature root systems in a nursery setting. In addition, results also suggest the erosion control and stabilization treatments utilized within the Upper Camp Creek drainage and other sub-basins of the Waldo Canyon burn scar are functioning to minimize downstream sedimentation and secure steep, bare slopes. Results from the pilot phase of this project are helping to inform Phase 2 of the project, which seeks to triple the number of willows propagated and planted within the Waldo Canyon burn scar. Challenges noted in the pilot phase include the unexpected difficulty encountered distinguishing the planted willows from the other native vegetation growing on-site. In Phase 2 of the project, we will continue to utilize adapted monitoring methods including measuring mortality rates and observations of channel degradation.

We'd like to thank Leah Lessard, Pike National Forest Hydrologist and Oscar Martinez, Pikes Peak District Ranger for their tremendous help and guidance during the project. In addition, we'd like to thank the Charles E. Bessey Nursery located in Halsey, Nebraska for propagating and managing the willows. Finally, we'd like to thank the volunteers and Mile High Youth Corps crews for helping complete the project objectives and the Colorado Water Conservation Board for funding the project.

PROJECT PHOTOS

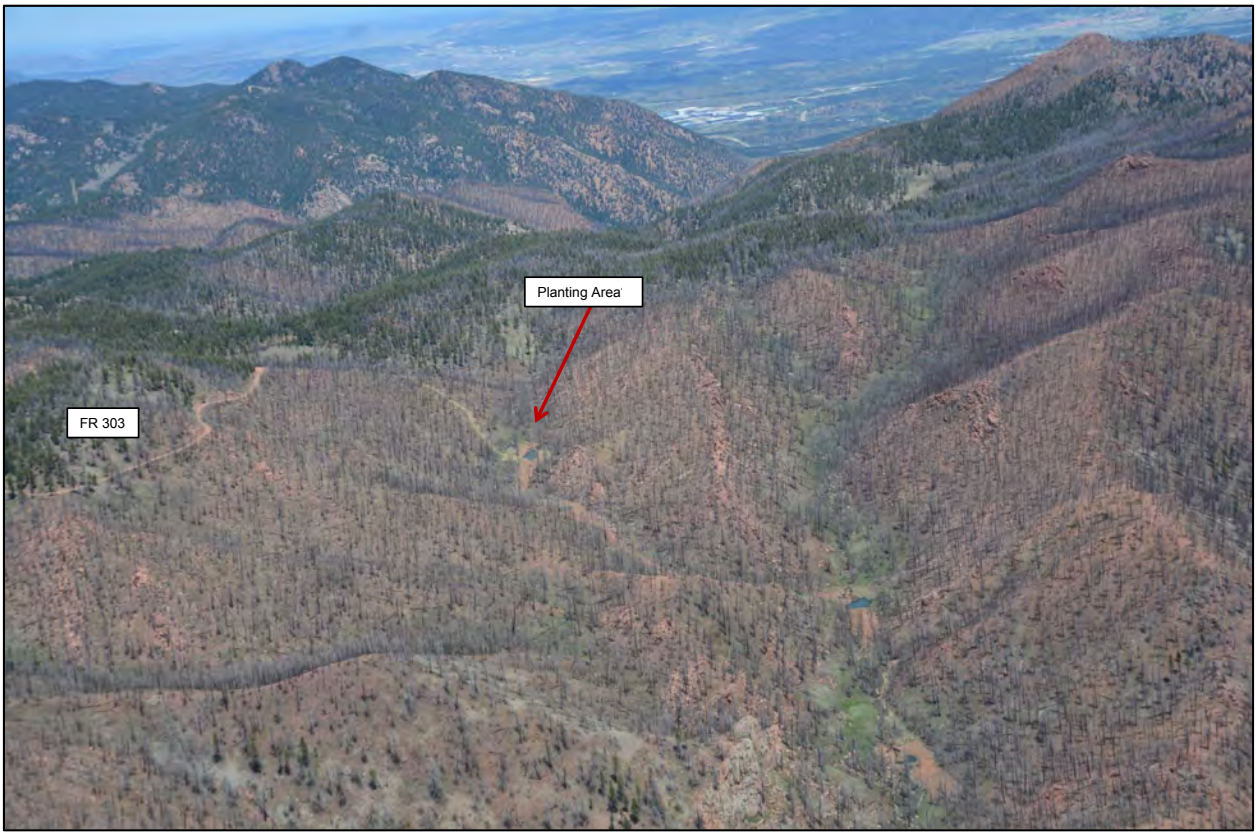


Figure 1a. Planting area within the Camp Creek drainage. FR 303 is also known as Rampart Range Road. Sediment detention basins are visible in the image.

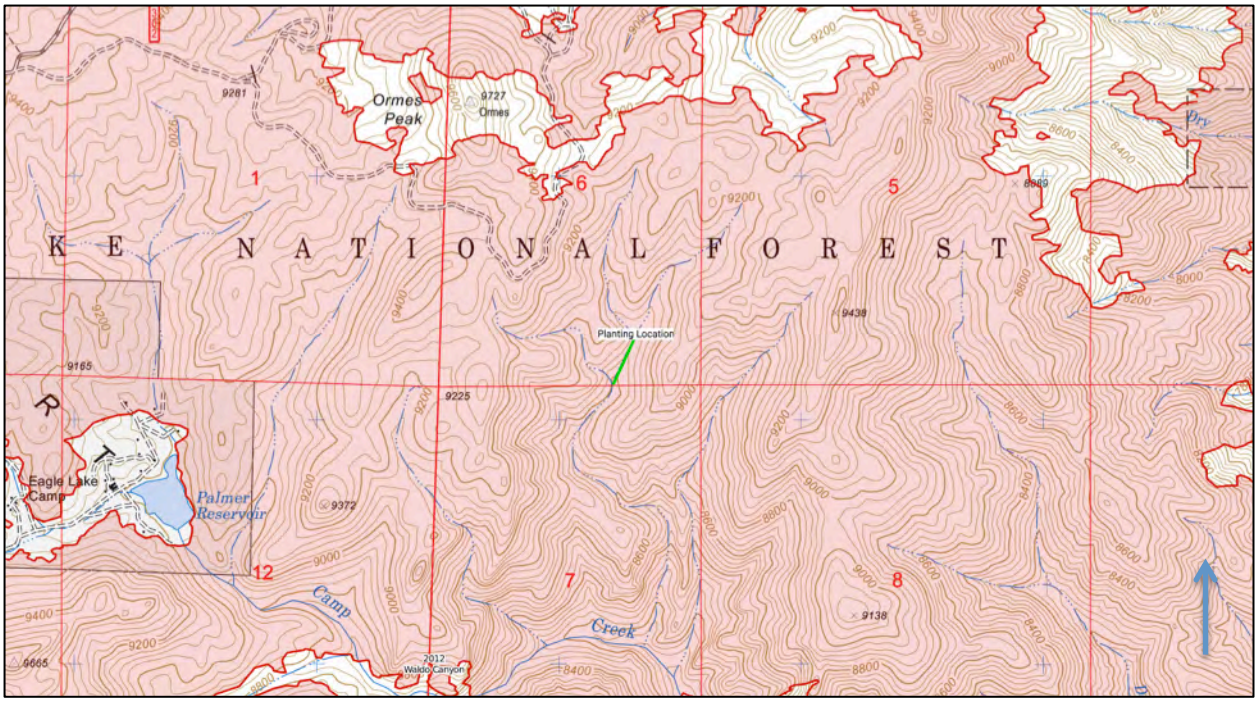


Figure 1b. Topographical view showing the planting area within the Camp Creek drainage. FR 303 is also known as Rampart Range Road. The red overlay represents the Waldo Canyon burn scar.

Figure 2. Harvesting dormant willows along the Pikes Peak Highway near the Crowe Gulch Picnic Area.

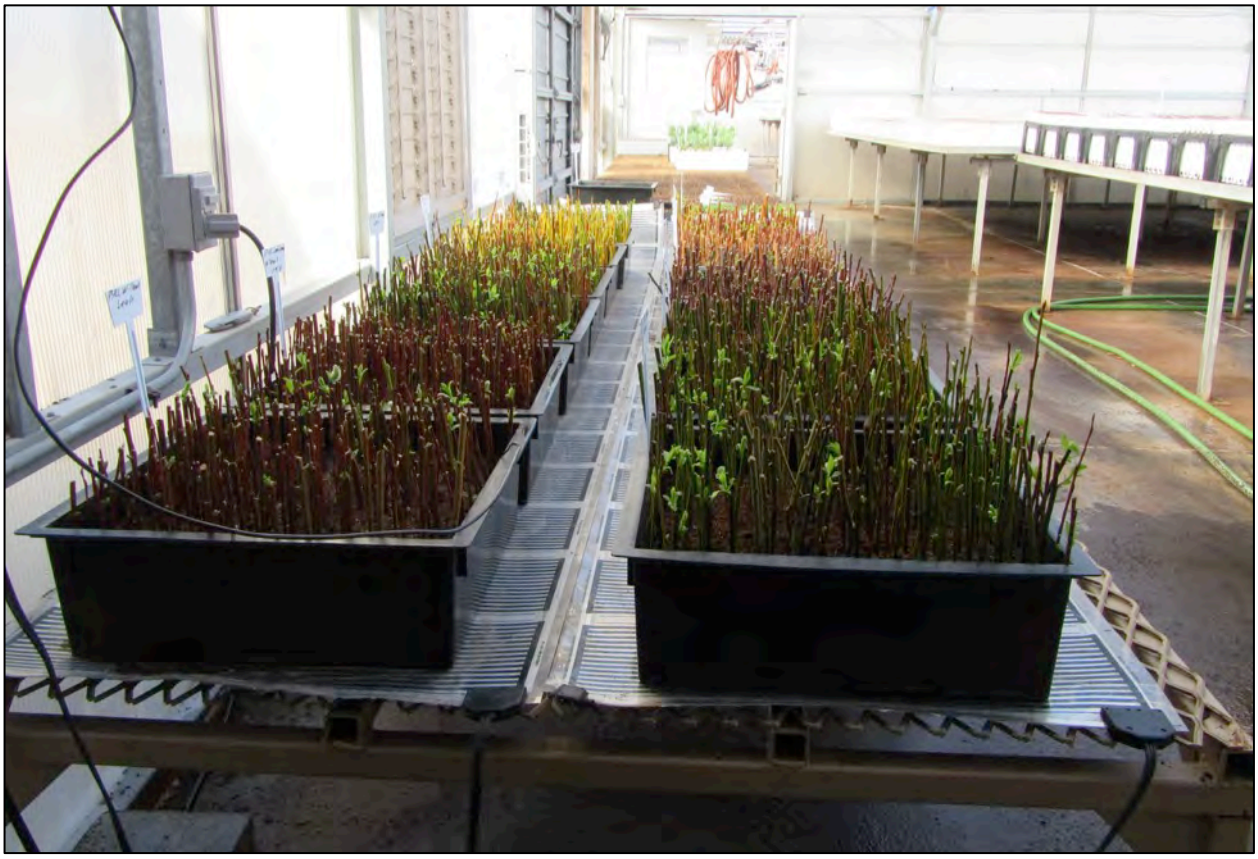


Figure 3. Willows cut to 1-foot segments and planted in containers at the Bessey Nursery in Halsey, Nebraska.

Figure 4. Willows transplanted into individual pots to continue growth and root maturation.


Figure 5. Crews transporting willows from Rampart Range Road to the planting location in the Camp Creek drainage.

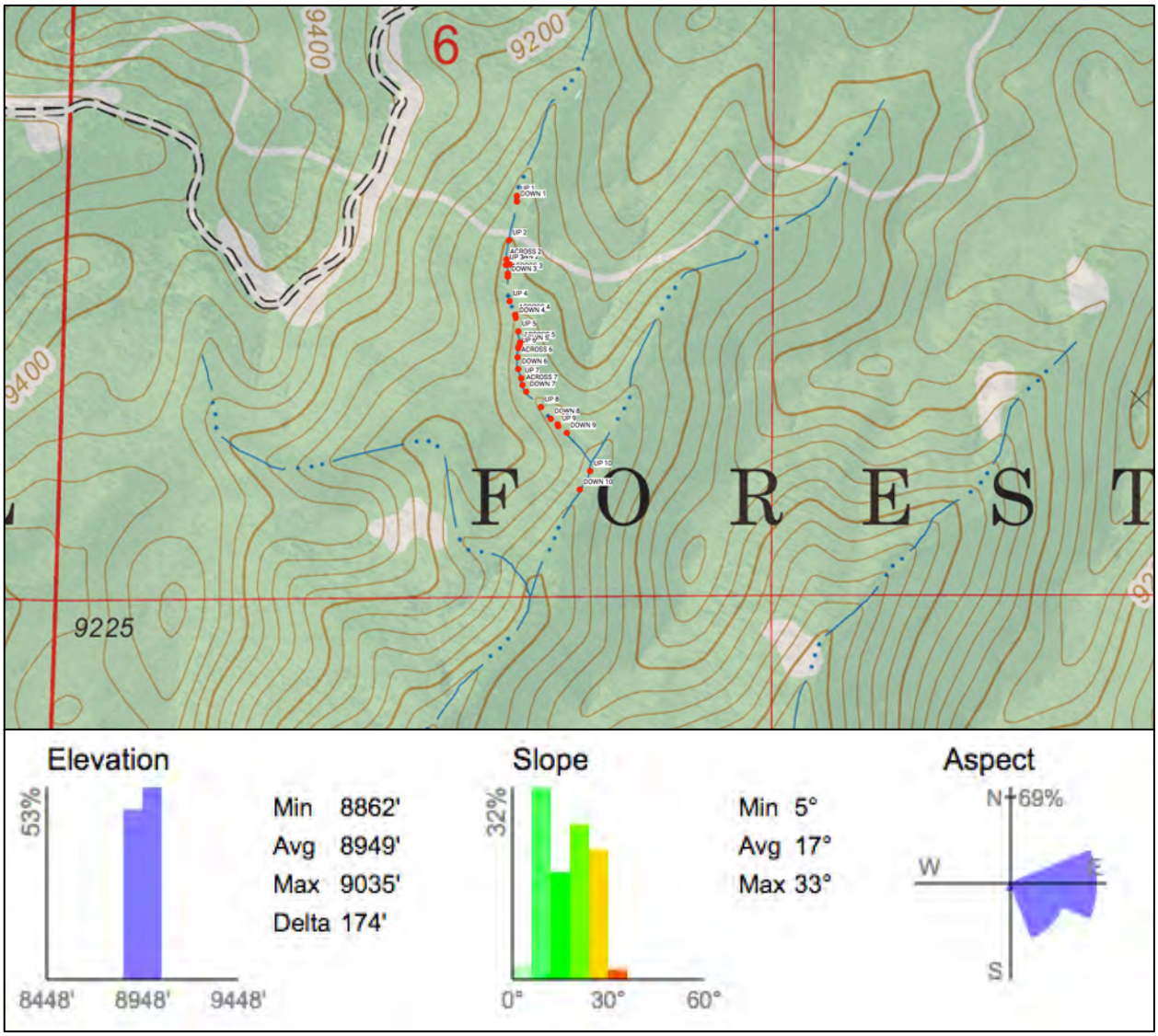


Figure 6. Location of planting zones 1-10 in the Upper Camp Creek drainage of the Waldo Canyon burn scar, and terrain statistics (elevation, slope, and aspect) for the 1,624 ft. reach. For coordinates of each upper and lower limit of each planting zone, please refer to Appendix B.

Figure 7. Leah Lessard, USFS Hydrologist, demonstrating proper planting techniques.

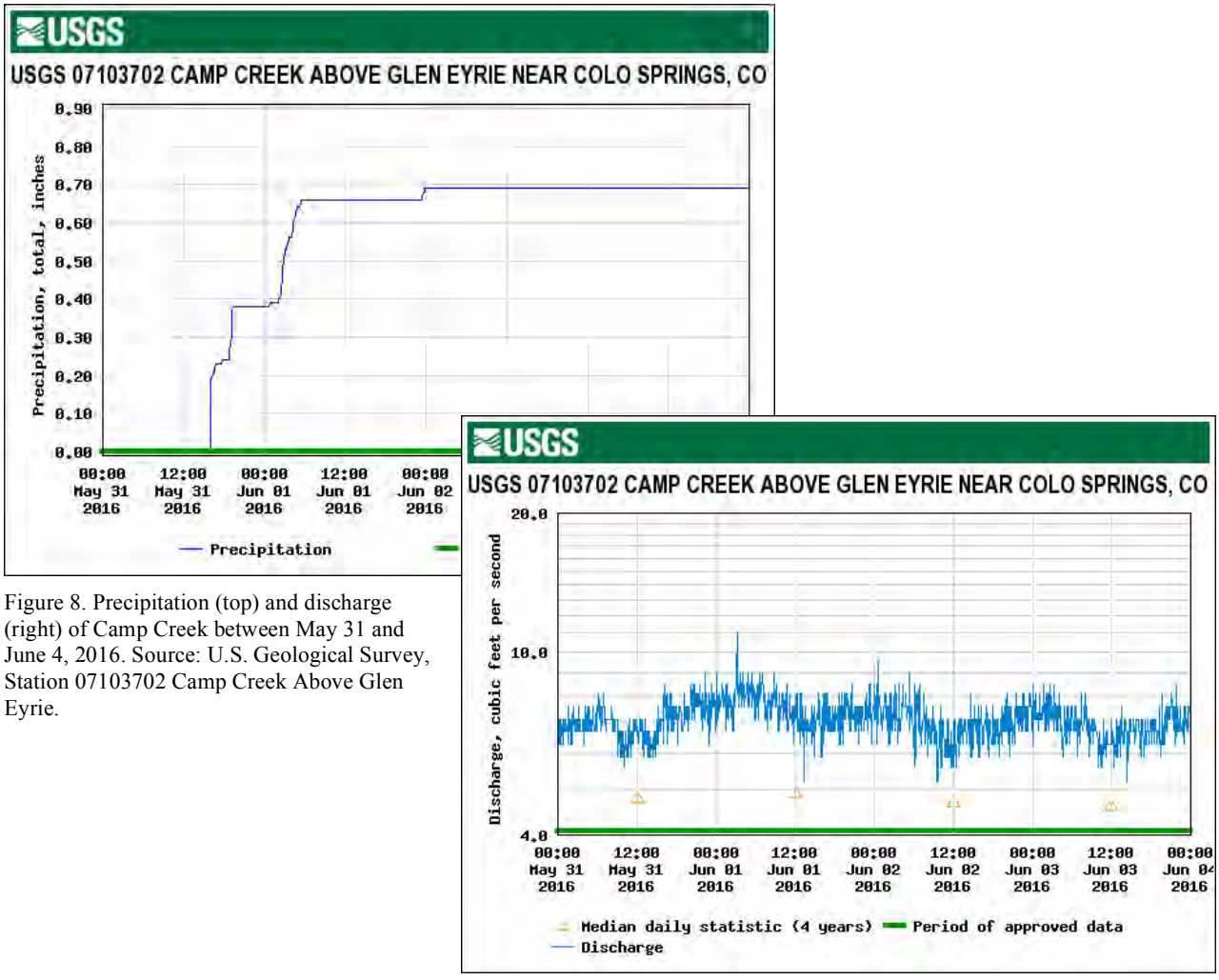


Figure 8. Precipitation (top) and discharge (right) of Camp Creek between May 31 and June 4, 2016. Source: U.S. Geological Survey, Station 07103702 Camp Creek Above Glen Eyrie.

Figure 9. Before (left) and after (right) photos of headcut stabilization treatments completed by RMFI and MHYC.

Figure 10. Before (left) and after (right) photos showing sills emplaced in a side drainage to stabilize the slope.

Figure 11. Before (left) and after (right) showing headcut stabilization treatment.

Figure 12. Before (left) and after (right) of a stepfall construction technique to stabilize the stream channel.

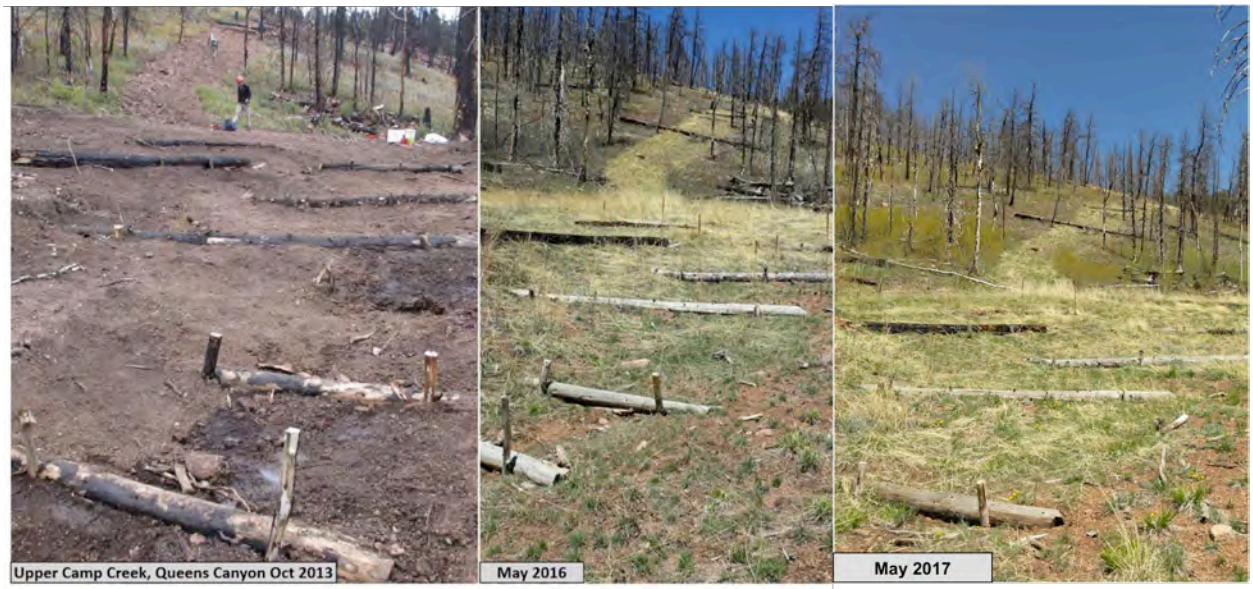


Figure 13. A 4-year photo series showing the impact of RMFI's restoration work in the Upper Camp Creek drainage of the Waldo Canyon burn scar.

Figure 14. Photos of Zone 1 looking downstream and upstream. Photos taken on May 25, 2017.

Figure 15. Photos of Zone 2 looking downstream and upstream. Photos taken on May 25, 2017.

Figure 16. Photos of Zone 3 looking downstream and upstream. Photos taken on May 25, 2017.

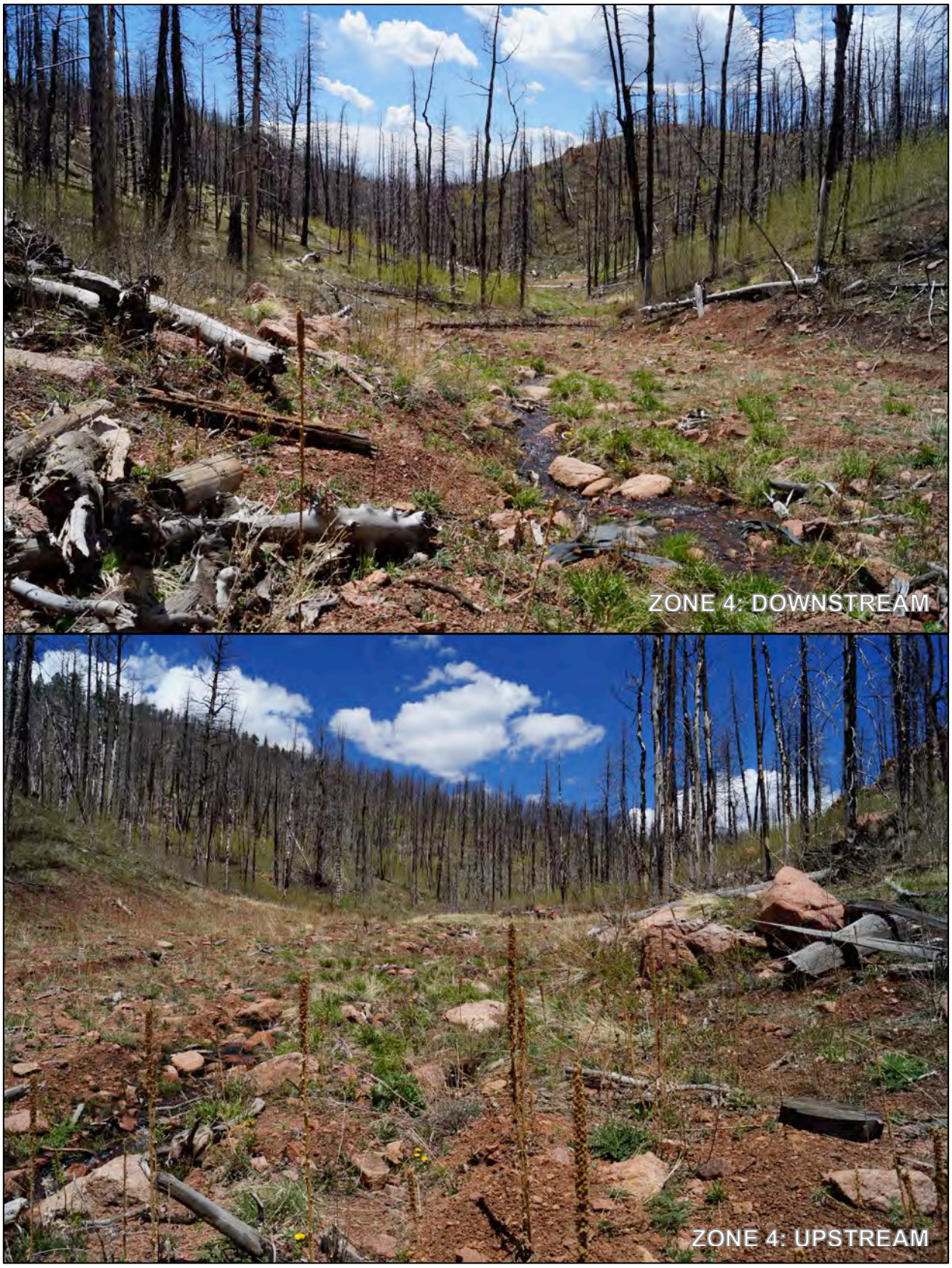


Figure 17. Photos of Zone 4 looking downstream and upstream. Photos taken on May 25, 2017.

Figure 18. Photos of Zone 5 looking downstream and upstream. Photos taken on May 25, 2017.

Figure 19. Photos of Zone 6 looking downstream and upstream. Photos taken on May 25, 2017.

Figure 20. Photos of Zone 7 looking downstream and upstream. Photos taken on May 25, 2017.

Figure 21. Photos of Zone 8 looking downstream and upstream. Photos taken on May 25, 2017.

Figure 22. Photos of Zone 9 looking downstream and upstream. Photos taken on May 25, 2017.

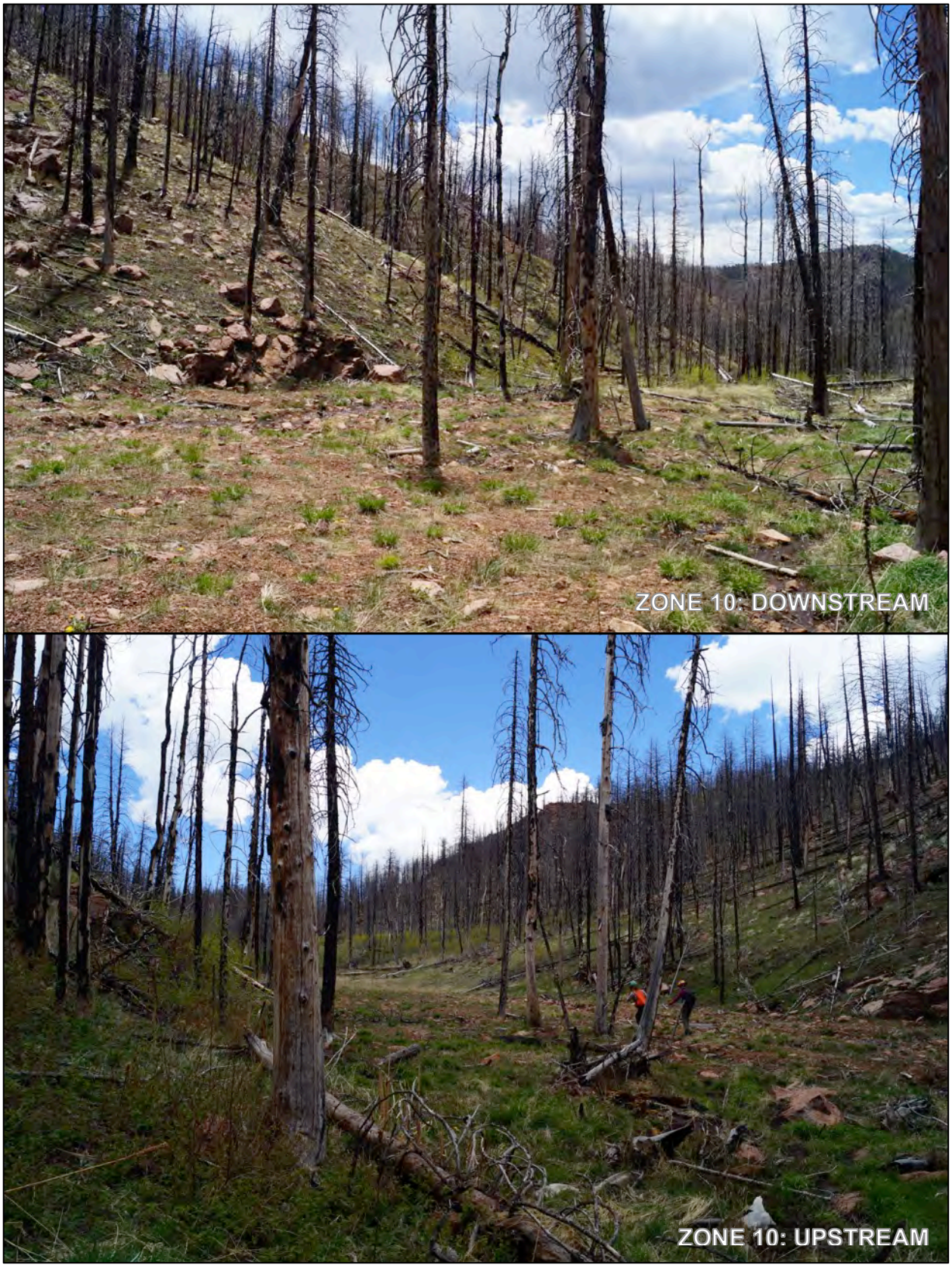


Figure 23. Photos of Zone 10 looking downstream and upstream. Photos taken on May 25, 2017.

APPENDIX A
WILLOW MONITORING FIELD DATA SHEET

Date: _____ Planting Location: _____ Name of Observers: _____

Temperature (□): _____ Elevation (ft.): _____ Average Monthly Precipitation (in.):_____

A Zone #	**B** # Willows Planted	**C** # Surviving Willows	**D** # Mortality Observed	**E** % Estimated Survival Rate (C/B)*100	**F** Willow Species Observed	**G** Observations/Notes

PHOTOPOINT DATA SHEET

Reach/Zone #	Coordinates of Photopoints	Corresponding Photo Name/Number(s)	Number of Photos Taken Per Reach/Zone	Observations/Notes

*Please use the diagram on page 3 to indicate photopoint locations within each planting zone as well as other pertinent information.

DIAGRAM OF MONITORING ZONES AND PHOTOPOINT LOCATIONS

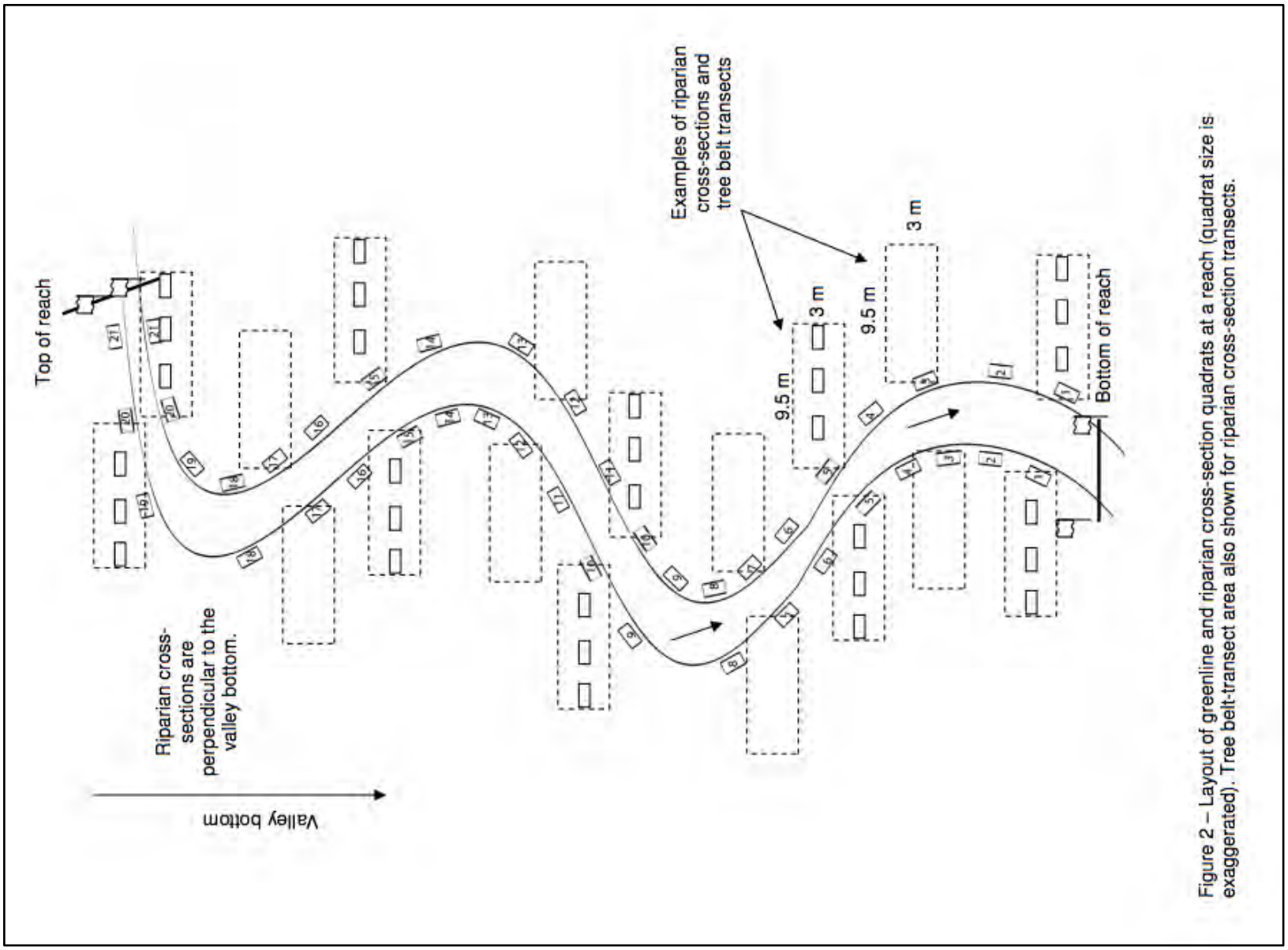


Figure 2 – Layout of greenline and riparian cross-section quadrats at a reach (quadrat size is exaggerated). Tree belt-transect area also shown for riparian cross-section transects.

OTHER OBSERVATIONS/NOTES

1. Are willows expanding and producing additional limbs and leaves?

2. If not, do the roots appear the be anchored and expanding?

3. Is surface water observed at each site?

4. Is there evidence of grazing?

5. Is there evidence of other disturbances (i.e. mass movement, erosion, or tampering)?

6. What is the estimated survival/mortality rate?

7. Other remarks…

Narrowleaf Willow (*Salix exigua*)

Bebb Willow, Long-Beaked Willow (*Salix bebbiana*)

Scouler Willow (*Salix scouleriana*)

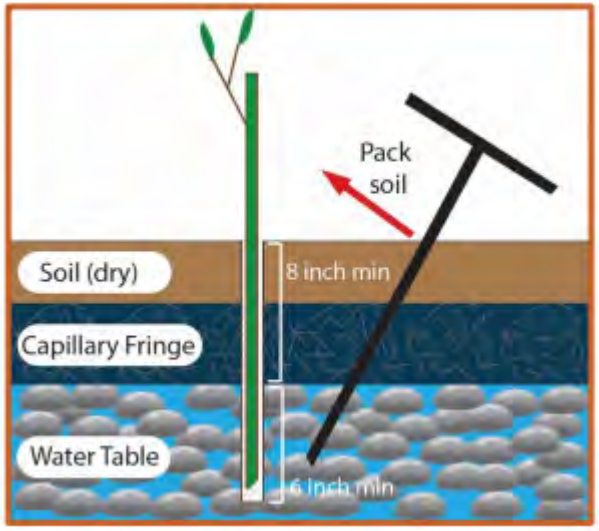
Rocky Mountain Willow (*Salix monticola* Bebb)

Photopoints

Photopoint monitoring is a standardized procedure, developed largely by Dr. Fred Hall of the U.S. Forest Service for taking precisely replicable photographs of resources that require long-term management (Hall, 1997). Photopoint monitoring is both a qualitative and quantitative tool that can assist resource managers in detecting unacceptable conditions in target resources before severe or irreversible changes occur, and allow time to implement corrective actions. The technique can also be used to assess the success or failure of management decisions based on the use of clearly defined indicators and standards. The photopoint monitoring technique can be used as an early warning system in conjunction with other quantitative approaches or as an independent monitoring procedure. At each willow planting zone intersection, photopoints were established as follows: from left bank looking to right bank; from right bank looking to left bank; from above the intersection looking downstream; and from below the intersection looking upstream. Additional photopoints were established at other appropriate locations where the channel could be observed.

Importance of Willows in Restoration

In arid regions of the Rocky Mountains, willows and cottonwoods provide important wildlife cover for nesting birds and small mammals, and forage for elk, moose, and other herbivores. Willows and other riparian vegetation provide effective soil stabilization through the large web of underground roots that bind soil particles together. The above-ground biomass of riparian vegetation slows water velocities and therefore aids in reducing shear stress along stream banks, road embankments, and other erosion-prone areas. Willows have a number of characteristics that make them resilient to high-velocity flood waters, burial by sediments, long periods of inundation, high winds, and heavy browsing by wildlife.



APPENDIX B – COMPLETED DATA SHEET

WILLOW MONITORING FIELD DATA SHEET

Date: 5/25/17 Planting Location: Camp Creek Name of Observers: Kelly, Joe, Jen, Leah

Temperature (°F): 78 Elevation (ft.): 8,949' Average Monthly Precipitation (in.): 1.61"

A Reach/Zone #	B # Willows Planted	C # Surviving Willows Counted # Counted	D % Estimated Survival Rate (B/C)	E Willow Species Observed	F Observations/Notes
1	25	~19	Ø mortality observed	Exidua | Coyote Narrow	evidence of elk | deer
2	125	counted 55		Exidua	mumit of debris/soil
3	100	~~48~~		Exidua	Hard to see/count willows
4	50	~~38~~		Exidua	
5	100	56		Exidua	
6	100	40		bebbianna	braided channel becomes more substantial
7	75	30		Exidua	around 6 & 7 → more water found
8	75	~~40~~		Exidua	no across photo point
9	150	45		Exidua	strong growth
10	100	38 15 53		Exidua	shiny silver stuff = silver oxide
			90-95% survival w/ 5-10% margin of error		soil is decomposing and oxidizing

1

no mortality observed → could have washed downstream

where we did see dead ones (almost) lots of bacteria growth, indicates high salinity

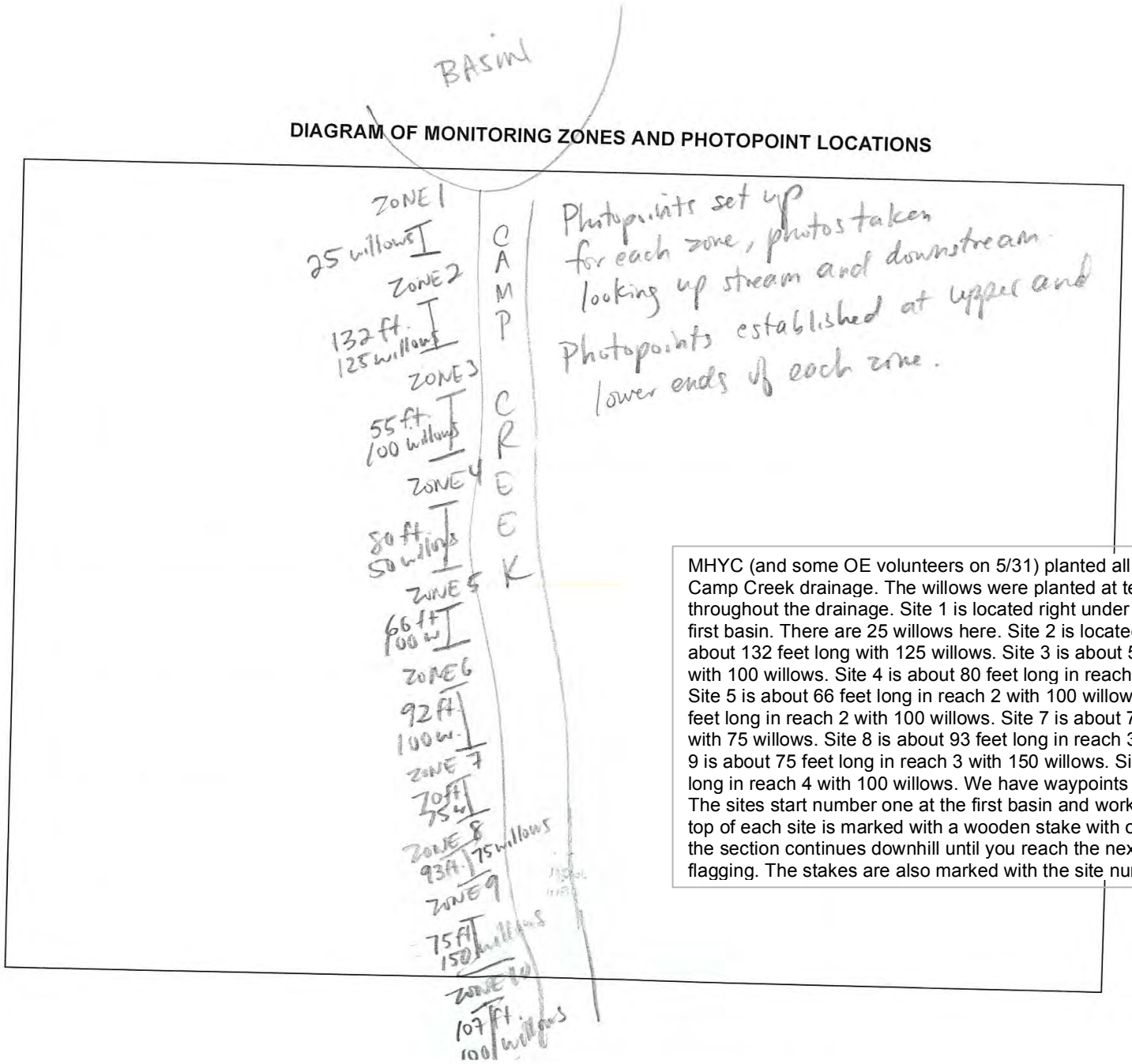
trends ↑: washing away in mass movement areas

PHOTOPOINT DATA SHEET

Reach/Zone #	Coordinates of Photopoints	Aspect of Photopoint	Corresponding Photo Name/Number(s)	Number of Photos Taken Per Reach/Zone	Observations/Notes	
1	UP1 DOWN1	off	1407 1408	2	**UP 1** 38.9456, -104.9284 13S 0506201E 4310745	**DOWN 1** 38.9455, -104.9284 13S 0506201E 4310736
2	UP 2 DOWN 2 ACROSS 2	stream	1411 1412 1413	3	**UP 2** 38.9450, -104.9286 13S 0506190E 4310677	**DOWN 2** 38.9447, -104.9286 13S 0506191E 4310641
3	UP 3 A 3 D 3	to @	1414 1417 1416	3	**UP 3** 38.9447, -104.9286 13S 0506185E 4310641	**DOWN 3** 38.9445, -104.9286 13S 0506188E 4310623
4	U4, A4, D4	stake	1418, 1420, 1419	3	**UP 4** 38.9442, -104.9286 13S 0506191E 4310586	**DOWN 4** 38.9440, -104.9285 13S 0506200E 4310561
5	U5, A5, D5		1421, 1424, 1422	3	**UP 5** 38.9438, -104.9284 13S 0506204E 4310540	**DOWN 5** 38.9436, -104.9284 13S 0506205E 4310519
6	U6, A6, D6		1423, 1425, 1426	3	**UP 6** 38.9436, -104.9284 13S 0506204E 4310515	**DOWN 6** 38.9433, -104.9284 13S 0506203E 4310484
7	U7, A7, D7		1427, 1428, 1429	3	**UP 7** 38.9431, -104.9284 13S 0506209E 4310470	**DOWN 7** 38.9430, -104.9283 13S 0506216E 4310449
8	U8, ~~A8~~, D8		1430, 1431	2	**UP 8** 38.9428, -104.9280 13S 0506238E 4310427	**DOWN 8** 38.9426, -104.9278 13S 0506253E 4310409
9	U9, ~~A9~~, D9		1432 1433	2	**UP 9** 38.9425, -104.9277 13S 0506264E 4310398	**DOWN 9** 38.9424, -104.9276 13S 0506277E 4310387
10	U10, ~~A10~~, D10		1434 1435	2	**UP 10** 38.9419, -104.9272 13S 0506312E 4310330	**DOWN 10** 38.9416, -104.9273 13S 0506297E 4310303

*Please use the diagram on page 3 to indicate photopoint locations within each planting zone as well as other pertinent information.

DIAGRAM OF MONITORING ZONES AND PHOTOPOINT LOCATIONS



MHYC (and some OE volunteers on 5/31) planted all 900 willows in the Camp Creek drainage. The willows were planted at ten different sites throughout the drainage. Site 1 is located right under the outlet above the first basin. There are 25 willows here. Site 2 is located in reach 1 and is about 132 feet long with 125 willows. Site 3 is about 55 feet long in reach 1 with 100 willows. Site 4 is about 80 feet long in reach 2 with 50 willows. Site 5 is about 66 feet long in reach 2 with 100 willows. Site 6 is about 92 feet long in reach 2 with 100 willows. Site 7 is about 70 feet long in reach 2 with 75 willows. Site 8 is about 93 feet long in reach 3 with 75 willows. Site 9 is about 75 feet long in reach 3 with 150 willows. Site 10 is about 107 feet long in reach 4 with 100 willows. We have waypoints of the top of each site. The sites start number one at the first basin and work their way down. The top of each site is marked with a wooden stake with orange flagging and the section continues downhill until you reach the next stake with orange flagging. The stakes are also marked with the site number.

OTHER OBSERVATIONS/NOTES

1. Are willows expanding and producing additional limbs and leaves?
   Yes. Several were observed to be adding new leaves and limbs despite obvious browsing from elk.
2. If not, do the roots appear the be anchored and expanding?
   Yes.
3. Is surface water observed at each site?
   Yes - camp creek was flowing
4. Is there evidence of grazing?
   Yes - by elk.
5. Is there evidence of other disturbances (i.e. mass movement, erosion, or tampering)?
   Minimal observance of mass movement and erosion.
6. What is the estimated survival/mortality rate?
   Mortality: 0% observed.
   Estimated survival: 90-95% w/ 5-10% margin of error incorporated.
7. Other remarks...