- Cebolla Creek Wetland Restoration Monitoring:
  Status Report, December, 2009. Geomorphology Monitoring
  Steve Vrooman Restoration Ecology, December 9, 2009

- *Hydrologic and topographic monitoring of wetland restoration effectiveness in Cebolla Canyon Closed Basin*
  Final Report, December 2011, Prepared by Ellen Soles

- Cebolla Canyon Restoration Area
  Ablquerque Resource Area
  Bureau of Land Management, New Mexico
  *Preliminary Small Mammal Survey*
  Prepared by:
  Katherine M. Thibault, Travis W. Perry
  Department of Biology, Furman University

- Cebolla Canyon
  *Restoration Treatment Photomonitoring*
  2011-2012

# 17. APPENDIX

## 17.1 LIST OF PROFESSIONALS AND EXPERTS INTERVIEWED

| Name | Title/Profession |
|---|---|
| **Bill Zeedyk** | Land, Biologist / Ecologist, Riparian Wildlife and Wetlands Specialist. |
| **Steve Fischer** | Former Retired BLM |
| **Matthew Schultz** | Surface Water Quality Environmental Scientist, New Mexico Environmental Department |
| **Steve Vrooman** | Professional Ecologist |
| **Gretchen Obenaus** | BLM Archeologist Rio Puerco Field Office Cebolla Canyon/Malpais |
| **Craig Sponholtz** | Riparian and Watershed Restoration Expert |
| **Dave Mattern** | BLM Hydrologist |
| **Ed Singleton** | Retired BLM District Manager |
| **Brian Gleadle,** | Chief of NW Area Operations, NM Department of Game Fish and Fish Game Albuquerque |
| **Gene Tatum** | Retired BLM, Albuquerque Wildlife Federation |
| **Joe Lally** | BLM Archaeologist Cebolla Canyon/Malpais Rio Puerco Field Office |

## 17.2 LIST OF PHOTOPOINTS

### *17.2.1 Photopoint Identification Sheet*

The following is a collection of photopoints gathered by Matt Schultz in order to document the restoration in the Cebolla Canyon.

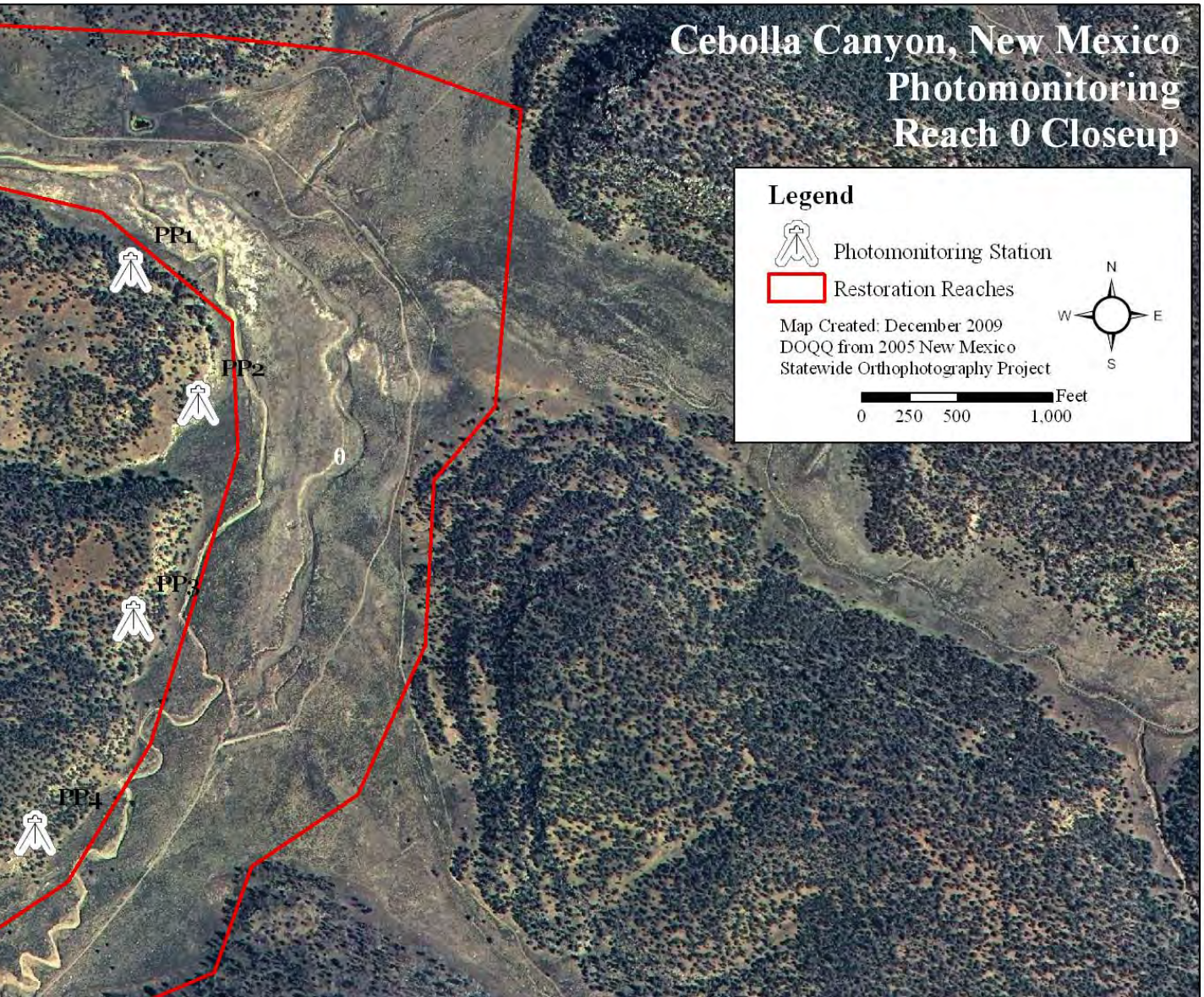
| | |
|---|---|
| **Site Name:** Cebolla Canyon; El Malpais National Conservation Area, BLM | **Date of survey:** 11/5/09 |
| **Recorder's name:** Matt Schultz | **Photographer's name:** Matt Schultz |
| **Camera description (focal length of lens, digital or print camera, is it same as last one used for monitoring?) If digital, what is the resolution setting of the camera?** Canon Powershot SX100 IS Digital Camera 6.0-60.0mm 1:2.8-4.3 8.0 Mega Pixels | |
| **Speed of film (ASA) if shooting print film:** NA | |
| **Height from ground to eye of the photographer.** Approximately 5 feet | |
| **Declination of compass:** 10 degrees E | |

### *17.2.2 Data*

| Number on roll or file image number | Time of day & Direction of photograph (compass bearing) | Photopoint label/code, height of photo from ground level and location description (see map and photo captions) |
|---|---|---|
| 2508 | 11:48AM / 1° | PP1; DD 34.675683° -107.846786° (Datum WGS 1984) |
| 2509 | 11:48 AM / 49° | PP1; DD 34.675683° -107.846786° (Datum WGS 1984) |
| 2503 | 11:32 AM / 170° | PP2; DD 34.673793° -107.845555° (Datum WGS 1984) |
| 2505 | 11:35 AM / 40° | PP2; DD 34.673793° -107.845555° (Datum WGS 1984) |
| 2506 | 11:36 AM / 85° | PP2; DD 34.673793° -107.845555° (Datum WGS 1984) |
| 2511 | 12:17 PM / 125° | PP3; DD 34.670636° -107.846576° (Datum WGS 1984) |
| 2512 | 12:18 PM / 85° | PP3; DD 34.670636° -107.846576° (Datum WGS 1984) |
| 2515 | 12:43 PM / 205° | PP4; DD 34.667518° -107.848185° (Datum WGS 1984) |
| 2516 | 12:44 PM / 165° | PP4; DD 34.667518° -107.848185° (Datum WGS 1984) |
| 2517 | 12:46 PM / 115° | PP4; DD 34.667518° -107.848185° (Datum WGS 1984) |
| 2518 | 12:46 PM / 75° | PP4; DD 34.667518° -107.848185° (Datum WGS 1984) |

| | | |
|---|---|---|
| 2519 | 12:48 PM / 55° | PP4; DD 34.667518° -107.848185° (Datum WGS 1984) |
| 2521 | 1:31 PM / 65° | PP5; DD 34.67845° -107.85429° (Datum WGS 1984) |
| 2522 | 1:33 PM / 325° | PP5; DD 34.67845° -107.85429° (Datum WGS 1984) |

| | | |
|---|---|---|
| 2524 | 2:08 PM / 295° | PP6; DD 34.682755° -107.864503° (Datum WGS 1984) |
| 2525 | 2:09 PM / 335° | PP6; DD 34.682755° -107.864503° (Datum WGS 1984) |
| 2526 | 2:11 PM / 40° | PP6; DD 34.682755° -107.864503° (Datum WGS 1984) |
| 2527 | 2:13 PM / 65° | PP6; DD 34.682755° -107.864503° (Datum WGS 1984) |
| 2529 | 2:48 PM / 260° | PP7; DD 34.692409° -107.879531° (Datum WGS 1984) |
| 2530 | 2:49 PM / 225° | PP7; DD 34.692409° -107.879531° (Datum WGS 1984) |
| 2531 | 2:50 PM / 190° | PP7; DD 34.692409° -107.879531° (Datum WGS 1984) |
| 2532 | 2:51 PM / 160° | PP7; DD 34.692409° -107.879531° (Datum WGS 1984) |


Cebolla Canyon, New Mexico
Photomonitoring
Reach 0 Closeup
Legend
Photomonitoring Station
Restoration Reaches
Map Created: December 2009
DOQQ from 2005 New Mexico
Statewide Orthophotography Project
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PP1
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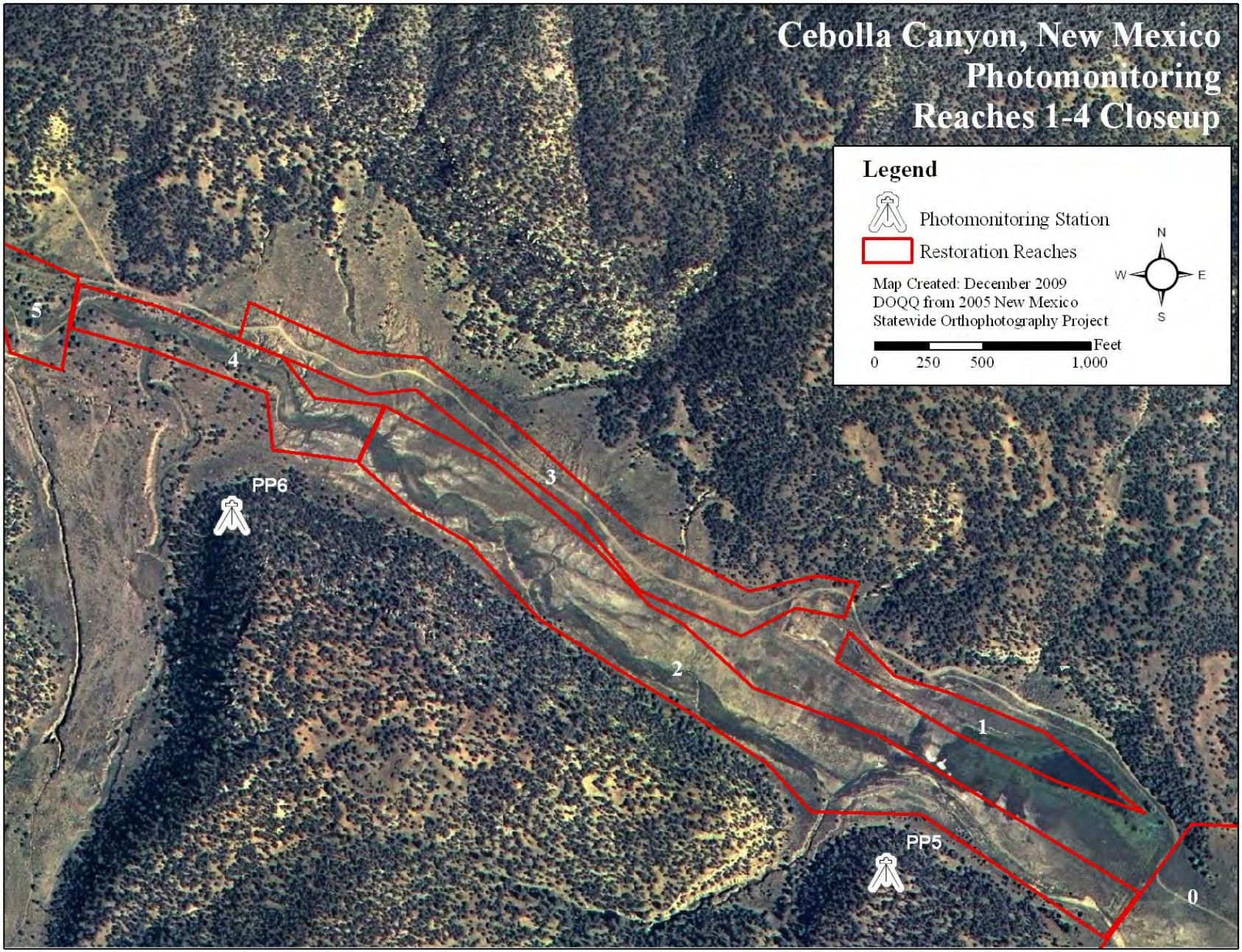
PP4
0


Cebolla Canyon, New Mexico
Photomonitoring
Reaches 1-4 Closeup
Legend
Photomonitoring Station
Restoration Reaches
Map Created: December 2009
DOQQ from 2005 New Mexico
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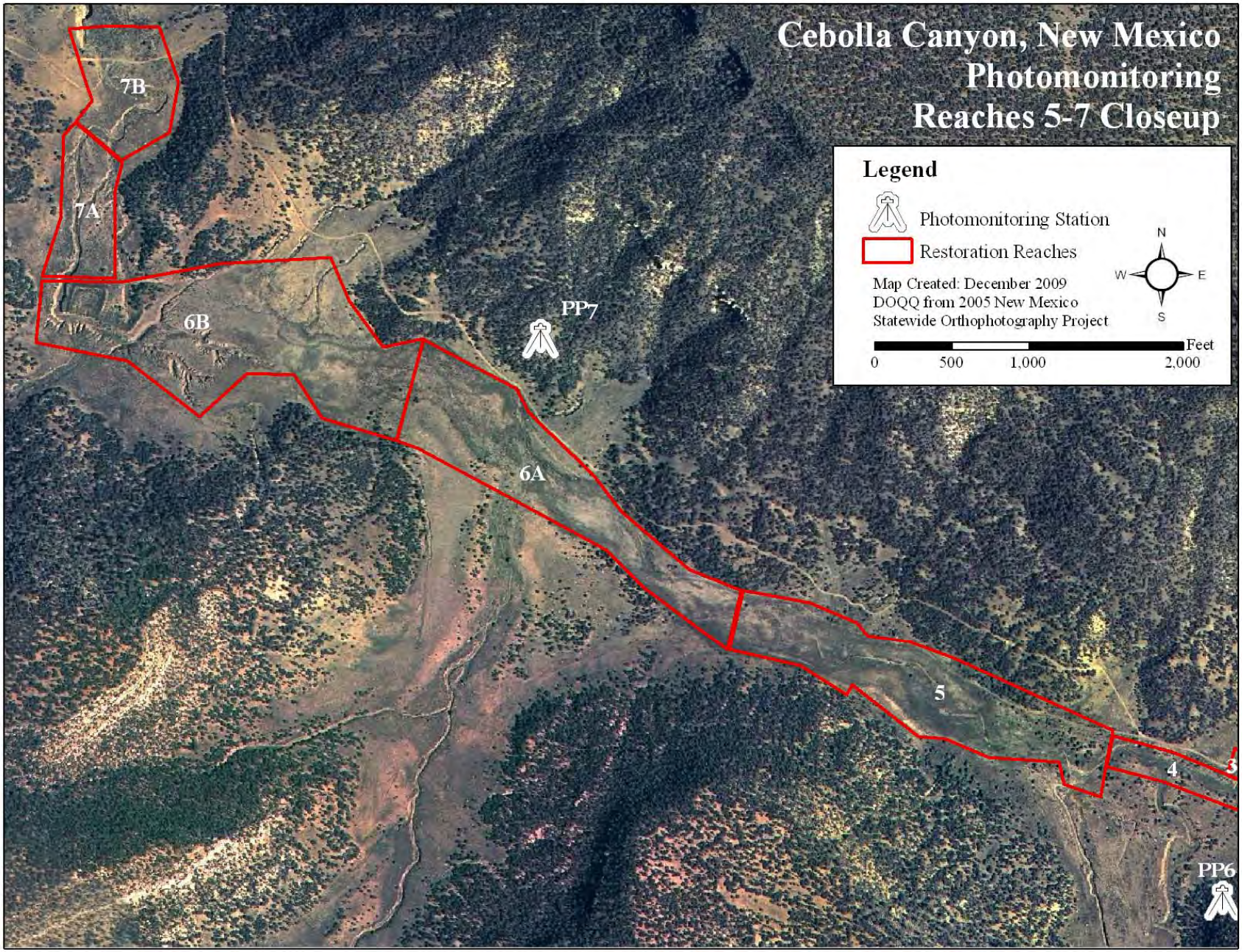
Cebolla Canyon, New Mexico
Photomonitoring
Reaches 5-7 Closeup
Legend
Photomonitoring Station
Restoration Reaches
Map Created: December 2009
DOQQ from 2005 New Mexico
Statewide Orthophotography Project
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S
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0
500
1,000
2,000
7B
7A
6B
PP7
6A
5
4
3
PP6

**Photopoint 1 – 1 degrees –** Reach 0: View of Little Cebolla Springs and Lake Cebolla as well as the sediment plug resulting from the confluence of the abandoned irrigation ditch.

**Photopoint 1 – 49 degrees –** Reach 0: View of Lake Cebolla in the center with Side Valley Right #3 in the background and the abandoned irrigation ditch in the foreground.

**Photopoint 2 – 170 degrees –** Reach 0: View upstream of Cebolla valley in the center with Side Valley Right #1 in the background and the abandoned irrigation ditch in the foreground.

**Photopoint 2 – 40 degrees –** Reach 0: View downstream of Cebolla natural channel in the center with Side Valley Right #2 and 3 in the background and the abandoned irrigation ditch in the foreground.

**Photopoint 2 – 85 degrees –** Reach 0: View of Cebolla natural channel in the center with Side Valley Right #2 in the background and the abandoned irrigation ditch in the foreground.

**Photopoint 3 – 125 degrees –** Reach 0: View of Cebolla natural channel and diversion berm in the center with Side Valley Right #1 in the background and the abandoned irrigation ditch in the foreground.

**Photopoint 3 – 85 degrees –** Reach 0: View of Cebolla natural channel and road in the center and the abandoned irrigation ditch in the foreground.

**Photopoint 4 – 205 degrees –** Reach 0: View upstream of Cebolla valley with Side Valley Left #1 to the right.

**Photopoint 4 – 165 degrees –** Reach 0: View across Cebolla valley with tortured meanders and road in center.

**Photopoint 4 – 115 degrees –** Reach 0: View across Cebolla valley with channel and road visible in center.

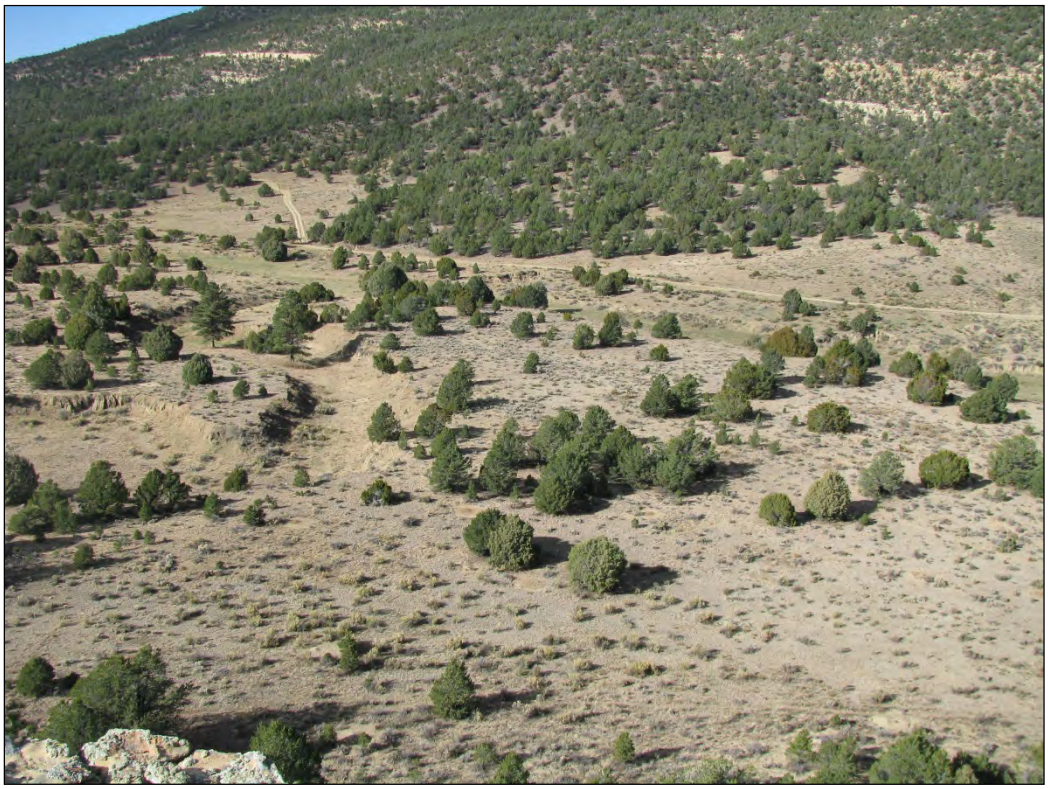
**Photopoint 4 – 75 degrees –** Reach 0: View across Cebolla valley with channel and road visible in center and Side Valley Right #1 in the background.

**Photopoint 4 – 55 degrees –** Reach 0: View downstream of Cebolla valley with channel and road visible in center and Side Valley Right #1 and #2 in the background.

**Photopoint 5 – 65 degrees –** Reach 1: View upstream of Cebolla Springs.

**Photopoint 5 – 325 degrees –** Reaches 2 and 3: View downstream of Cebolla valley with the road (Reach 3) visible on valley right and the irrigation ditch on valley left. A fenceline is located in the center.

**Photopoint 6 – 295 degrees –** Reaches 4 and 5: View downstream of Cebolla valley with Side Valley Left #4 in the foreground.



**Photopoint 6 – 335 degrees –** Reach 4: View slightly downstream of Cebolla valley with Side Valley Left #4 in the foreground and the road visible in the background.

**Photopoint 6 – 40 degrees –** Reaches 4 and 3: View across Cebolla valley with the road (Reach 3) visible in the background.

**Photopoint 6 – 65 degrees –** Reaches 4, 3, and 2: View across Cebolla valley with the junction of reaches 4 and 2 in the center, and the road (Reach 3) visible in the background.

**Photopoint 7 – 260 degrees –** Reaches 6A and 6B: View downstream Cebolla valley with the massive headcuts in the center.

**Photopoint 7 – 225 degrees –** Reach 6A: View across Cebolla valley.

**Photopoint 7 – 190 degrees –** Reach 6A: View across Cebolla valley into Side Valley Left #5.

**Photopoint 7 – 160 degrees –** Reach 6A: View upstream of Cebolla valley with Side Valley Left #5 at the upper right

## 17.3 2013 MONITORING REPORT

# Restoring Cebolla Canyon
# Monitoring Report
# Keystone Restoration Ecology, December, 2013

**Prepared for the Rio Puerco Alliance and the New Mexico Environment Department's SWQB Wetlands Program**

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## Introduction

Steve Vrooman of Keystone Restoration Ecology was contracted to lead the geomorphology and monitoring efforts for the Cebolla Creek Wetland Restoration Project. This project is funded through two separate grants. One grant is through the EPA's 319 clean water act program, called: "Restoring Cebolla Canyon," which is being funded through NMED CD # (FY2008). The second grant is through the State of New Mexico's River Ecosystem Restoration Initiative (RERI) and called "Restoring and Protecting Wetlands in Cebolla Canyon Closed Basin," which is being funded through NMED CD #966857-01-0C (FY2008). The two grants were used to fund separate reaches of the total project. The RERI grant funding ended on June 30, 2012. The NMED wetlands program funding was extended to Dec 31st, 2013, and the monitoring for the wetlands grant was re-taken in 2013 with this funding.

## Land Use History and Purpose of Restoration

Past channel manipulations for agriculture included cattle tank dams, irrigation diversions, headcut protection dams, cattle trails, and road building. All of these manipulations together caused gullying in the main Cebolla Canyon and the associated tributaries, loss of the historic wetland community, and drying out of the area. These manipulations occurred in the 1930s to 1950s.

After the last homesteaders left, their land mostly became Bureau of Land Management property, and the agricultural works were not maintained. The area was grazed heavily as part of the King Ranch, and most recently the York Ranch. Heavy grazing pressure was the norm for 50 years, and the gullying and headcutting became worse. When the first restoration activities were begun by Gene Tatum, the BLM and the Albuquerque Wildlife Federation under Bill Zeedyk's supervision, the Cebolla Spring was a 100 foot wide mud hole with little or no riparian vegetation. Simple actions such as plugging a gully with sandbags started a chain reaction that filled a 200 foot gully and created a 10 acre wetland that continues to expand today.

These treatments applied were selectively designed by Bill Zeedyk and other resource experts to undo the historic manipulations of the watershed and use the resource of flowing water and sediment transport to restore the historic wetland areas, fix the gullies and eliminate headcutting. Most of these treatments involved earth moving activities such as plug and pond, removing or repairing old cattle tank dams, and road drainage. Where necessary, smaller headcuts were treated with Zuni bowls and one rock dams. Due to the fact of water flowing downhill, all of the downhill treatments are the beneficiaries of the upstream treatments, the storage of water upstream in Reach 0 can be said to have an effect downstream in Reach 5.

## Wetland Delineation at Cebolla Creek

A wetland delineation was performed at Cebolla Creek with Matt Schultz of the NM Environment Department. A polygon was mapped with GPS (sub-meter Trimble) to delineate the boundaries of the wetland. The wetland delineation was re-surveyed in October 2013 to show how the wetland conditions have responded to the restoration treatments.

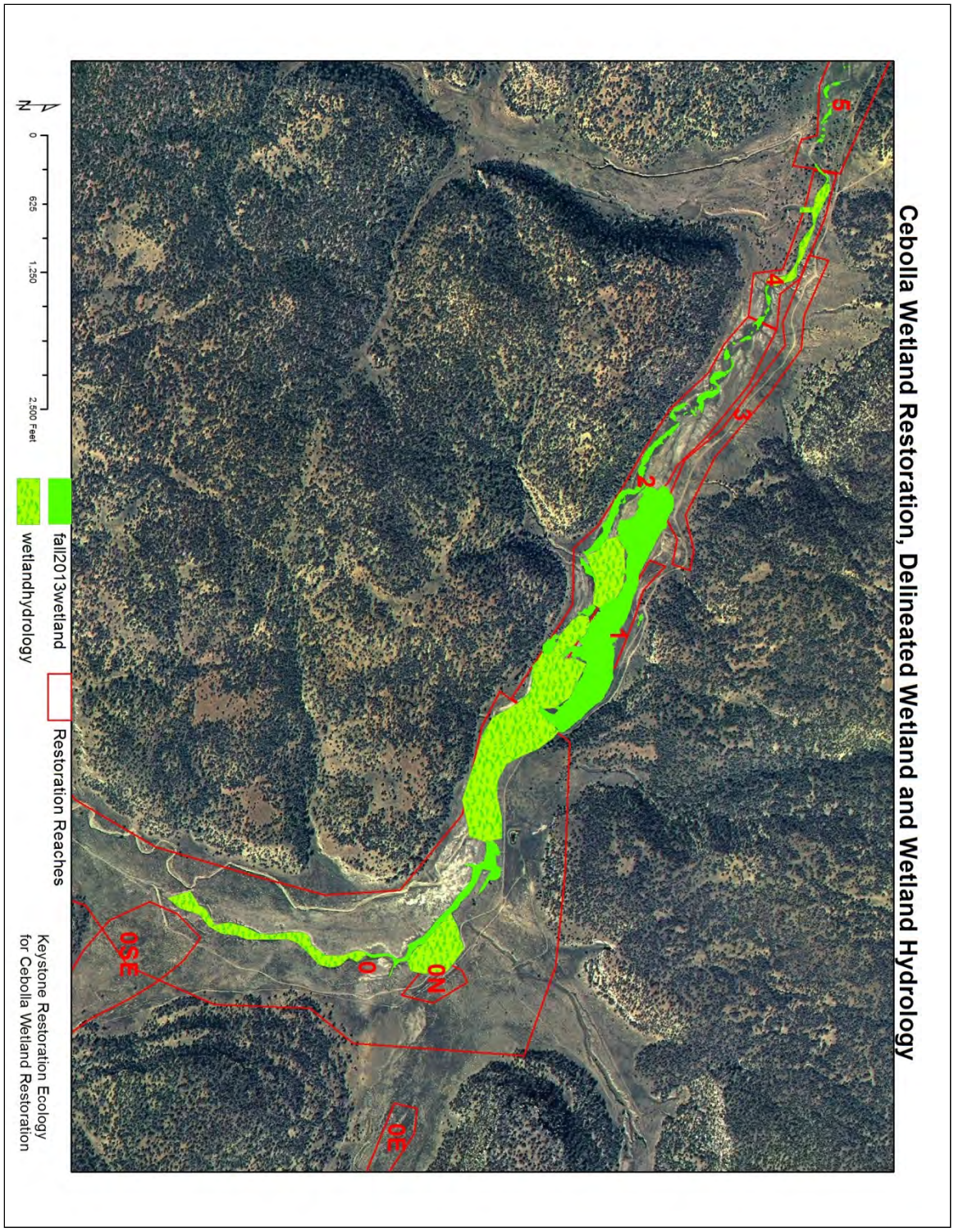
This data was also used to create a wetland vegetation gradient and is presented in a state-transition model format.

A summary of the findings:

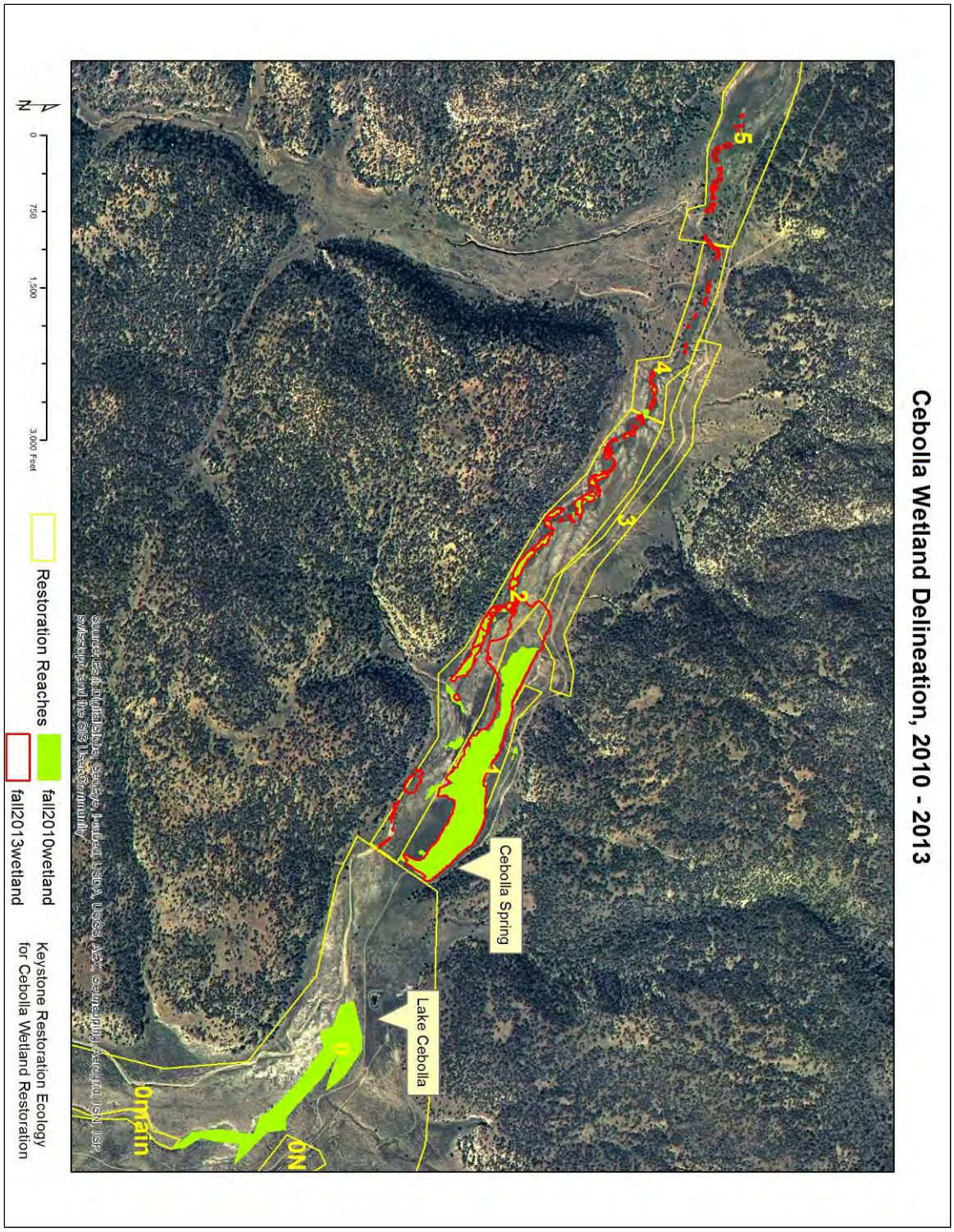
1. Wetland vegetation must be over 50% of the herb/grass stratum. When western wheatgrass is present, the area is not inundated enough to be wetland, and the vegetation is not hydrophytic. When these areas get wetter, the western wheatgrass dies off and is replaced by more foxtail barley and smartweed polygonum.
2. None of the soils surveyed were hydric soils, there was no layering or redox reactions, and the only sign of wetland soil was oxidized rhizospheres (rust along roots), which is a secondary hydrology wetland hydrology indicator on the worksheet.
3. Most of the surveyed areas have wetland hydrology, due to either surface water, regular flooding, or secondary indicators such as water marks and sediment and drift deposits. DUE TO THIS, we delineated an area as wetland when wetland vegetation was present in addition to the wetland hydrology indicators. Lake Cebolla was unique due to the presence of water throughout the growing season and a fringe of Baltic rush.
4. Areas that had wetland hydrology but did not have wetland vegetation were shown separate as "wetland hydrology" polygons. These areas were buried in 1-4 feet of sand in 2013, burying any evidence of any vegetation present. Wetland plants will be able to sprout through the sand in 2014, and their presence in the future would make these areas delineated wetland.

Wetland Areas in Cebolla Creek, Reaches 0-5

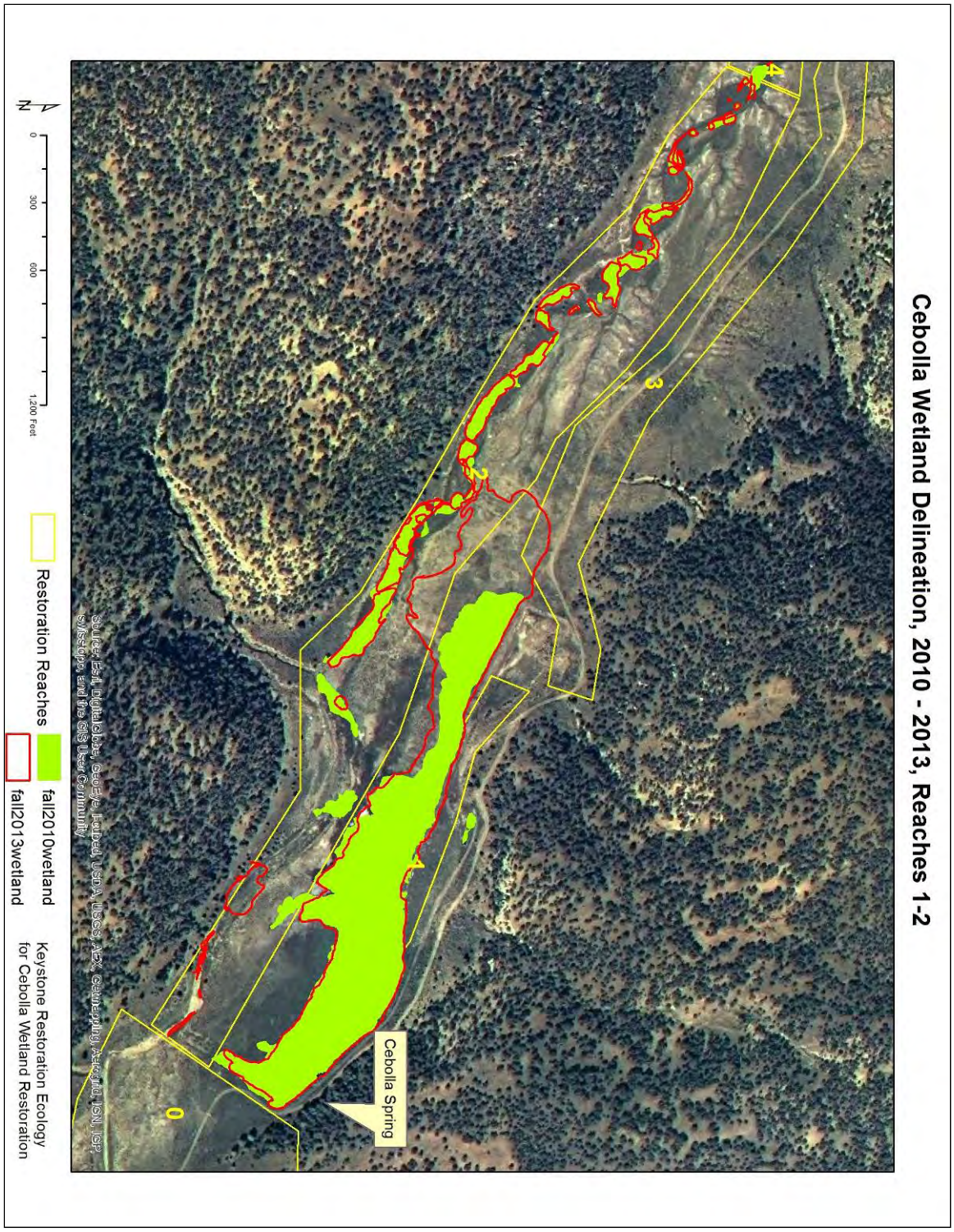
| Location | Delineated wetland in acres 2010 | Delineated wetland in acres 2013 | Wetland hydrology in 2013 |
|---|---|---|---|
| Lake Cebolla (Reach 0) | 2.9 | 2.9 | |
| Reaches 1-2 | 13.33 | 16.9 | |
| Reaches 4-5 | 0.37 | 0.7 | |
| Total acres | 16.6 acres | 20.5 acres | 29.4 acres |
| | | | |



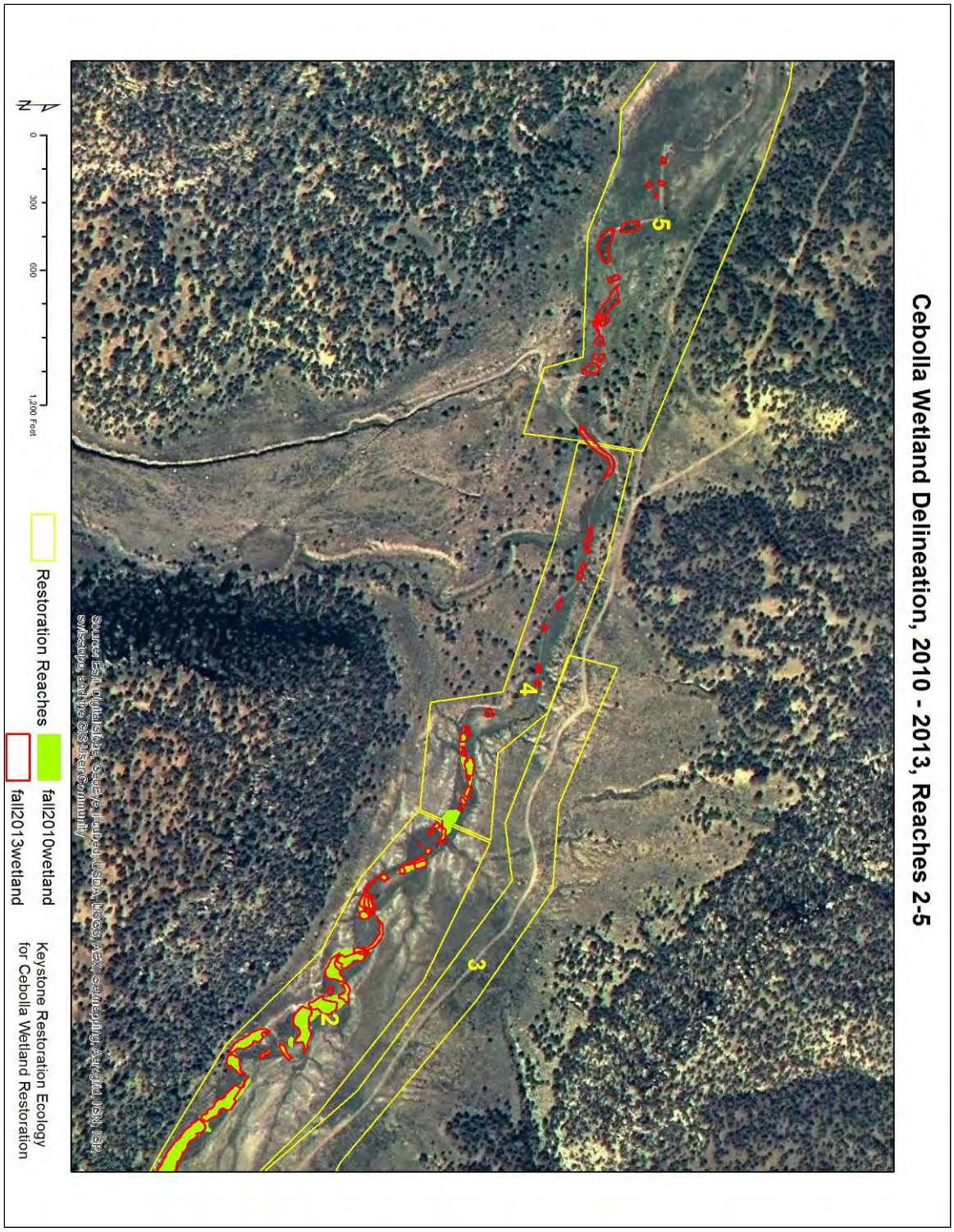

Comparison between areas with wetland hydrology and areas with wetland hydrology and vegetation (delineated wetland) in 2013. A large portion of these areas were covered with several feet of sand, burying any vegetation present when surveyed in Oct 2013.




Overview of wetland areas in Cebolla Wetland, a comparison between 2010 and 2013.




Close-up on Reaches 1 and 2 at Cebolla wetland. Wetland areas were identified up-channel to the large exclosure fence between reaches 0 and 1. Most of the area near Cebolla Spring had been buried in sand and litter after the large floods in September, 2013. This caused some areas that had been identified as wetland in 2010 to be missed in 2013, as they were buried under sand and had not yet sprouted new growth, one month after the flood.



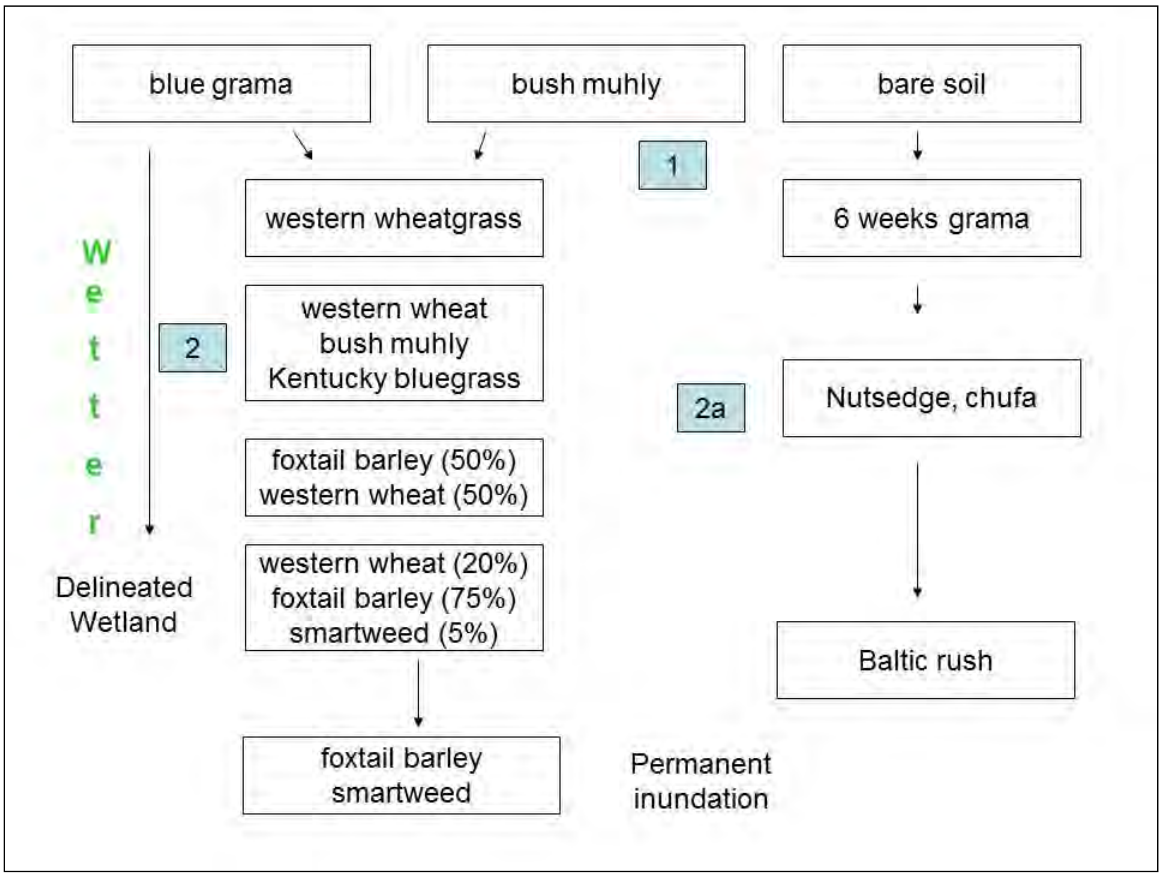

Close-up on Reaches 4 and 5 at Cebolla wetland. Wetland areas had advanced down-channel into reach 5 from the upstream reaches. A large alluvial fan from Savage Canyon to the south has filled the valley bottom and caused water to spread and soak into the ground, creating conditions appropriate for wetland vegetation, in this case, Baltic rush.

Two photos taken from different locations on the south side of Cebolla Canyon fall 2010 and fall 2013, looking at end of wetland. Upper photo has wetland ending near pond, in lower photo; wetland extends downstream 500 feet or so to bend in road and white truck to left of picture.

## Wetland Vegetation Indicator Gradient

An assessment was performed and a proposed wetland gradient was proposed for Cebolla Creek. As areas change from dry to wet, the vegetation community responds. Once an area is completely inundated, the successional gradient proceeds from common spikerush (*Eleocharis palustris*) to cattail and bulrush.

LARGE CHANGES FROM 2010 TO 2013: this wetland vegetation indicator gradient model was created in 2010-2011. Over the last three years, the numbers of cattails in the main Cebolla wetland has dropped to almost none, as bulrush has taken over the main wetland area at Cebolla Spring. The cattails may have been a relic of a burning of the wetland that occurred years before and created open water at the spring.



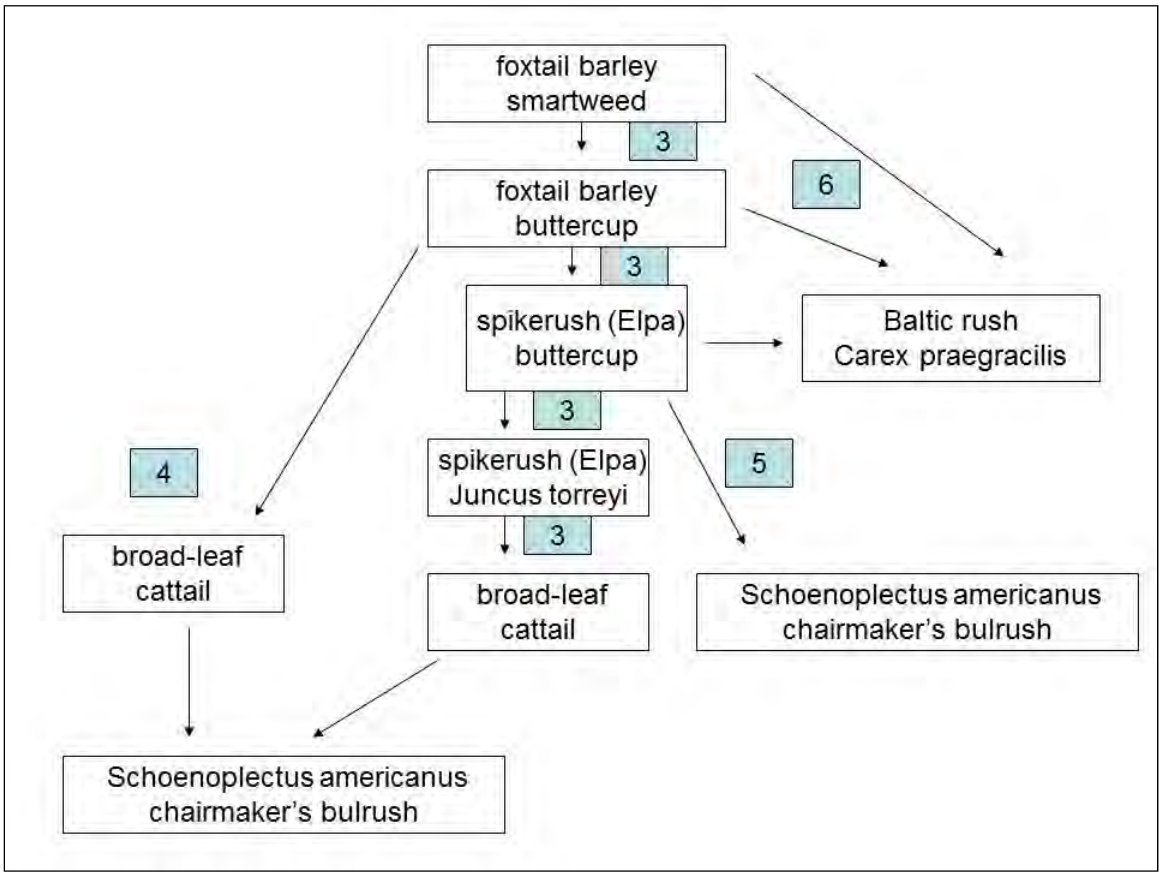

### State-transition stages

1. Community becomes wetter through brief flood events from main channel or tributary channels. Extra water during growing season grows more vigorous vegetation and plant community changes to wet meadow (Western Wheatgrass) community. Bare Soil is colonized by Six-weeks grama if flooding is present.
2. Area becomes inundated for a significant time, either by pooling in the channel or tributaries of Cebolla Creek, or by expansion of Cebolla Spring wetland. Vegetation

responds by becoming more hydric until it becomes a delineated wetland community with Foxtail Barley, Western Wheatgrass, and Polygonum smartweed.

2a. Areas that are slightly drier and have deposition of wet sand can be colonized by nutsedge or Chufa (*Cyperus esculentus*). This plant is a vigorous grower and is most common at the end of Reach 0 near Little Cebolla Spring (lower exclosure) and the end of Reach 4. These areas progress to Baltic rush over time as they stay saturated and become delineated wetland. Due to the position in the channel and lack of permanent surface water, this stage ends at Baltic rush.

3. This is a successional stage from early to late successional species. In the absence of disturbance and continual inundation, this stage proceeds. The vegetation transects 1-1, 1-2, 1-3 will study this effect through several years.
4. This transition occurs when elk or cattle wallow in the spikerush and create large open pools (6 feet across). The open space allows for cattails to colonize the thick spikerush (Eleocharis palustris) vegetation.
5. The spikerush (Elpa) can quickly change to bulrush if the seeds of bulrush get established, otherwise, the change proceeds more slowly through Juncus torreyi.
6. If the spikerush areas dry out seasonally, they can become colonized by Juncus balticus and Carex praegracilis (Baltic rush and field sedge). These areas are saturated, but have no surface moisture. This community is found along the edges of the Cebolla Spring area, between the spring and the channel, and not found (yet) to the west where the wetland is advancing.



Indicator vegetation species list for State-transition model for wetland creation, species at top of table are dry, wetness increases down the list from top to bottom.

| Vegetation species | Common name | habitat | wetness |
|---|---|---|---|
| *Bouteloua gracilis* | blue grama | Slopes, flats | dry |
| *Muhlenbergia repens* | creeping muhly | Valley bottoms with some additional moisture | dry/mesic |
| *Pascopyrum smithii* | western wheatgrass | Slopes, flats, valley | mesic, additional moisture |
| *Poa pratensis* | Kentucky bluegrass | All | mesic |
| *Cyperus esculentus* | nutsedge, chufa | Wet sand deposition | mesic |
| *Hordeum jubatum* | foxtail barley | Valley bottoms | wetland |
| *Polygonum puncatatum* | smartweed | Valley bottoms | wetland |
| *Ranunculus sceleratus* | cursed buttercup | Valley bottoms | wetland |
| *Eleocharis palustris* | common spikerush | Valley bottoms | wetland |
| *Juncus balticus* | Baltic rush | Valley bottoms | wetland, not inundated |
| *Juncus torreyi* | Torrey rush | Valley bottoms | wetland |
| *Carex praegracilis* | field sedge | Valley bottoms | wetland, not inundated |
| *Typha latifolia* | broad-leat cattail | Valley bottoms | wetland |
| *Schoenoplectus americanus* | chairmaker's bulrush | Valley bottoms | wetland |

## Rabbitbrush Mortality Experiment

Rabbitbrush (*Ericameria nauseosa, Chrysothamnus nauseosa*) is a large, common shrub found all over the Western U.S. It is known locally as Chamisa, it Spanish name, as well. This shrub grows in seasonally flooded areas, and quickly becomes the dominant shrub species. On former wetland areas at Cebolla, such as Reach 0, it is very common.

An experiment was set up to study the effects of inundation and flooding on rabbitbrush survival. Bill Zeedyk, the noted restorationist who is the designer of this project, has proposed that rabbitbrush is quickly eliminated from areas where it is common by saturated or seasonally saturated soils.

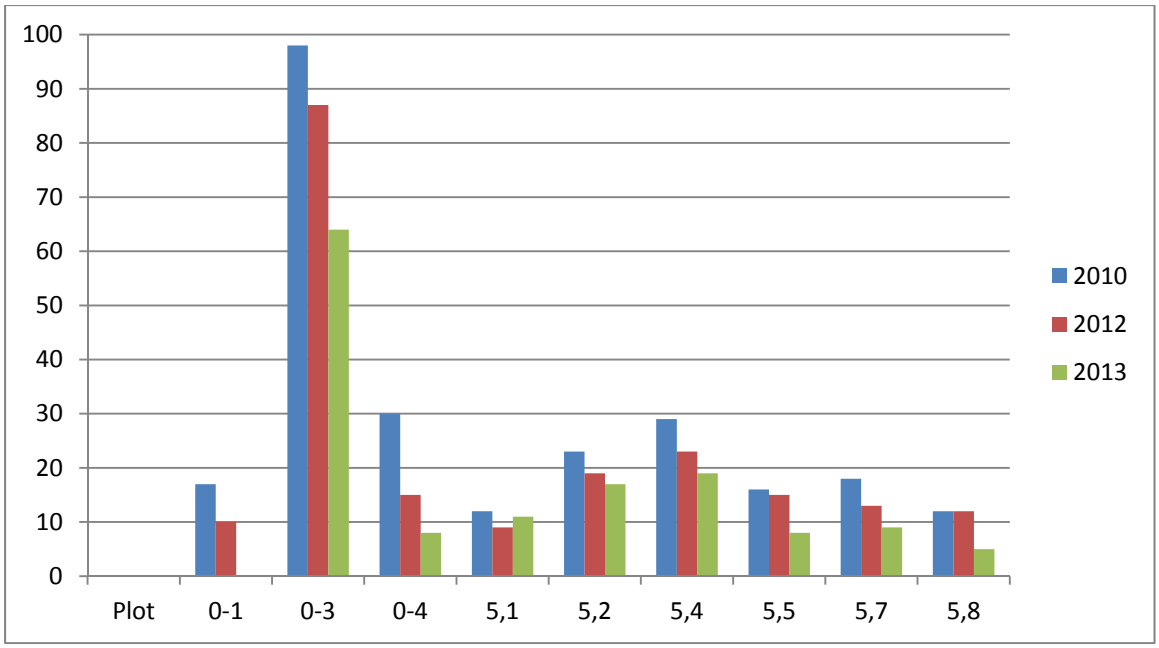
Nine treatment plots and three control plots were set up to study rabbitbrush survivorship. Each plot was a 30 foot radius circle around a single rebar centerpoint. Only reaches 0 and 5 to 6 had significant rabbitbrush cover, so the experiment was located in these reaches.

| | 2010 | 2012 | 2013 | 2010 | 2012 | 2013 | 2010 | 2012 | 2013 |
|---|---|---|---|---|---|---|---|---|---|
| Plot | mature | mature | mature | seedling | seedling | seedling | all plants | all plants | all plants |
| 0-1 | 17 | 10 | 0 | 12 | 1 | 0 | 29 | 11 | 0 |
| 0-3 | 98 | 87 | 64 | 13 | 14 | 19 | 111 | 101 | 83 |
| 0-4 | 30 | 15 | 8 | 20 | 8 | 12 | 50 | 23 | 20 |
| 5,1 | 12 | 9 | 11 | 1 | 0 | 0 | 13 | 9 | 11 |
| 5,2 | 23 | 19 | 17 | 4 | 4 | 1 | 27 | 23 | 18 |
| 5,4 | 29 | 23 | 19 | 3 | 0 | 1 | 32 | 23 | 20 |
| 5,5 | 16 | 15 | 8 | 0 | 0 | 0 | 16 | 15 | 8 |
| 5,7 | 18 | 13 | 9 | 1 | 0 | 1 | 19 | 13 | 10 |
| 5,8 | 12 | 12 | 5 | 1 | 0 | 0 | 13 | 12 | 5 |
| | | | | | | | | | |
| 0-2 control | 62 | 40 | 50 | 21 | 19 | 16 | 83 | 59 | 66 |
| 5-3 control | 21 | 21 | 21 | 6 | 3 | 0 | 27 | 24 | 21 |
| 5-6 control | 18 | 17 | 20 | 9 | 15 | 1 | 27 | 32 | 21 |

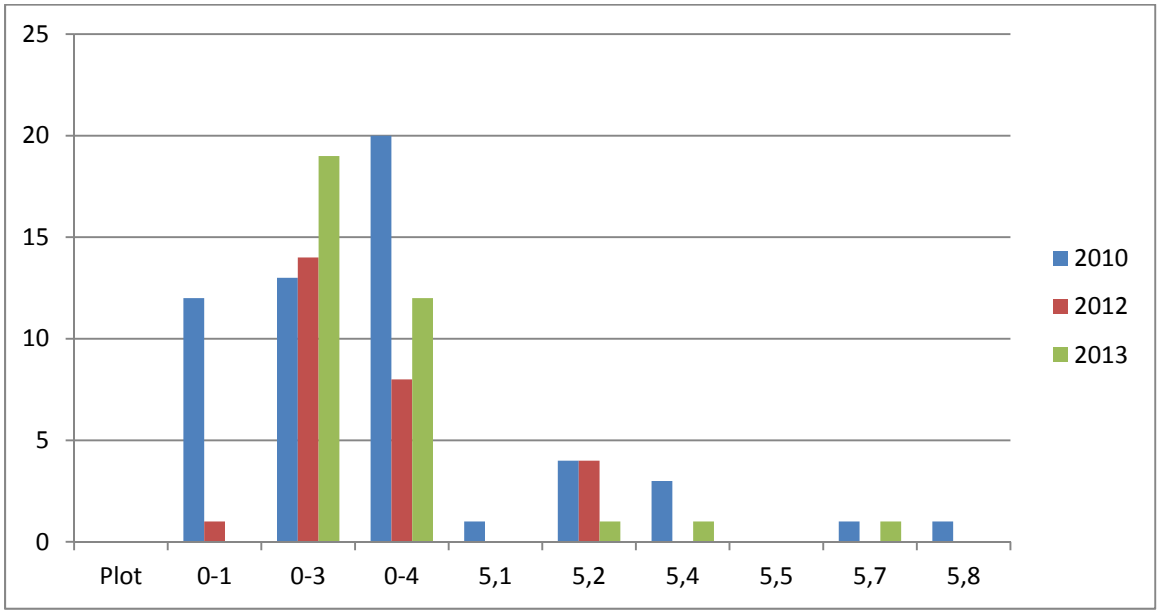
Table of Rabbitbrush counts (live plants) for 2010 (pre-treatment), 2012, and 2013.

The data was tested with a Wilcoxon signed-rank test to determine the significance of differences between each year. The Wilcoxon test assumes that the pairs tested are correlated, and that the distribution is not a normal distribution, among other assumptions.

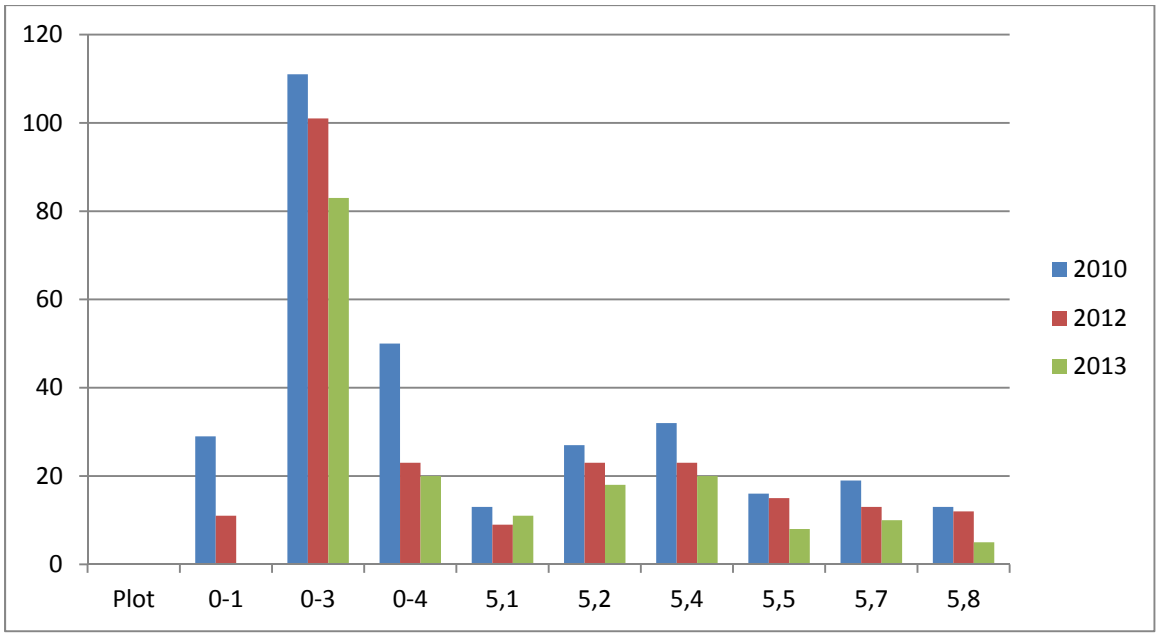
The number of control samples was limited to three, due to the lack of locations that had rabbitbrush, were in a similar location and were not in the valley bottom and responding to treatment. Because of this limited number, the test was insignificant and not performed on this data.




Bar chart of mature rabbitbrush counts from three years. The trend was towards less rabbitbrush from year to year, with a significant difference of 0.01 between 2010 and 2012. The significance of the difference bewteen 2010 and 2013 was also 0.01.




Bar chart of rabbitbrush seedling counts from three years of sampling. There was a significant difference between the counts of seedlings from 2010-2012 and 2010-2013, at 0.01.




This bar chart shows the comparisons for all three years for all rabbitbrush counted (seedlings and adults summed). There was a a significant difference between 2010 and 2012, as well as 2010 and 2013, with the trend being a decrease in rabbitbrush numbers.

Interpretation:
The Wilcoxon signed-rank test determines if a pair of samples are significantly different, and it appears as if the number of rabbitbrush in the "treatment" plots were significantly less over time from 2010 to 2013. Whether this was due to the treatment or another factor such as rainfall can be determined by comparison with the control, however, the three control plots were not enough samples to run this test.

One interesting observation is that the control plots also showed some pattern of a reduction in rabbitbrush numbers from 2010 to 2013. This was most marked in the numbers of seedlings, which saw a large reduction in numbers (see table above). The adult rabbitbrush in the control plots showed no pattern of increase or decrease, but there was a change in number, which may be due to the difficulty of counting a species that "suckers" from its roots and grows in large clumps.

If the numbers of seedlings was less, but the adults were the same in the control plot samples, this could be evidence of drought mortality on the weaker, less rooted seedlings.

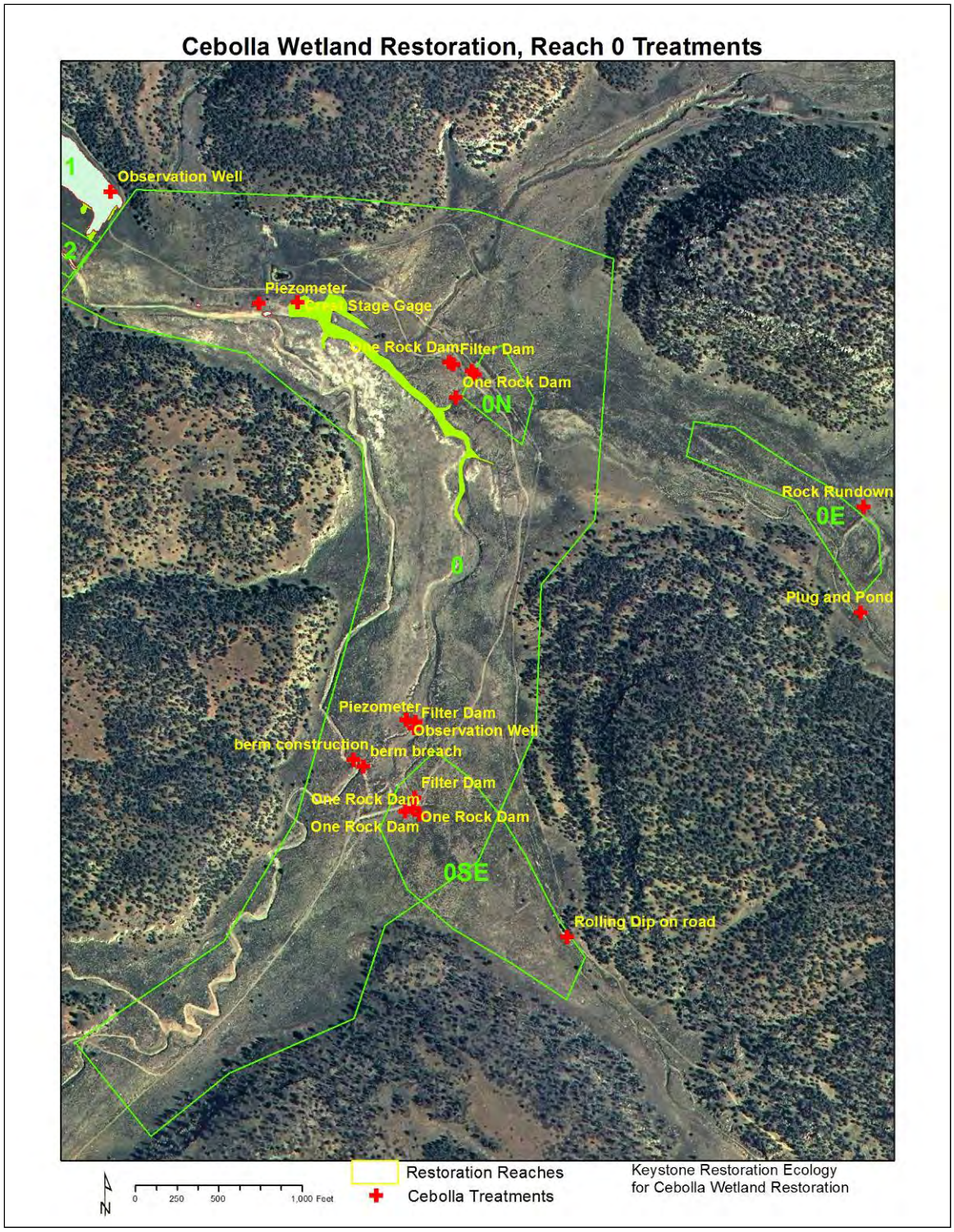
The most probable result is that there is an effect of both flooding (strong) and drought (weak) on rabbitbrush mortality over the last three years. In reach 5, the effects of flooding were huge, and at least 2 large, valley-wide floods left 1-2 feet of flood debris pushed up against the rabbitbrush stems. Any dead adults appear to have washed away quickly as they died and became un-rooted.

**Treatment and Monitoring Reach 0, Cebolla Creek**

A large number of treatments were constructed in Reach 0, which is at the confluence of three major canyons and the main valley of Cebolla Creek. The three tributaries were identified as SE trib, E trib, and N tributaries.

The major treatment in Reach 0 was the irrigation dam removal and the return of Cebolla Creek to its original channel from an irrigation ditch which had captured the channel. This has led to some major changes in the channel morphology and hydrology which should lead to benefits for both reach 0 and all the downstream reaches of Cebolla Creek.

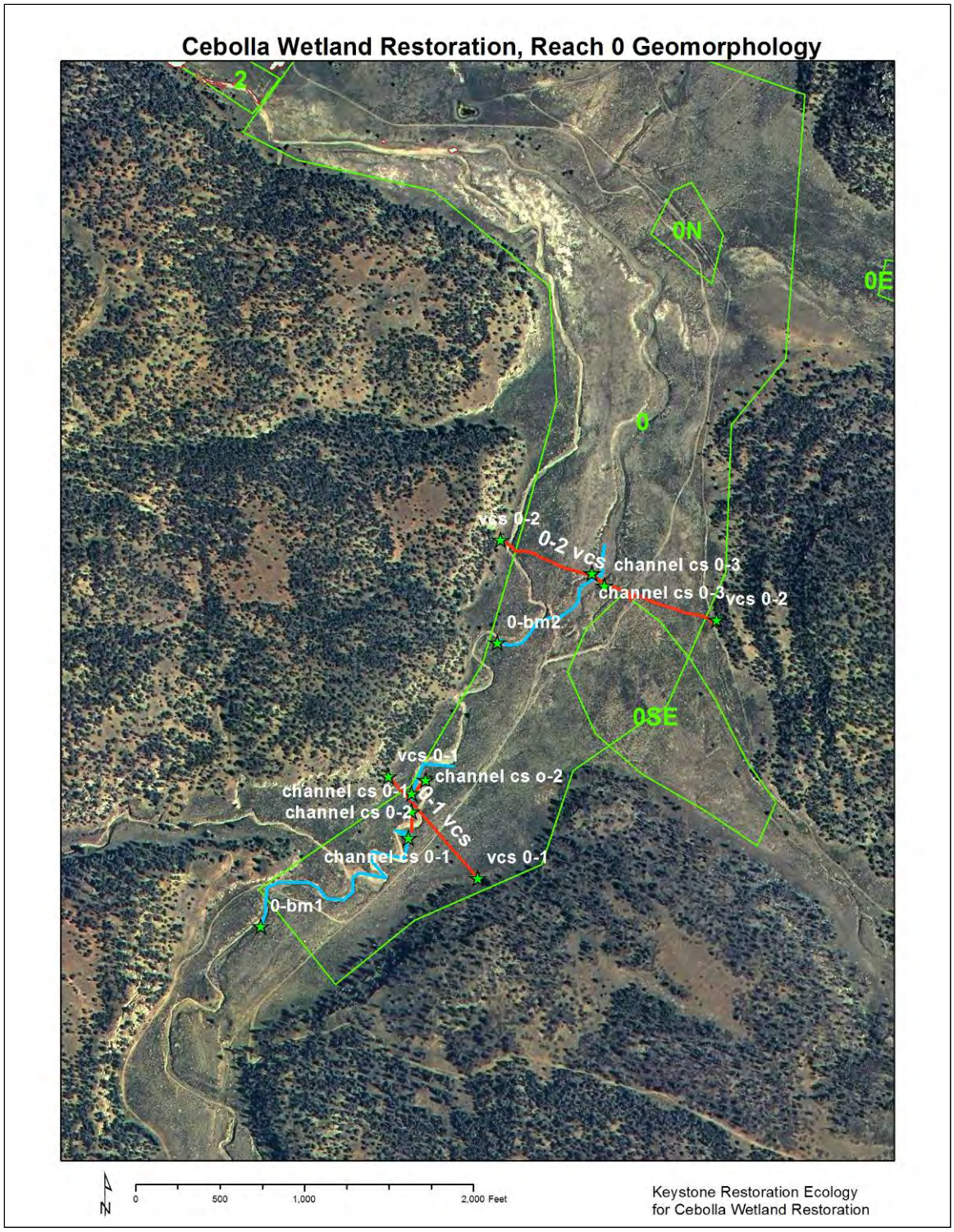
| Treatment | Location | Expected results | Monitoring |
|---|---|---|---|
| Rolling dip road drain, Reconstruction of Main Access roads | SE tributary | Wetland expansion, flooding of large area, elimination of rabbitbrush | Veg transects 0-1, 0-1a, 0-2, rabbitbrush circle 0-3 |
| Plug and Pond , Rock Rundown | E tributary | Wetland expansion, flooding of large area, fixing of cattle tank | Veg transect 0-4 |
| Four one rock dams, filter dam, berm repair, mini-exclosure | N tributary | Wetland expansion, flooding of large area, restoration of natural channel flow | Veg transect 0-3 |
| Road drainage, three one rock dams, one filter dam, berm removal and channel construction, earthen plug, mini-exclosure | Main channel of Cebolla Canyon | Wetland expansion, filling of old and new channels of Cebolla Creek, creation of wet meadow communities, elimination of Rabbitbrush | Valley Cross Section 0-2, Channel Cross section 0-2 Veg Circle 0-1. Longitudinal Profile 0-2 |


Cebolla Wetland Restoration, Reach 0 Treatments
1
2
Observation Well
Piezometer
Stage Gage
One Rock Dam
Filter Dam
One Rock Dam
0N
Rock Rundown
0E
0
Plug and Pond
Piezometer
Filter Dam
Observation Well
berm construction
berm breach
Filter Dam
One Rock Dam
One Rock Dam
One Rock Dam
0SE
Rolling Dip on road
Restoration Reaches
Cebolla Treatments
0 250 500 1,000 Feet
N
Keystone Restoration Ecology
for Cebolla Wetland Restoration

**Geomorphology Monitoring in Reach 0**

A list of geomorphology monitoring performed is presented in the table below. Much of this reach was re-surveyed in 2012, and Reach 0-2 was re-surveyed in 2013 as well.

| Name | Length | Notes, |
|---|---|---|
| Longitudinal profile 0-1 | 2100 feet | No work done in this reach, begins above road crossing over Cebolla Creek |
| Longitudinal Profile 0-2 | 1100 feet | Profile through removed irrigation dam and return of Cebolla Creek to original channel, taken 3X |
| Channel Cross Section 0-1 | 171 | Reference cross section, potential diversion site |
| Channel Cross Section 0-2 | 109 | Reference cross section, no work performed in this reach |
| Channel Cross Section 0-3 | 101 | Cross section on top of filter dam |
| Valley Cross Section 0-1 | 867 | Reference, taken at location of potential diversion site |
| Valley Cross Section 0-2 | 1437 | Lines up with Channel Cross Section 0-3 on top of filter dam (just upstream) |

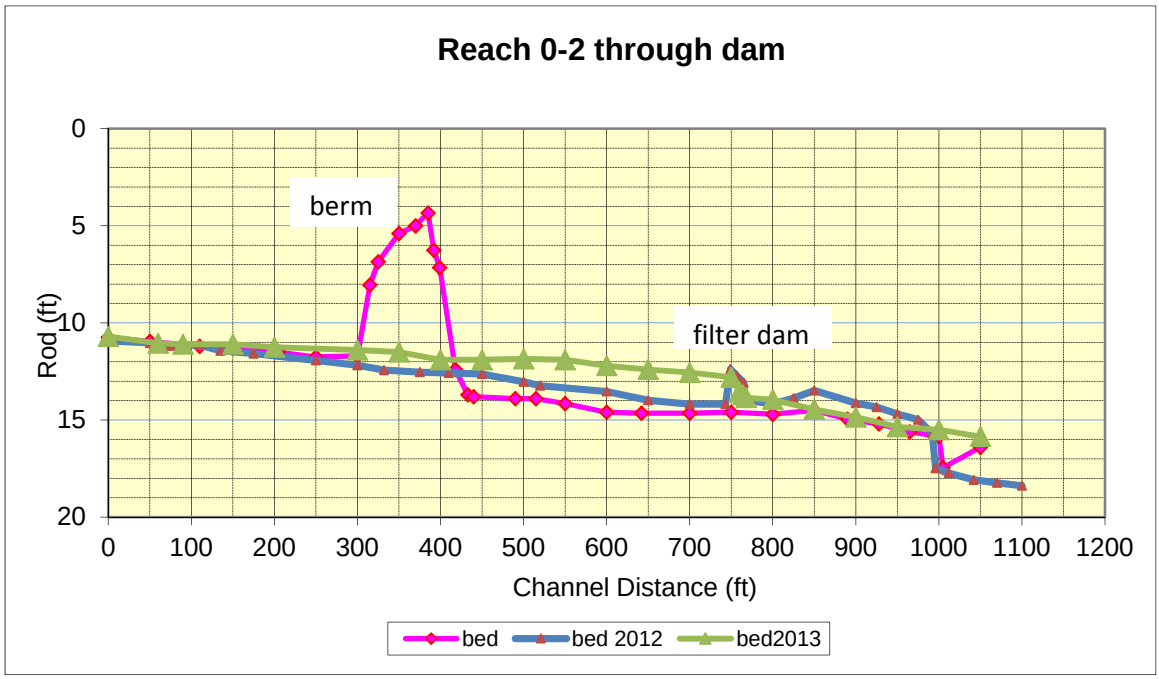

Cebolla Wetland Restoration, Reach 0 Geomorphology
2
0N
0E
0
vcs 0-2
0-2 vcs
channel cs 0-3
channel cs 0-3
vcs 0-2
0-bm2
0SE
vcs 0-1
channel cs o-2
channel cs 0-1
channel cs 0-2
0-1 vcs
channel cs 0-1
vcs 0-1
0-bm1
N
0
500
1,000
2,000 Feet
Keystone Restoration Ecology
for Cebolla Wetland Restoration

The major work performed in Reach 0 was the removal of an irrigation dam and installation of a berm to return Cebolla Creek to its original channel. Downstream from the berm, a large filter dam was constructed to capture sediment and water and create wetland.

A list of possible results from the treatment:

- Irrigation of former channel including the entire Lake Cebolla area
- Lengthening of channel and reduction of slope of channel, as former channel is much longer than the irrigation ditch
- Capture of sediment in channel as it is much wider than irrigation ditch with a lesser slope
- Filling in of Lake Cebolla with water and sediment

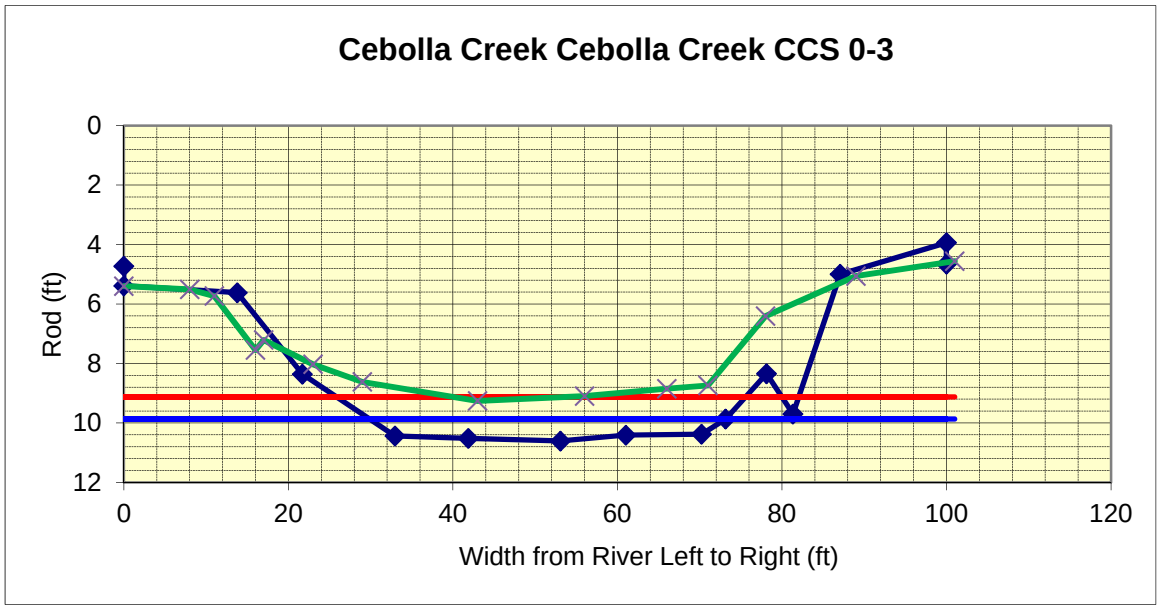
Reach 0-2 longitudinal profile is presented below:



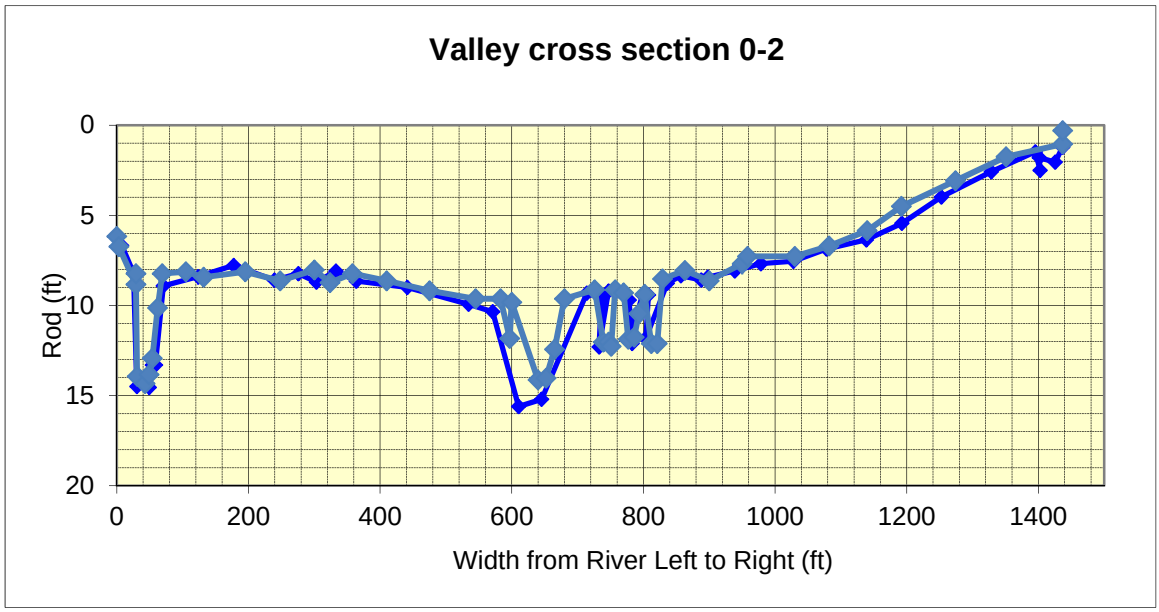

Three years of longitudinal profile survey at Cebolla Creek. Over that time, the filter dam has filled in with sediment, mostly sand, over 2 feet deep. This area has the potential to capture and store a great deal of water underneath the sand, which also acts as a mulch to prevent the stored water from evaporating.

In addition, the lower end of the profile had a 2 foot headcut which was enlarging from the effects of returning water to this channel and the capture of sediment above the filter dam. This increase in size and depth of the headcut can be seen in the difference between the pink 2010 profile and the blue 2012 profile. Once the filter dam filled in with flooding in the summer of 2013, sand was deposited down the entire channel of Cebolla Creek, even

filling in the bed of Lake Cebolla. This has eliminated the headcut at 1000 feet on the longitudinal profile.




The green line is the 2012 survey of the channel cross section 0-3 at the Filter Dam. The blue line is the 2010 survey. The elevation has increased by more than 2 feet, the height of the filter dam.



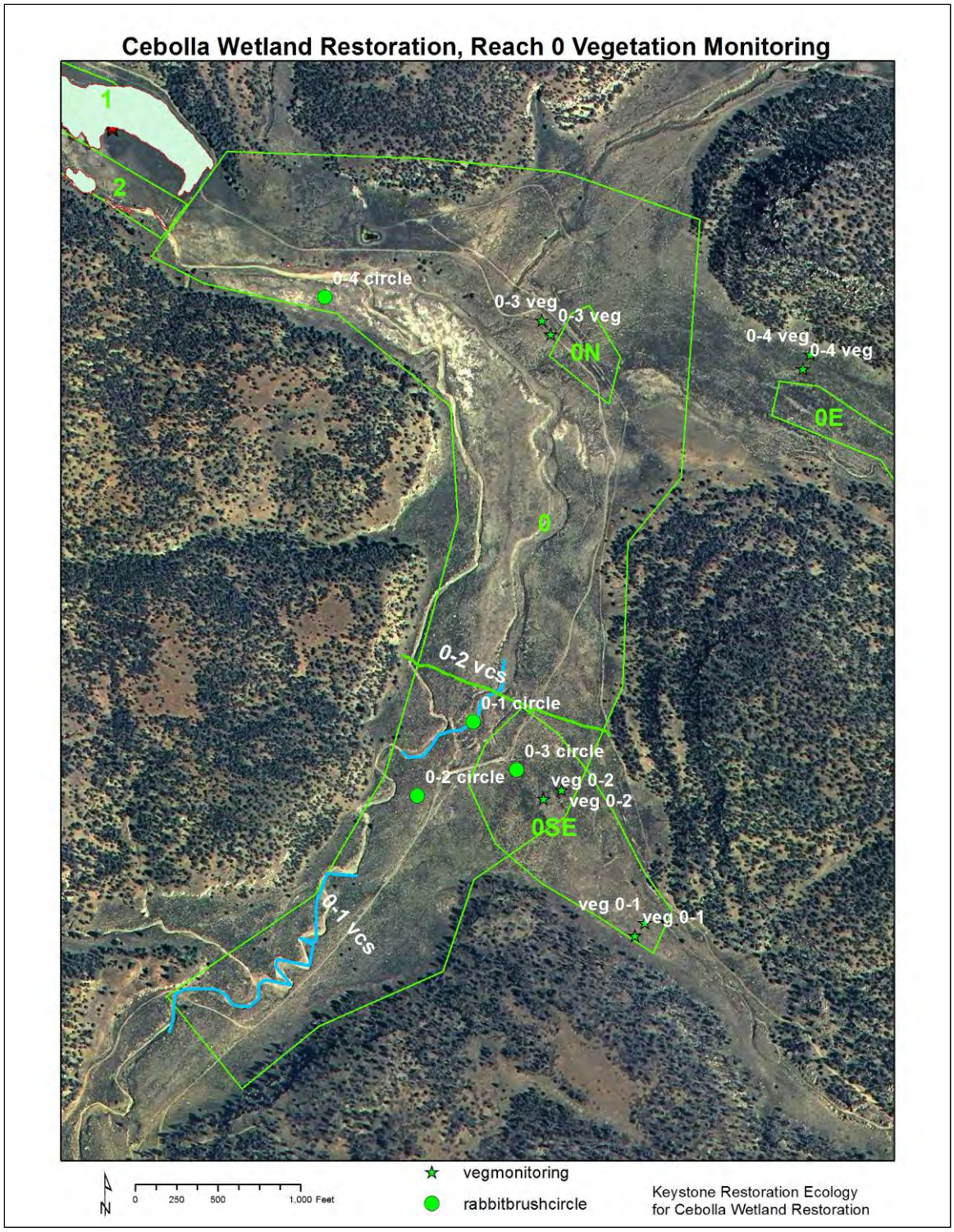

Valley Cross Section 0-2 runs across the filter dam and spans the entire valley. Few changes have happened over the length of the cross section, but the filter dam at 660 has raised the grade locally.

Filter Dam below Berm breach and channel reconstruction, spring 2012

Filter Dam in October 2013, filled in with sand

**Vegetation Monitoring in Reach 0, Cebolla Creek**

| Treatment | Location | Expected results | Vegetation Monitoring |
|---|---|---|---|
| Rolling dip road drain, Reconstruction of Main Access roads | SE tributary | Wetland expansion, flooding of large area, elimination of rabbitbrush | Veg transects 0-1, 0-1a, 0-2, rabbitbrush circle 0-3 |
| Plug and Pond , Rock Rundown | E tributary | Wetland expansion, flooding of large area, fixing of cattle tank | Veg transect 0-4 |
| Four one rock dams, filter dam, berm repair, mini-exclosure | N tributary | Wetland expansion, flooding of large area, restoration of natural channel flow | Veg transect 0-3 |
| Road drainage, three one rock dams, one filter dam, berm removal and channel construction, earthen plug, mini-exclosure | Main channel of Cebolla Canyon | Wetland expansion, filling of old and new channels of Cebolla Creek, creation of wet meadow communities, elimination of Rabbitbrush | Rabbitbrush Circle 0-1, Valley cross-section 0-2 |


Cebolla Wetland Restoration, Reach 0 Vegetation Monitoring
1
2
0-4 circle
0-3 veg
0-3 veg
0N
0-4 veg
0-4 veg
0E
0
0-2 vcs
0-1 circle
0-3 circle
0-2 circle
veg 0-2
veg 0-2
0SE
0-1 vcs
veg 0-1
veg 0-1
N
0
250
500
1,000 Feet
vegmonitoring
rabbitbrushcircle
Keystone Restoration Ecology
for Cebolla Wetland Restoration

**Vegetation Results, Reach 0, Main Channel of Cebolla Creek**

Channel Cross Section 0-3 was placed directly across the filter dam structure. While this transect will continue to be an excellent monitoring point for geomorphology, the use of filter fabric under the structure will prohibit any vegetation from establishing. Because of this, this transect will no longer be used for vegetation monitoring.

Valley Cross Section 0-2
This cross section was taken on top of the Valle CS 0-2 geomorphology cross section. This cross section is monitoring in a broad scale much of the work done upstream in SE Trib, the BLM road realignment and drainage work, as well as the one rock dams and filter dams done near the berm breach and channel realignment. This cross section runs over the top of the filter dam.

This line-point transect has 211 monitoring points.

| Species | Common Name | cover 2010 | cover 2012 | Percent difference |
|---|---|---|---|---|
| *Artemisia dracunculus* | tarragon | 0% | 1% | 1% |
| *Artemisia species* | sagewort | 0% | 0% | 0% |
| *Bouteloua barbata* | six weeks grama | 0% | 23% | 23% |
| *Bouteloua gracilis* | blue grama | 12% | 5% | -8% |
| *Chrysothamnus nauseosus* | Rabbitbrush | 16% | 25% | 9% |
| *Elymus smithii* | Western wheatgrass | 32% | 16% | -16% |
| *Grindelia squarosa* | gumweed | 1% | 2% | 1% |
| *Gutierrezia sarothrae* | snakeweed | 0% | 1% | 1% |
| *Kochia scoparia* | kochia | 9% | 14% | 5% |
| *Muhlenbergia repens* | creeping muhly | 1% | 6% | 5% |
| *Muhlenbergia wrightii* | spike muhly | 0% | 1% | 1% |
| *Plantago patagonica* | Wooly plantain | 0% | 0% | 0% |
| Rock | | 0% | 3% | 3% |
| Soil | | 31% | 15% | -16% |
| litter | | 5% | 2% | -3% |

The most notable changes are an increase in six-weeks grama, which was not present previously on the site. This annual grass spread over some of the bare soil areas, which accounted for the increase. Kochia also invades these areas, and this saw an increase as well. Both of these plants provide cover on otherwise bare, old wetland soils that are heavy clays and difficult for many plant species to establish on.

There was a decrease in Western Wheatgrass, which is of concern, as this species is an effective forage grass that spreads by runners and seed. However, the 2010 data was taken in the fall, when Western wheatgrass may have been at its full growth potential, and cover more soil.

This may be the same for blue grama, another very important grass, it only grows and blooms in the summer months, and may have more cover in the fall.
There was an increase in rabbitbrush, which may be due to the irrigation of these shrubs by the restoration work done. While one goal is to eliminate rabbitbrush through flooding, partial flooding will only irrigate it and encourage its growth.

Vegetation Circle 0-1
This rabbitbrush vegetation circle was sampled as part of an experiment in rabbitbrush survivorship (see above). Each 60 foot diameter circle was placed in a clump of rabbitbrush to monitor the response to flooding. The number of adults and juvenile rabbitbrush were counted. Juvenile rabbitbrush were under two feet tall.

| Age class of rabbitbrush | 2010 | 2012 | 2013 |
|---|---|---|---|
| 0-1 adults | 17 | 10 | 0 |
| 0-1 juveniles | 12 | 1 | 0 |

There is a large difference between 2010 and 2012, with a large decrease in the numbers of mature and juvenile rabbitbrush. This site was impacted by the berm breach, a foot of sand was deposited, and most of the existing vegetation was drowned out.

Rabbitbrush Circle 0-1, Aaron Kauffman in middle of circle, taken in 2012, some rabbitbrush remain in channel.

**Vegetation Results, SE tributary, Reach 0**

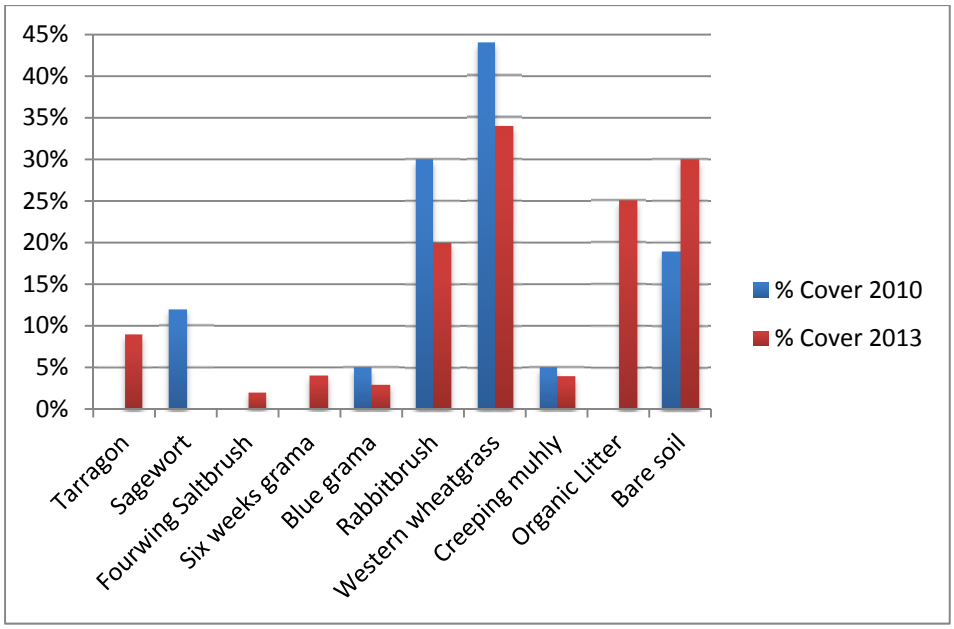
This tributary formerly flowed down the road to the north, and was trapped in a gully for most of its length. This gully was fed by the road up the SE trib valley, which captured the entire flow. The construction of a rolling dip road drain in the valley, as well as the BLM road work, has ensured that floodwaters from this valley are spreading across the largest area possible and are flowing in center of the valley.

Vegetation transect 0-1
This transect was lost to the effects of a large flood event in September 2013. Both endpoints were washed away in the flood event, which even over-topped the rolling dip road drain. Because of this, this transect was not re-monitored in 2013.

Vegetation transect 0-2
This transect was placed in a very thick patch of Rabbitbrush (*Chrysothamnus nauseosus*), a mid-sized shrub that invades overgrazed rangelands. Rabbitbrush can be eliminated by watering, its roots die in saturated soils. Vegetation transect 0-2 is monitoring the response of the rolling dip in the SE tributary and its effect on the downstream vegetation, once the floodwaters are spreading again.

| Vegetation Species | Common Name | Percent of Cover 2010 | Percent of Cover 2013 | Percent Difference |
|---|---|---|---|---|
| *Artemisia dracunculus* | Tarragon | 0% | 9% | 9% |
| *Artemisia frigida* | Sagewort | 12% | 0% | -12% |
| *Atriplex canescens* | Fourwing Saltbrush | 0% | 2% | 2% |
| *Bouteloua barbata* | Six weeks grama | 0% | 4% | 4% |
| *Bouteloua gracilis* | Blue grama | 5% | 3% | -2% |
| *Chrysothamnus nauseosus* | Rabbitbrush | 30% | 20% | -10% |
| *Elymus smithii* | Western wheatgrass | 44% | 34% | -10% |
| *Muhlenbergia repens* | Creeping muhly | 5% | 4% | -1% |
| Organic Litter | Organic Litter | 0% | 25% | 25% |
| Bare soil | Bare soil | 19% | 30% | 11% |

A column chart showing the data can be seen below, most species showed a decline in cover from 2010 to 2013. There is some decrease in rabbitbrush cover, perhaps due to flooding and reduction of growth from saturation of the root zone. There was an increase in bare soil (due to less vegetation overall), however there was also an increase in organic litter. This material has been deposited in a very large flood event in September 2013, and shows that this area does flood after the installation of the rolling dip treatment upstream.




Rabbitbrush Circle 0-3

This circle was located just above the berm removal/channel reconstruction and filter dam. Over time, this area should be saturated from the work below, such as the three one rock dams. However, it also will receive more water from SE tributary.

| Age class of Rabbitbrush | 2010 | 2012 | 2013 |
|---|---|---|---|
| Young | 98 | 87 | 64 |
| Mature | 13 | 14 | 19 |

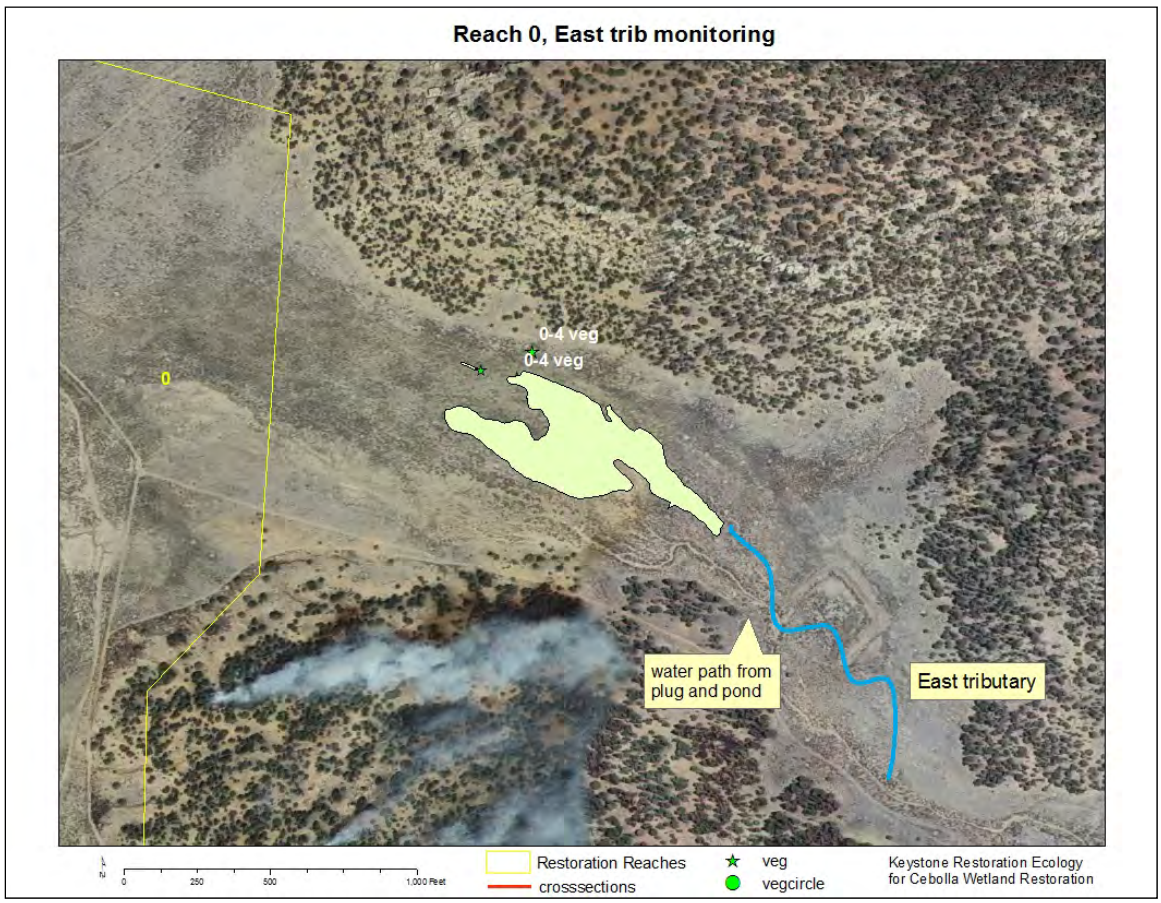
There was a small increase in the number of seedlings and a noticeable decrease in the number of adults.

## Vegetation Results, East tributary, Reach 0

The treatment in the East tributary involved the plug and ponding of a gully that was carrying water past a stock tank and out of the valley. The plug and pond drained into the stock tank, and a rock-lined rundown channel carried water out of the tank into the old valley bottom. Vegetation transect 0-4 was placed to monitor the effects of this treatment.

Visually, the floodwaters and deposition of sand from this treatment stopped just before the transect, so no results were seen. The sand deposition caused the growth of a large number of Rocky Mountain beeplant (*Cleome serrulata*). This plant has been seen to colonize newly deposited wet sands, over time, that area has become wet meadow habitat with vigorous grasses. This was seen only in 2012, with good spring/winter moisture, in 2013, the winter and spring moisture was poor and very little beeplant was seen in the canyon.

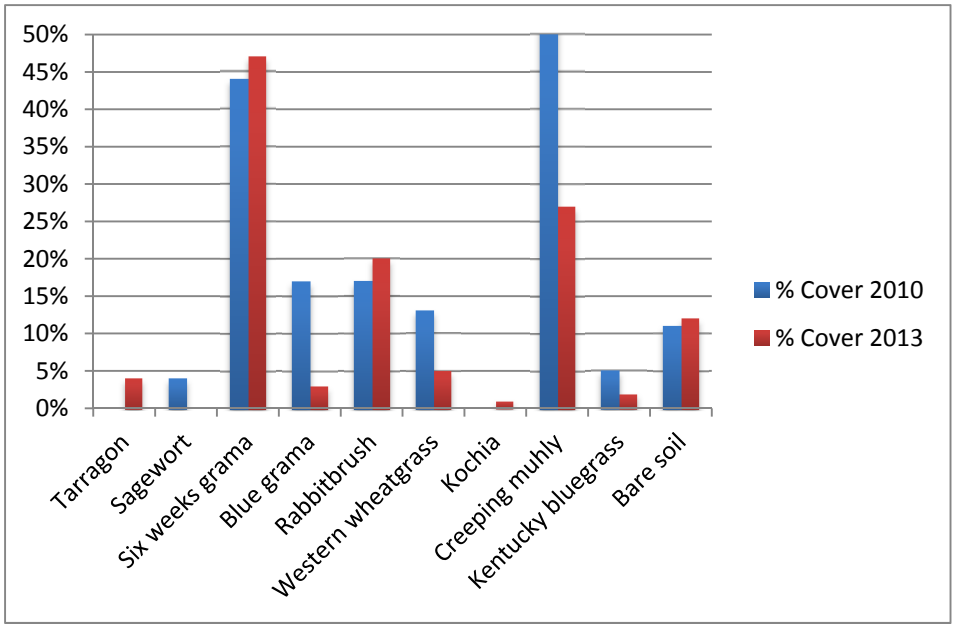
When this area was re-monitored in October of 2013, there was a herd of cattle living around the pond and grazing the area, which may have had an effect on vegetation cover.




East trib flooding, green boundary is sand and beeplant.

Results, Vegetation transect 0-4

| Vegetation Species | Common Name | Percent of Cover 2010 | Percent of Cover 2013 | Percent Difference |
|---|---|---|---|---|
| *Artemisia dracunculus* | Tarragon | 0% | 4% | 4% |
| *Artemisia spp.* | Sagewort | 4% | 0% | -4% |
| *Bouteloua barbata* | Six weeks grama | 44% | 47% | 3% |
| *Bouteloua gracilis* | Blue grama | 17% | 3% | -14% |
| *Chrysothamnus nauseosus* | Rabbitbrush | 17% | 20% | 3% |
| *Cleome serrulata* | Beeplant | 0% | 0% | 0% |
| *Elymus smithii* | Western wheatgrass | 13% | 5% | -8% |
| *Kochia scoparia* | Kochia | 0% | 1% | 1% |
| *Muhlenbergia repens* | Creeping muhly | 52% | 27% | -25% |
| *Poa pratensis* | Kentucky bluegrass | 5% | 2% | -3% |
| *Bare soil* | Bare soil | 11% | 12% | 1% |



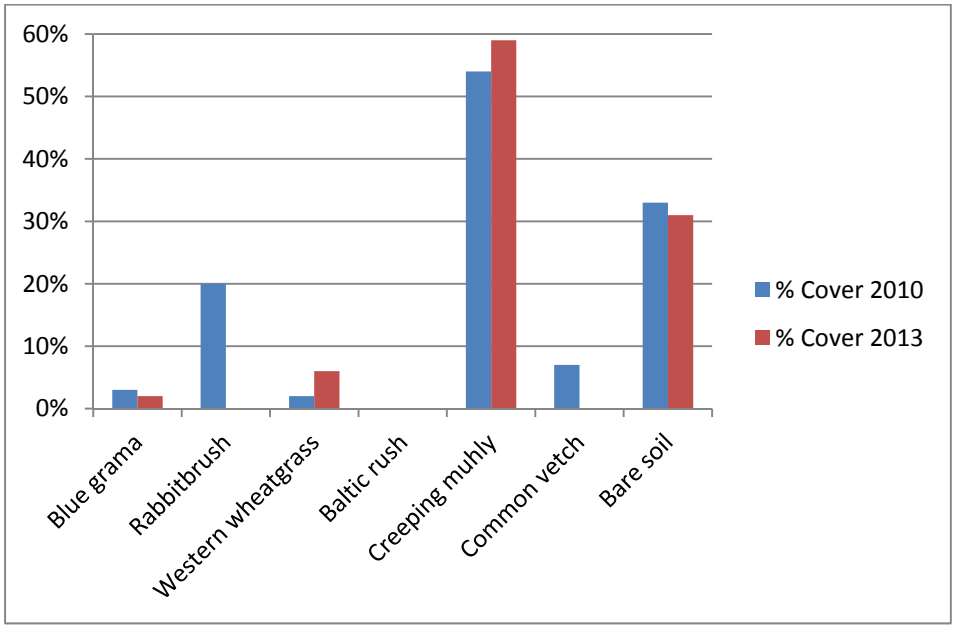

Results from vegetation transect 0-4 indicate a decrease in cover of desirable species, and a small increase in weeds such as Tarragon and Six-weeks grama. This site was grazed heavily in fall of 2013.

Detail of plug and pond at top of project, gully became a pond with overflow to left of picture. Pic October 2011.

## Results, North tributary, Reach 0

The treatments in this area included road relocation, berm repair, filter dams, two one rock dams and a mini-exclosure. The vegetation transect 0-3 was just upstream from the filter dam, and the area was flooded during fall of 2011, just after implementation.

| Vegetation Species | Common Name | Percent of Cover 2010 | Percent of Cover 2013 | Percent Difference |
|---|---|---|---|---|
| *Bouteloua gracilis* | Blue grama | 3% | 2% | -1% |
| *Chrysothamnus nauseosus* | Rabbitbrush | 20% | 0% | -20% |
| *Elymus smithii* | Western wheatgrass | 2% | 6% | 4% |
| *Juncus balticus* | Baltic rush | 0% | 0% | 0% |
| *Muhlenbergia repens* | Creeping muhly | 54% | 59% | 5% |
| *Vicia americana* | Common Vetch | 7% | 0% | -7% |
| Bare soil | Bare Soil | 33% | 31% | -2% |




The vegetation in plot 0-3 changed somewhat due to the treatment. There was a decrease in rabbitbrush due entirely to the machine installation of the filter dam. Western wheatgrass increased its cover, probably due to the wetting of the soil. One Baltic rush was identified, this wetland plant may be invading this area. This area also is grazed heavily by the same herd of cattle as seen in Trib 0-E.

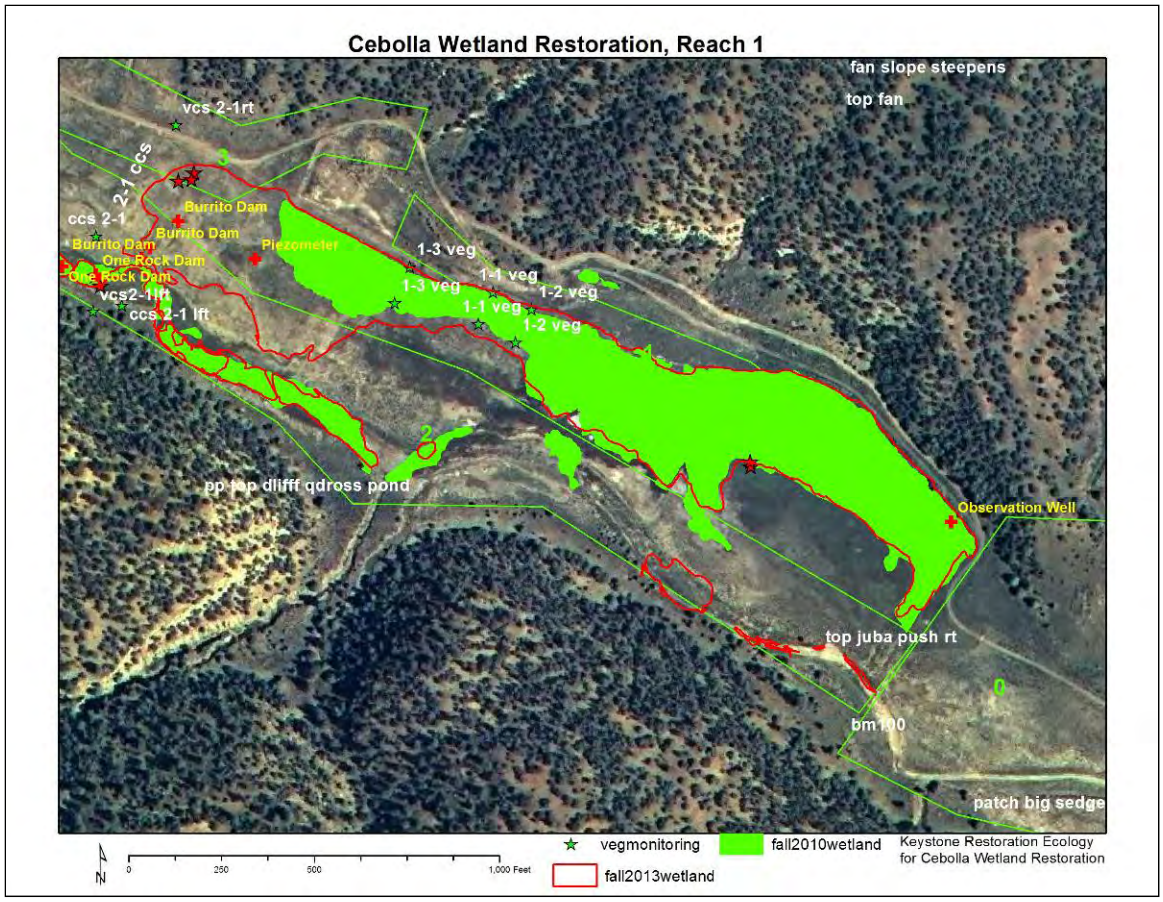
Filter dam, reach 0-N, transect is by Aaron Kauffman in top of picture

## Vegetation Results, Reach 1 Cebolla Creek

Reach 1 was created to encompass the main wetland at Big Cebolla Spring. This area has increased in size over the last 10 years due to simple plugging techniques with sandbags, rock and brush. These "burrito dams" plugged a man-made gully created to water cattle from the spring, and caused the wetland to expand to the north-west. The main channel of Cebolla Creek was formerly a 6-foot deep gully, over time, this has filled in entirely, most recently due to a large flood in September of 2013.

Water that previously flowed in the gully past Big Cebolla Spring is now spreading across the entire valley bottom. In fact, the last flood event was so large that it did serious damage to the fenceline exclosure surrounding the spring.

| Treatment | Location | Expected results | Monitoring |
|---|---|---|---|
| Return of Cebolla Creek to historic channel | Reach 0, main channel | Capture of sediment in Lake Cebolla, increased sub-surface water | Wetland delineation |
| Tributary treatments in reach 0 | Tribs 0-E, 0-N and 0-SE | Spread of water across large area, more sub-surface water downstream | Wetland delineation |
| Exclusion of cattle, burrito dams downstream, flooding in main channel | Reach 2 (main channel) and reach 1 | Expansion of wetland downstream, successional advance of wetland vegetation | Vegetation transects 1-1, 1-2,1-3 |




## Wetland delineation results

A complete description of the acreages and areas of delineated wetland can be found at the beginning of this report. A comparison of the wetland delineation of 2010 versus 2013 shows that some areas described as wetland in 2010 were not delineated in 2013. This was due to the large amount of sand deposited through this portion of Cebolla Creek, which can be seen in more detail in the Reach 2 geomorphology below. This sand buried the Baltic Rush, however, it should grow through this sediment in Spring 2014 and respond positively to the increased water and sediment.

Due to the construction of burrito dams in Reach 2, the wetland area has expanded about 3 acres to the west. The burrito dams raise the water table and prevent it from flowing into the channel of Cebolla Creek at the south of the aerial photo. Water can spread to the west as sheet flow and this sheet flow creates more wetland area.

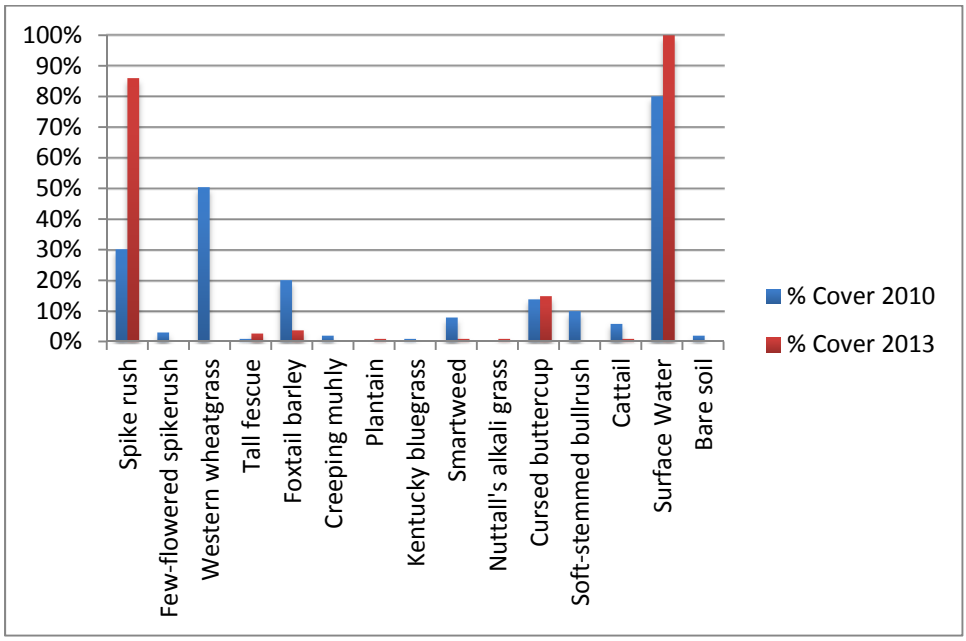
## Vegetation Results, transects 1-1, 1-2, 1-3.

These three transects are 100 foot long line-point intercept transects that monitor the development and successional changes in the wetland at Big Cebolla Spring. The composition of vegetation over time should show the successional sequence in flooded areas in Big Cebolla Spring.

**Results, Transect 1-1**

The results of transect 1-1 show development of the wetland from a foxtail barley early-successional community to a common spikerush community. The amount of the transect under water is now 100% (formerly 80%). Some species, such as western wheatgrass and foxtail barley have decreased in cover as they have been replaced by spikerush.

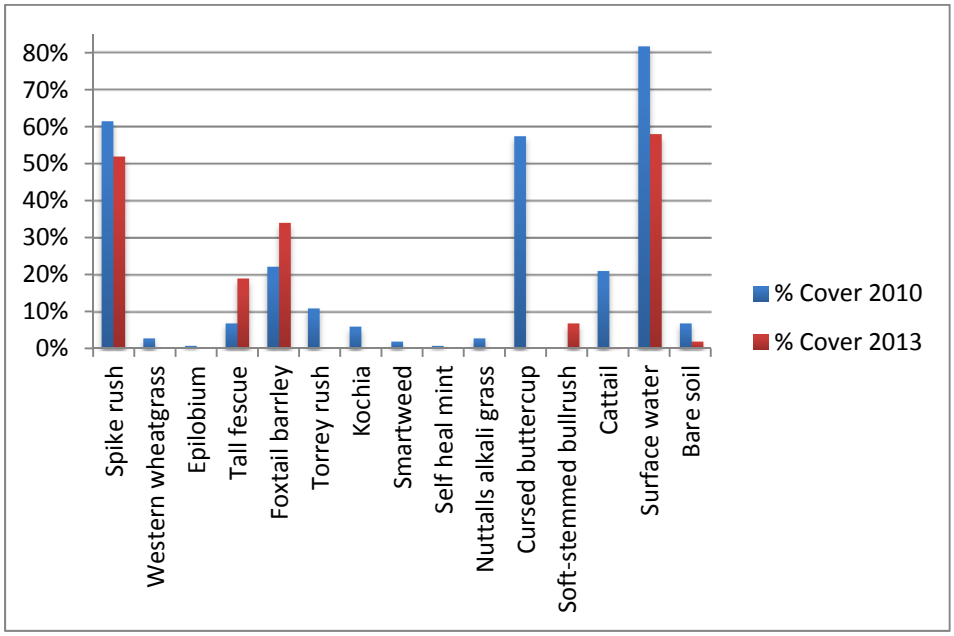
| Vegetation Species | Common Name | Percent of Cover 2010 | Percent of Cover 2013 | Percent Difference |
|---|---|---|---|---|
| *Eleocharis palustris* | Spike rush | 30% | 86% | 56% |
| *Eleocharis quinqueflora* | Few-flowered spikerush | 3% | 0% | -3% |
| *Elymus smithii* | Western wheatgrass | 51% | 0% | -51% |
| *Festuca arudinacea* | Tall fescue | 1% | 3% | 2% |
| *Hordeum jubatum* | Foxtail barley | 20% | 4% | -16% |
| *Muhlenbergia repens* | Creeping muhly | 2% | 0% | -2% |
| *Plantago spp.* | Plantain | 0% | 1% | 1% |
| *Poa pratensis* | Kentucky bluegrass | 1% | 0% | -1% |
| *Polygonum puncatatum* | Smartweed | 8% | 1% | -7% |
| *Puccinellia airoides* | Nuttall's alkali grass | 0% | 1% | 1% |
| *Ranunculus sceleratus* | Cursed buttercup | 14% | 15% | 1% |
| *Scirpus tabernaemontana* | Soft-stemmed bullrush | 10% | 0% | -10% |
| *Typha latifolia* | Cattail | 6% | 1% | -5% |
| Surface Water | Surface Water | 80% | 100% | 20% |
| Bare soil | Bare soil | 2% | 0% | -2% |



**Results, Transect 1-2**

This transect shows a reduction in the cover of nearly all species found. There is some increase in foxtail barley and tall fescue, both early-successional weeds. There was also an increase in Chairmaker's bulrush from 0 to 7%, which may be invading and replacing the spikerush vegetation. There is a decrease in surface water, probably due to trampling by the herd of cattle that was present and grazing the wetland edge in October 2013. Many species that were reduced in cover may have been eaten by cattle.

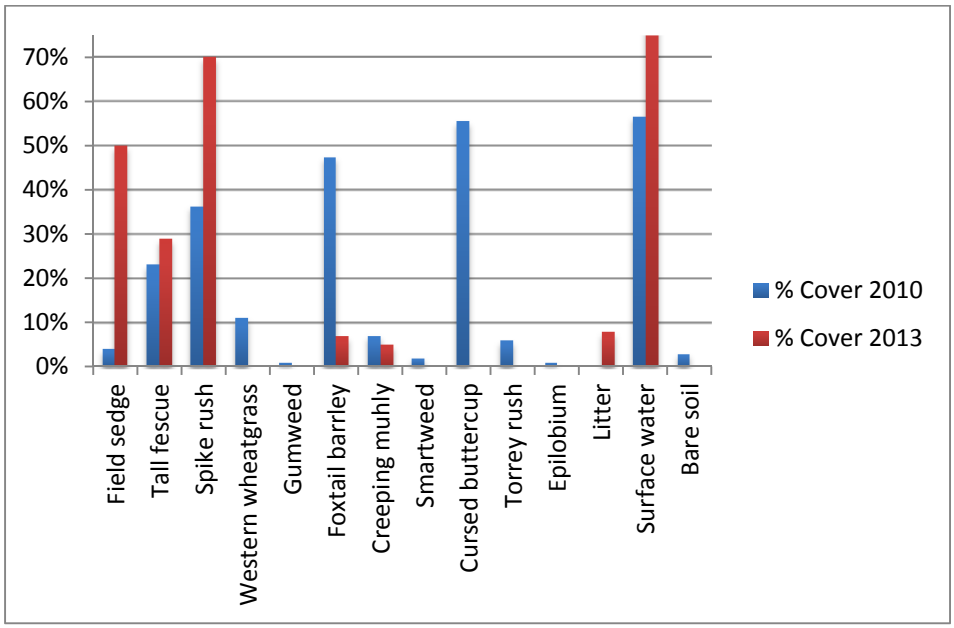
| Vegetation Species | Common Name | Percent of Cover 2010 | Percent of Cover 2013 | Percent Difference |
|---|---|---|---|---|
| *Eleocharis palustris* | Spike rush | 62% | 52% | -10% |
| *Elymus smithii* | Western wheatgrass | 3% | 0% | -3% |
| *Epilobium ciliatum* | Epilobium | 1% | 0% | -1% |
| *Festuca arudinacea* | Tall fescue | 7% | 19% | 12% |
| *Hordeum jubatum* | Foxtail barley | 22% | 34% | 12% |
| *Juncus torreyi* | Torrey rush | 11% | 0% | -11% |
| *Kochia scoparia* | Kochia | 6% | 0% | -6% |
| *Polygonum puncatatum* | Smartweed | 2% | 0% | -2% |
| *Prunella vulgaris* | Self heal mint | 1% | 0% | -1% |
| *Puccinellia airoides* | Nuttalls alkali grass | 3% | 0% | -3% |
| *Ranunculus sceleratus* | Cursed buttercup | 58% | 0% | -58% |
| *Scirpus tabernaemontan* | Soft-stemmed bullrush | 0% | 7% | 7% |
| *Typha latifolia* | Cattail | 21% | 0% | -21% |
| Surface water | Surface water | 82% | 58% | -24% |
| Bare soil | Bare soil | 7% | 2% | -5% |



**Results, Transect 1-3**

This transect was the furthest downstream (to the west). The most notable increase in species cover was in Field sedge and spikerush. These two species replace the Western wheatgrass, Foxtail barley, and Cursed buttercup that are found as early-succesional species in Big Cebolla Wetland. The introduction of Field sedge provides another link in the successional sequence, which appears to reach a climax as Chairmaker's bulrush. There is also a much larger amount of surface water, from 57% to 89% from 2010 to 2013.

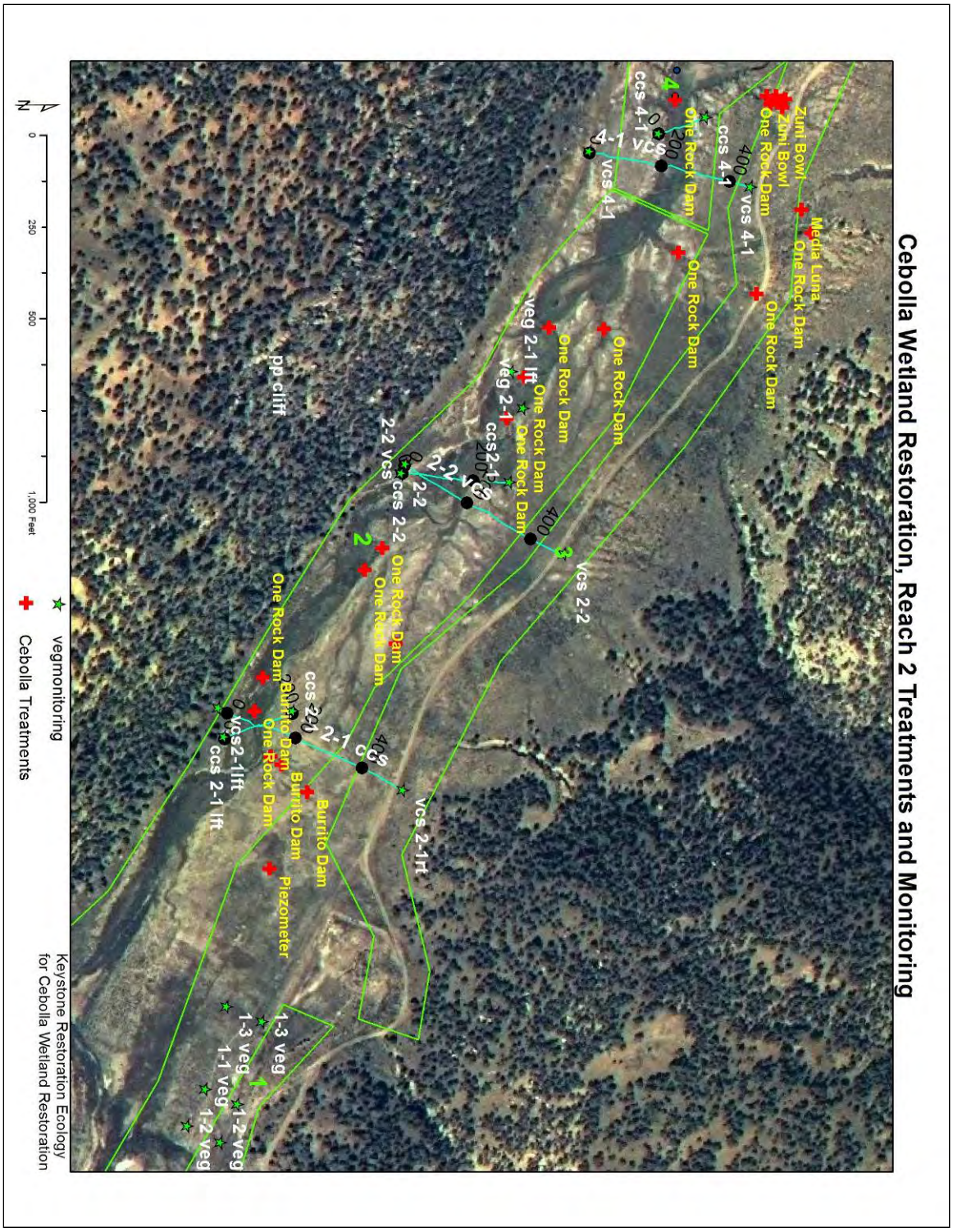
| Vegetation Species | Common Name | Percent of Cover 2010 | Percent of Cover 2013 | Percent Difference |
|---|---|---|---|---|
| *Carex praegracilis* | Field sedge | 4% | 50% | 46% |
| *Eleocharis palustris* | Spike rush | 36% | 70% | 34% |
| *Elymus smithii* | Western wheatgrass | 11% | 0% | -11% |
| *Epilobium ciliatum* | Epilobium | 1% | 0% | -1% |
| *Festuca arudinacea* | Tall fescue | 23% | 29% | 6% |
| *Grindelia squarosa* | Gumweed | 1% | 0% | -1% |
| *Hordeum jubatum* | Foxtail barley | 47% | 7% | -40% |
| *Juncus torreyi* | Torrey rush | 6% | 0% | -6% |
| *Muhlenbergia repens* | Creeping muhly | 7% | 5% | -2% |
| *Polygonum puncatatum* | Smartweed | 2% | 0% | -2% |
| *Ranunculus sceleratus* | Cursed buttercup | 56% | 0% | -56% |
| Organic matter litter | Litter | 0% | 8% | 8% |
| Surface water | Surface water | 57% | 89% | 32% |
| Bare soil | Bare soil | 3% | 0% | -3% |



**Treatment and Monitoring Reach 2, Cebolla Creek**

A large number of treatments were constructed in Reach 2, which is the main channel of Cebolla Creek as it flows past Big Cebolla Spring. The purposes of these treatments were to continue to fill the main channel of Cebolla Creek with sediment and expand the wetland downstream.

| Treatment | Location | Expected results | Monitoring |
|---|---|---|---|
| 3 burrito dams | End of wetland | Increased flooding, capture of sediment, change in vegetation | Valley Cross Section 2-1, Channel cross section 2-1, both geomorphology and vegetation |
| 3 one rock dams | Below cross sections | Capture of sediment, raised water table, more wetland | Valley Cross Section 2-1, Channel cross section 2-1, both geomorphology and vegetation, VCS 2-2, CCS 2-2, both geomorphology and vegetation |
| One rock dam | Near bottom of reach 2, just below veg transect 2-1 | Capture of sediment, raised water table, more wetland | Veg transect 2-1, 100 foot line-point intercept |
| One rock dams, burrito dams | Throughout reach | Capture of sediment, raised water table, more wetland | Wetland delination through reach, longitudinal profile |

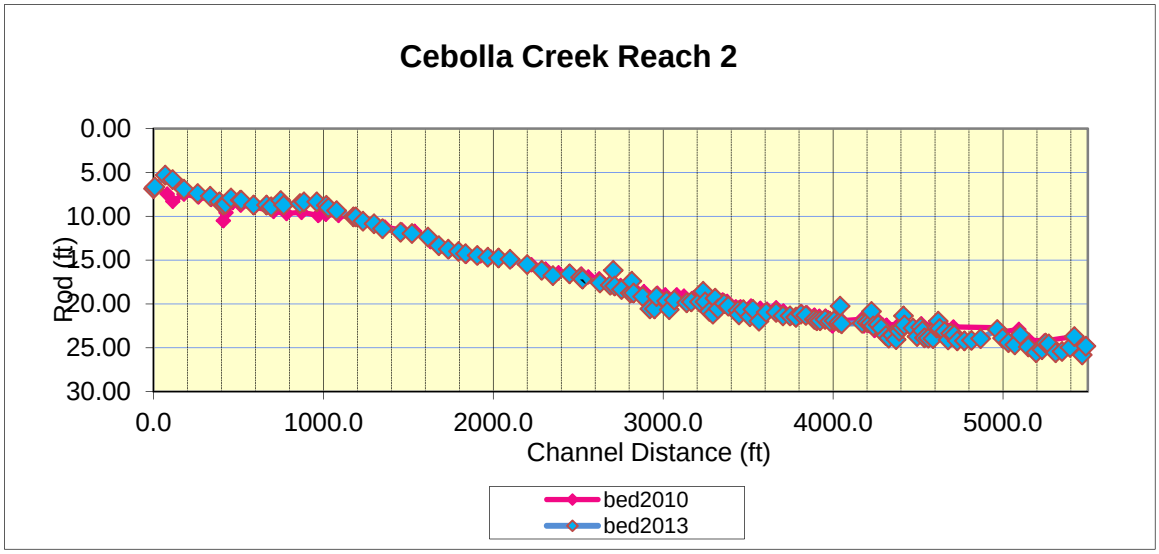

Cebolla Wetland Restoration, Reach 2 Treatments and Monitoring
Media Luna
Zuni Bowl
One Rock Dam
Zuni Bowl
One Rock Dam
One Rock Dam
ccs 4-1
400
vcs 4-1
One Rock Dam
One Rock Dam
4
200
0
ccs 4-1
vcs
4-1
vcs 4-1
One Rock Dam
One Rock Dam
vcs 2-2
400
One Rock Dam
veg 2-1 lft
One Rock Dam
veg 2-1
ccs2-1
200
2-1 vcs
0
2-2
2-2 vcs
ccs 2-2
One Rock Dam
One Rock Dam
2
vcs 2-1rt
Burrito Dam
ccs 2-1
400
2-1 ccs
ccs 2-1
200
Burrito Dam
Burrito Dam
Piezometer
pp cliff
One Rock Dam
One Rock Dam
1-3 veg
1
1-3 veg
1-2 veg
1-1 veg
1-2 veg
0
vcs2-1lft
ccs 2-1 lft
N
0
250
500
1,000 Feet
vegmonitoring
Cebolla Treatments
Keystone Restoration Ecology
for Cebolla Wetland Restoration

**Reach 2 Geomorphology Monitoring, using Trimble sub-meter GPS**
One unique challenge was the more than 9500 feet of longitudinal profile to be measured in Reaches 1-6. This challenge was met by a new technique involving the use of the Trimble Geo XT sub-meter GPS and a laser level. Rather than laying out 9500 feet of measuring tape in 300-foot intervals, the project involved using the GPS to survey the location of each surveying point, and using the comments field to enter the elevation. This involved taking a large number of points, especially to measure any sinuosity in the stream channel.

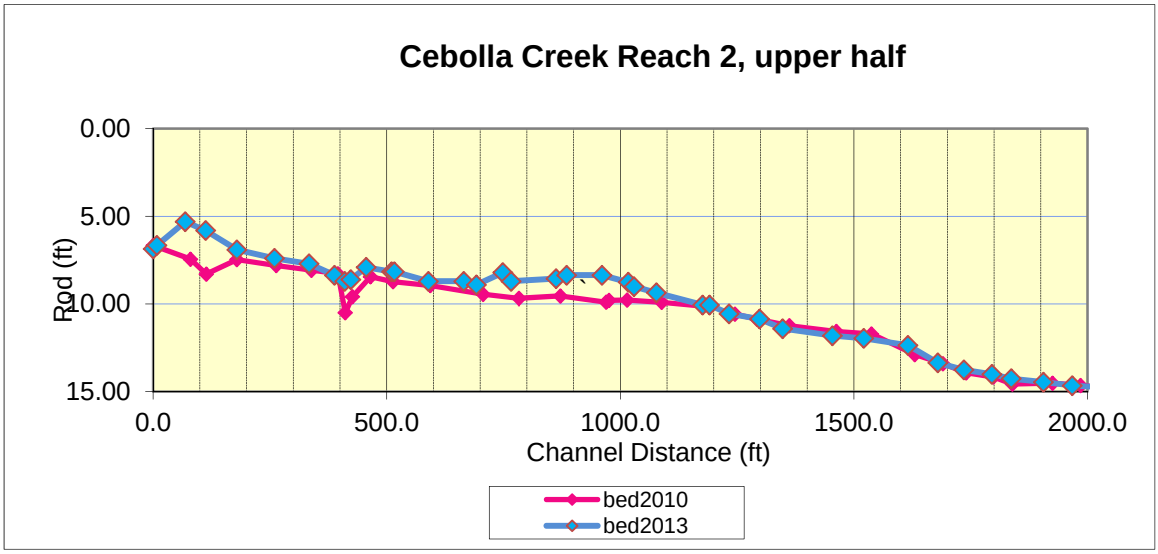
This data was tied together with the creation of a route feature in ArcGis 9.2 to assign a longitudinal profile "distance" to the elevation point features. Using the tool "Locate features along route" ArcGis was able to draw a line through the points that has a measureable length, and then use this line to assign profile locations to the elevation measurements. When this data was re-surveyed in 2013, two Trimble Geo XT sub meter GPSs were used, one to find the survey point, and another to re-take the data.

The very useful portion of this process is that the data can be displayed on top of the aerial photo and the longitudinal seen in 2D. The usual process is to create a GIS map with unique features and the location of proposed structures, but to leave the longitudinal profile in Excel or another graphing program. The designer goes back and forth between the map and the excel file to measure and calculate slopes and dimensionless ratios for stream geomorphology. With this new advance, the slope between any two points can be determined on the map with the scale.

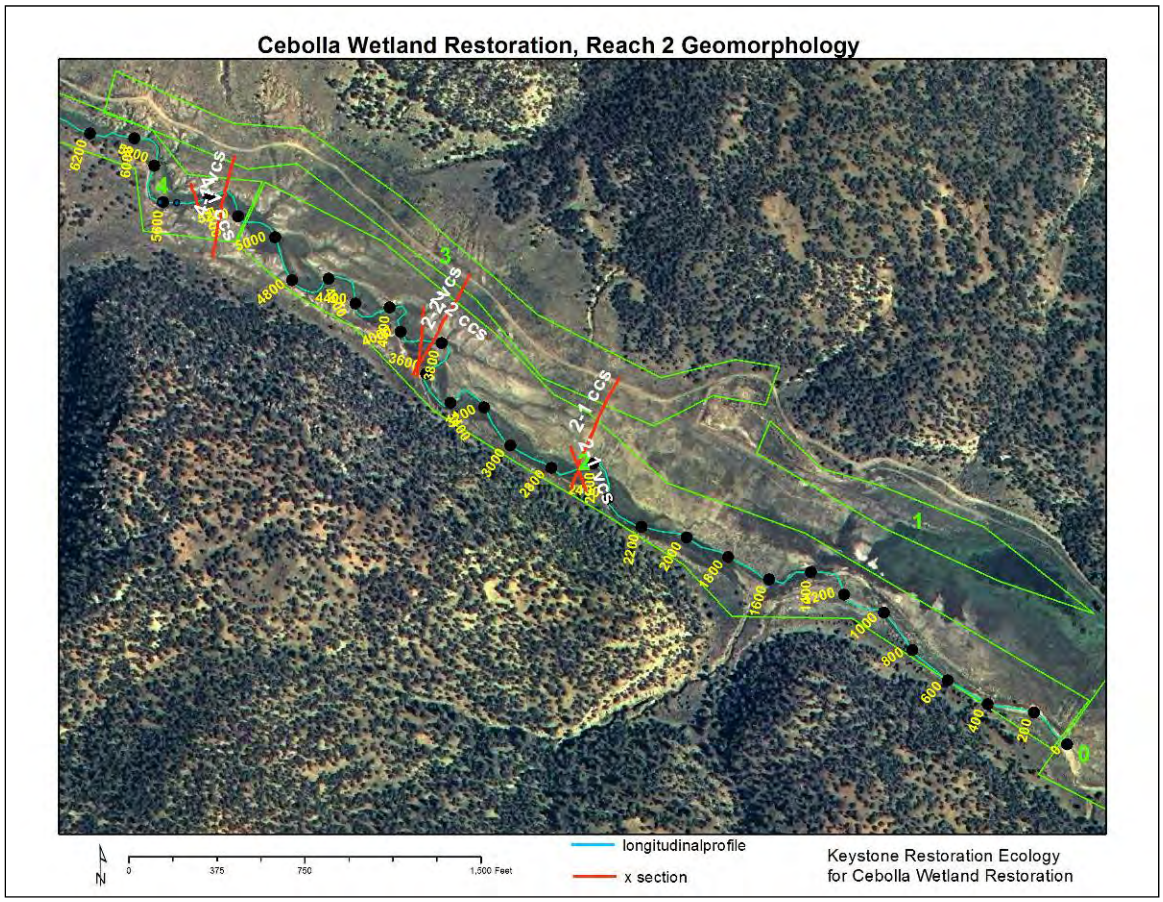
This advance is especially important for Cebolla Canyon. The portion of Cebolla Creek near Reach 1 and Big Cebolla Spring is geomorphically very active and aggrading rapidly. Because of this, the course of the Creek changes yearly or less, and repeating a longitudinal profile over three years with a measuring tape would have been very difficult. With this GIS mapping, the elevation of the channel can be re-mapped each year, no matter how deposition and flooding have changed the course of the channel.

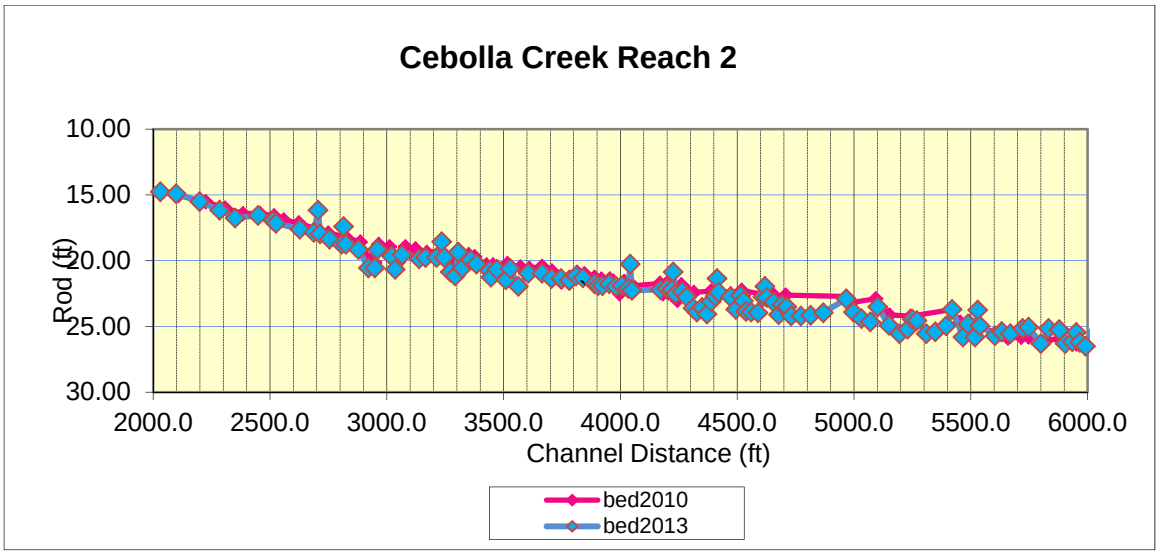


This scale shows very little detail, it is the entire Reach 2.




This portion of the longitudinal profile shows the elevation difference between 2010 and 2013 for the upper 2000 feet. There is a large amount of deposition in the first 1000 feet, the channel has been covered by sand from Cebolla Creek, and flows as sheet flow.

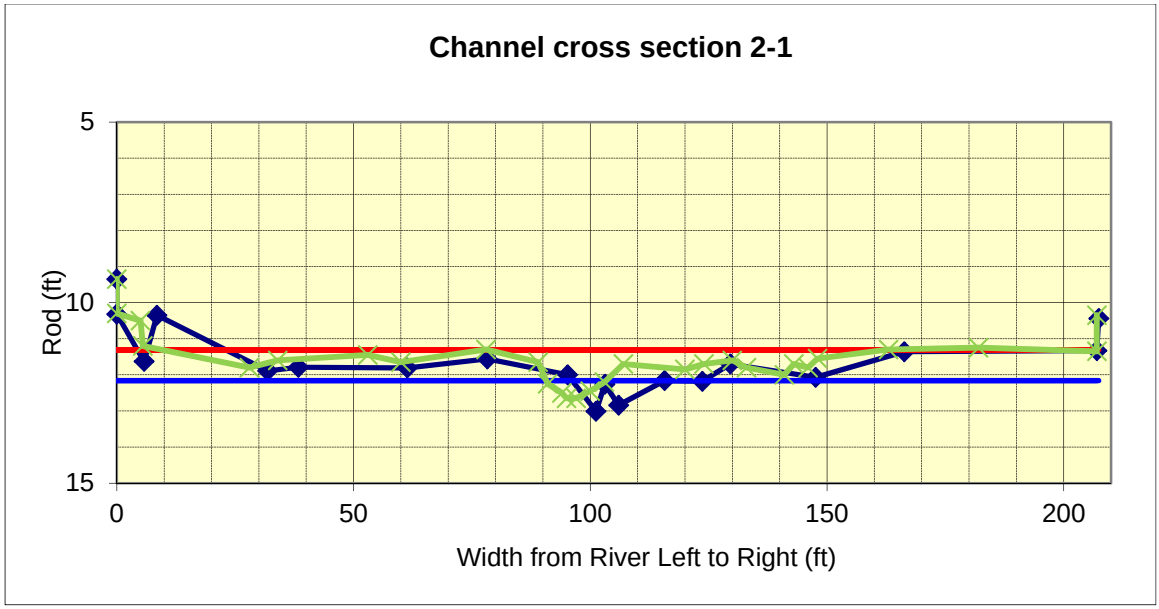




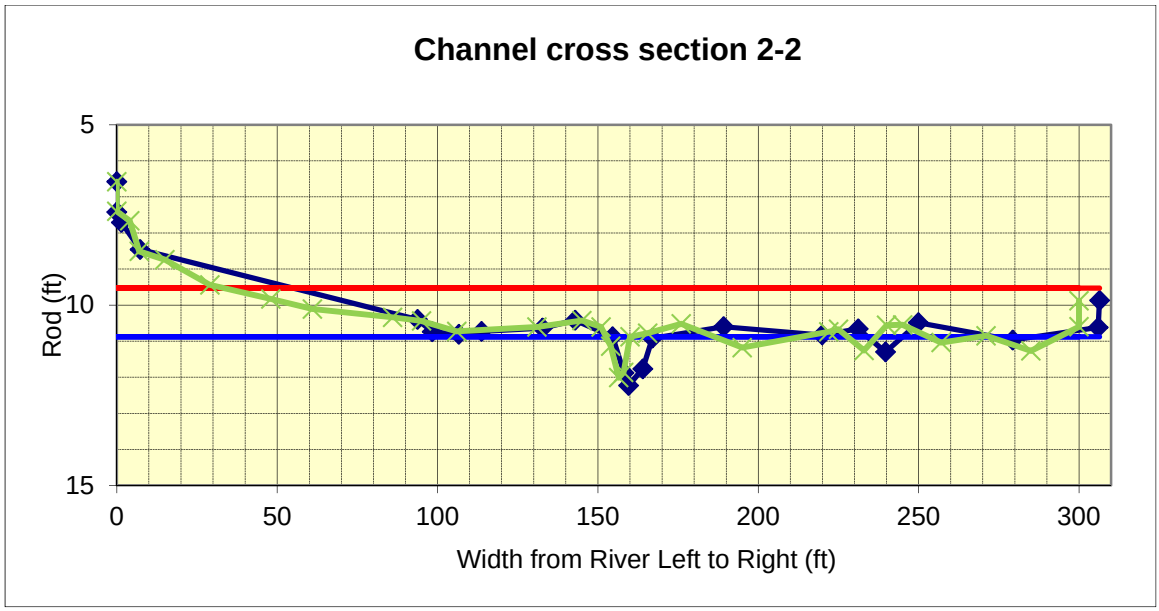

The lower half of reach 2 longitudinal profile. The changes seen between 2010 and 2013 indicate a lack of data, the graph is a straight line. Very little change has happened between these two profiles, the "spikes" in the 2013 profile are one rock dams installed by the Albuquerque Wildlife Federation and others in 2012.

There is a large one rock dam at 5500 on the profile, which was originally designed as a filter dam. As the deposition proceeds downstream from the top of reach 2, these one rock dams should fill in with sediment and the channel form become sheet-flow wetland with no defined channel.

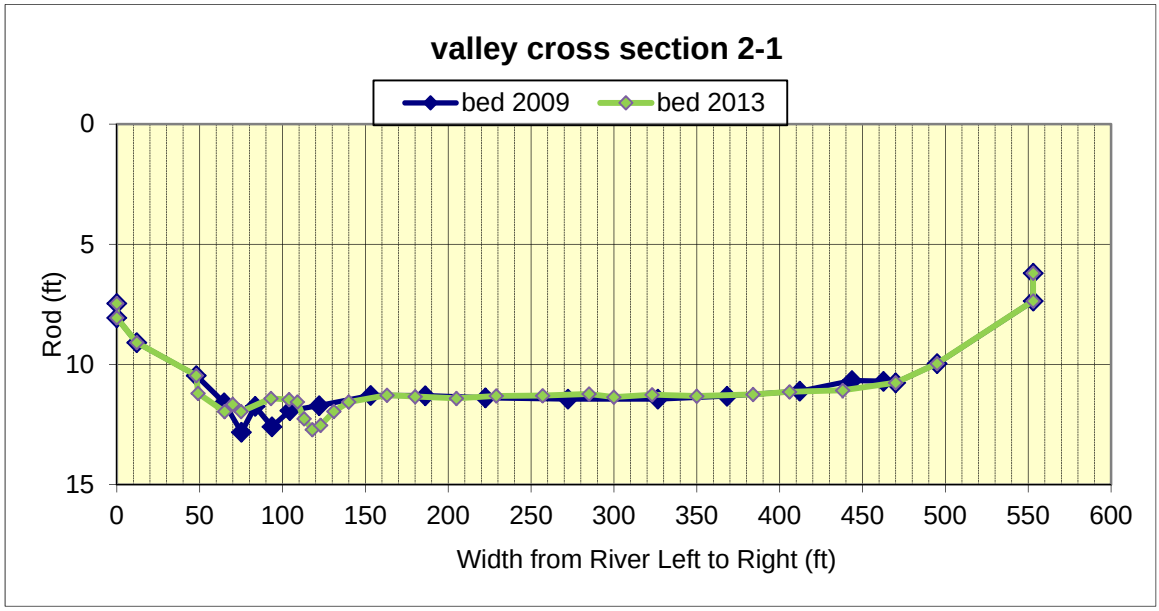
## Cross Section Results, Reach 2



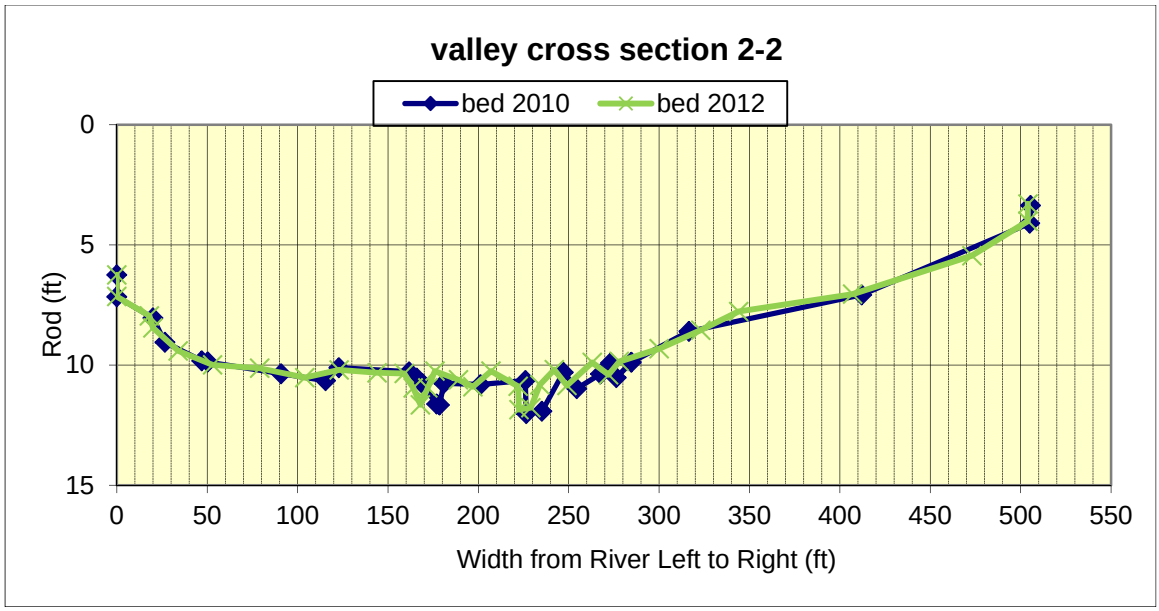

The green line is the 2012 survey. The channel has moved to the left somewhat, as the growth of Juncus balticus captures sediment. There has been a large one rock dam built below this cross section that will fill the channel entirely, moving the channel over to distance 140 on the cross section, the old valley channel before agriculture.




This cross section is downstream from 2-1, and it also has a one rock dam that will fill the channel over time. The channel in this cross section has narrowed somewhat, as more of the flow moves to the right into the old valley bottom before agriculture.




This valley cross section shows a small change in the location of the thalweg, most likely due to deposition and re-channelization in a large flood event.




This valley cross section shows little change across the entire valley. This portion of Reach 2 is further downstream from any source of sediment and may not change due to deposition as Valley Cross Section 1 changed.

## Vegetation Monitoring Results, Reach 2

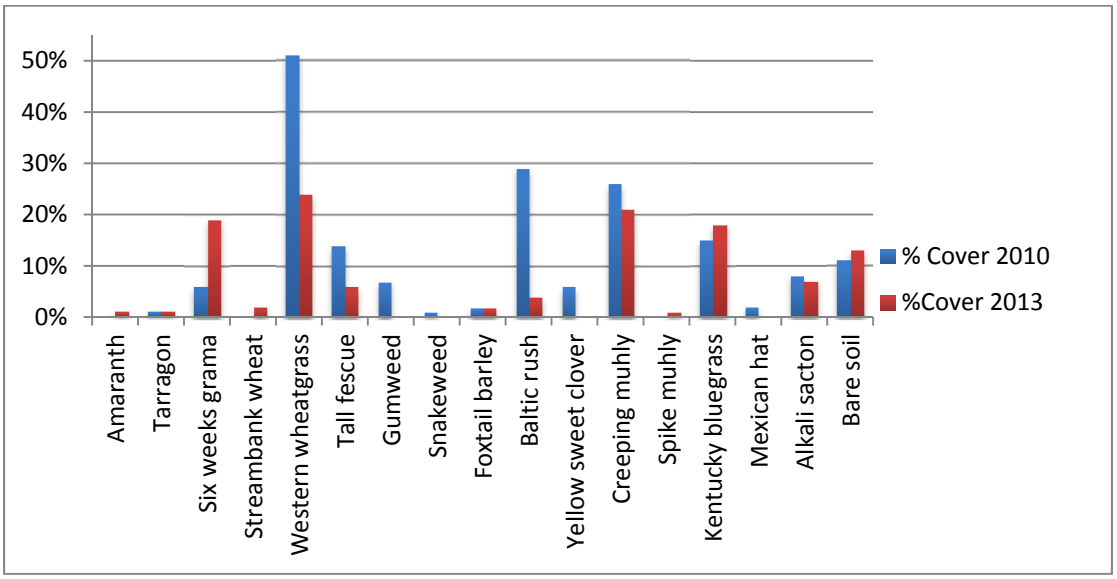
Vegetation monitoring was performed in reach 2 at four cross sections and one vegetation transect. The monitoring transects are described below:

| Monitoring transect | Treatment | Expected results |
|---|---|---|
| Valley cross section 2-1 | Burrito dams, one rock dams | Expansion of wetland from Big Cebolla Spring |
| Channel cross section 2-1 | One rock dams | Capture of sediment in main channel, expansion of wetland |
| Valley cross section 2-2 | One rock dams in channel upstream and downstream | Capture of sediment in main channel, little change expected in rest of valley |
| Valley cross section 2-2 | One rock dams in channel upstream and downstream | Capture of sediment in main channel, expansion of wetland |
| Veg transect 2-2 | One rock dam downstream in channel | Capture of sediment in main channel, expansion of wetland |
| Wetland delineation in reach 2 | Burrito dams, one rock dams | Expansion of wetland |

Cebolla Wetland Restoration, Reach 2 Vegetation Monitoring
vcs 2-2
2-2 vcs
veg 2-1
veg 2-1 lft
ccs2-1
2-2 ccs
ccs 2-2
2-2 vcs
vcs 2-1rt
2-1 ccs
ccs 2-1
2-1 vcs
pp cliff
vcs2-1lft
ccs 2-1 lft
N
0
187.5
375
750 Feet
longitudinalprofile
x section
fall2013wetland
Keystone Restoration Ecology
for Cebolla Wetland Restoration

Channel Cross Section 2-1

| Vegetation Species | Common Name | Percent of Cover 2010 | Percent of Cover 2013 | Percent Difference |
|---|---|---|---|---|
| *Amaranthus spp.* | Amaranth | 0% | 1% | 1% |
| *Artemisia dracunculus* | Tarragon | 1% | 1% | 1% |
| *Bouteloua barbata* | Six weeks grama | 6% | 19% | 13% |
| *Elymus* | Streambank wheat | 0% | 2% | 2% |
| *Elymus smithii* | Western wheatgrass | 51% | 24% | -27% |
| *Festuca arudinacea* | Tall fescue | 14% | 6% | -8% |
| *Grindelia squarosa* | Gumweed | 7% | 0% | -7% |
| *Gutierrezia sarothrae* | Snakeweed | 1% | 0% | -1% |
| *Hordeum jubatum* | Foxtail barrley | 2% | 2% | 0% |
| *Juncus balticus* | Baltic rush | 29% | 4% | -25% |
| *Melilotus offinalis* | Yellow sweet clover | 6% | 0% | -6% |
| *Muhlenbergia repens* | Creeping muhly | 26% | 21% | -5% |
| *Muhlenbergia wrightii* | Spike muhly | 0% | 1% | 1% |
| *Poa pratensis* | Kentucky bluegrass | 15% | 18% | 3% |
| *Ratibida tagetes* | Mexican hat | 2% | 0% | -2% |
| *Sporobolus airoides* | Alkali sacton | 8% | 7% | -2% |
| Bare soil | Bare soil | 11% | 13% | 2% |

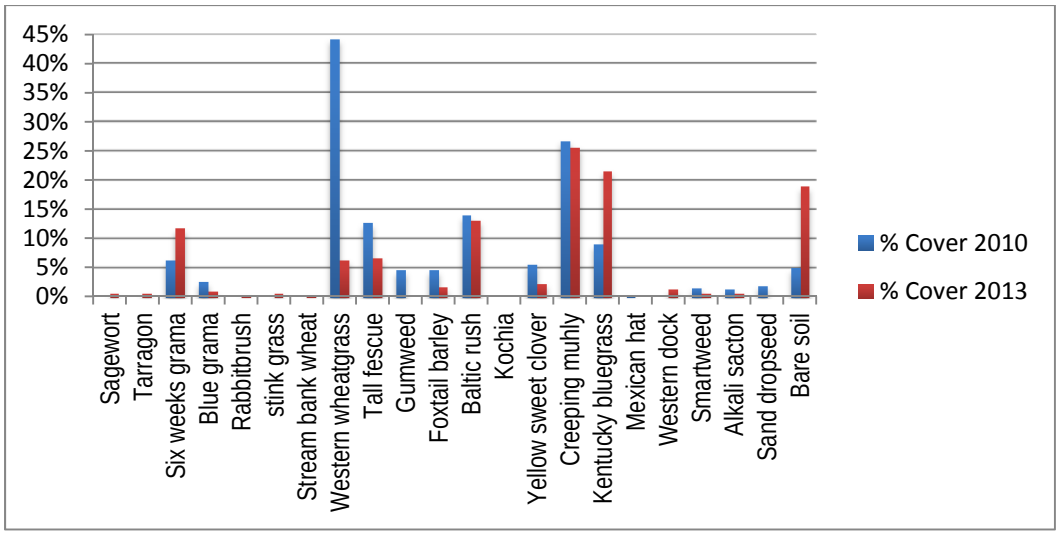



The results of vegetation monitoring at channel cross section 2-1 show a decrease in many important species. Western wheatgrass, Baltic rush, and tall fescue are all species along the wetland gradient, and they all decreased in percent cover. There was a hole in the exclosure fence on this side of Big Cebolla wetland, and this transect was grazed heavily in

2013 due to its proximity to this access bewtween the larger pasture area and the exclosure around the spring.

Channel cross section 2-2

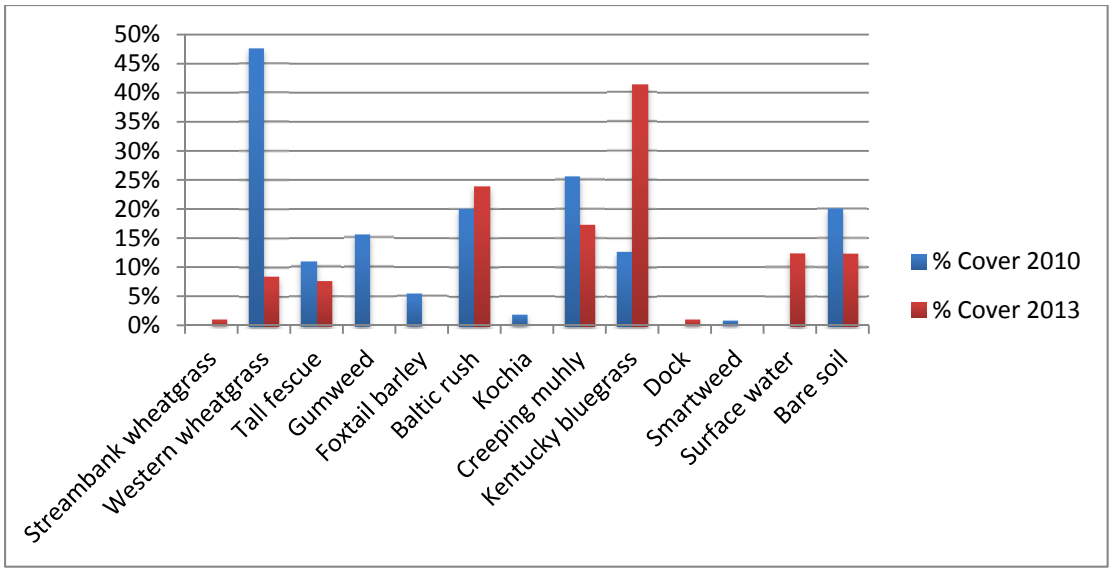
| Vegetation Species | Common Name | Percent of Cover 2010 | Percent of Cover 2013 | Percent Difference |
|---|---|---|---|---|
| *Artemisa frigida* | Sagewort | 0% | 1% | 1% |
| *Artemisia dracunculus* | Tarragon | 0% | 1% | 1% |
| *Bouteloua barbata* | Six weeks grama | 6% | 12% | 5% |
| *Bouteloua gracilis* | Blue grama | 3% | 1% | -2% |
| *Chrysothamnus nauseosus* | Rabbitbrush | 0% | 0% | 0% |
| *Eragrostis cilianensis* | Stink grass | 0% | 1% | 1% |
| *Elymus lanceolatus* | Streambank wheat grass | 0% | 0% | 0% |
| *Elymus smithii* | Western wheatgrass | 44% | 6% | -38% |
| *Festuca arudinacea* | Tall fescue | 13% | 7% | -6% |
| *Grindelia squarosa* | Gumweed | 5% | 0% | -5% |
| *Hordeum jubatum* | Foxtail barley | 5% | 2% | -3% |
| *Juncus balticus* | Baltic rush | 14% | 13% | -1% |
| *Kochia scoparia* | Kochia | 0% | 0% | 0% |
| *Melilotus offinalis* | Yellow sweet clover | 6% | 2% | -3% |
| *Muhlenbergia repens* | Creeping muhly | 27% | 26% | -1% |
| *Poa pratensis* | Kentucky bluegrass | 9% | 22% | 13% |
| *Ratibida tagetes* | Mexican hat | 0% | 0% | 0% |
| *Rumex aquaticus L.* | Western dock | 0% | 1% | 1% |
| *Rumex species* | Smartweed | 2% | 1% | -1% |
| *Sporobolus airoides* | Alkali sacton | 1% | 1% | -1% |
| *Sporobolus cryptandrus* | Sand dropseed | 2% | 0% | -2% |
| *Bare soil* | Bare soil | 5% | 19% | 14% |




The effects of heavy grazing activity were also seen at cross section 2-2, however it seemed less pronounced. There was little decrease in Baltic rush, an important wetland indicator, but a large decrease in western wheatgrass, which is an important species that colonizes wet sites. Kentucky bluegrass increased in cover from 9 to 22%, it is a perrenial sod-forming grass species that is grazing tolerant, which may be a reason for its expansion. There was more bare soil in 2013 as well, a decrease in the % cover of many forb species may be linked to this increase in bare soil.

Vegetation transect 2-1

| Vegetation Species | Common Name | Percent of Cover 2010 | Percent of Cover 2013 | Percent Difference |
|---|---|---|---|---|
| *Elymus lanceolatus* | Streambank wheatgrass | 0% | 1% | 1% |
| *Elymus smithii* | Western wheatgrass | 48% | 9% | -39% |
| *Festuca arudinacea* | Tall fescue | 11% | 8% | -3% |
| *Grindelia squarosa* | Gumweed | 16% | 0% | -16% |
| *Hordeum jubatum* | Foxtail barley | 6% | 0% | -6% |
| *Juncus balticus* | Baltic rush | 20% | 24% | 4% |
| *Kochia scoparia* | Kochia | 2% | 0% | -2% |
| *Muhlenbergia repens* | Creeping muhly | 26% | 17% | -8% |
| *Poa pratensis* | Kentucky bluegrass | 13% | 41% | 29% |
| *Rumex crispus* | Dock | 0% | 1% | 1% |
| *Rumex species* | Smartweed | 1% | 0% | -1% |
| Surface water | Surface water | 0% | 13% | 13% |
| Bare soil | Bare soil | 20% | 13% | -8% |




There was a large decrease in western wheatgrass, again probably due to grazing. Grazing-tolerant Kentucky bluegrass increased greatly. A positive result was seen in some increase in Baltic rush, as more of this transect became delineated wetland (from 20% to 24%) of a 100 foot transect.

Valley Cross section 2-1, 91 points

| Species | Common Name | cover 2010 | cover 2012 | Percent difference |
|---|---|---|---|---|
| *Artemisia dracunculus* | tarragon | 2% | 1% | -1% |
| *Bouteloua barbata* | six weeks grama | 7% | 7% | 0% |
| *Bouteloua gracilis* | blue grama | 13% | 9% | -4% |
| *Festuca arudinacea* | tall fescue | 5% | 4% | -1% |
| *Elymus smithii* | Western wheatgrass | 44% | 20% | -24% |
| *Grindelia squarosa* | gumweed | 5% | 1% | -4% |
| *Gutierrezia sarothrae* | snakeweed | 2% | 0% | -2% |
| *Hordeum jubatum* | foxtail barley | 22% | 34% | 12% |
| *Juncus balticus* | baltic rush | 4% | 4% | 0% |
| *Kochia scoparia* | kochia | 3% | 2% | -1% |
| *Muhlenbergia repens* | creeping muhly | 8% | 10% | 2% |
| *Muhlenbergia wrightii* | spike muhly | 4% | 1% | -3% |
| *Sporobolus airoides* | alkali sacton | 5% | 8% | 2% |
| Soil | | 5% | 9% | 3% |

The vegetation results were taken at different times of year, so different grasses and plants may be expected to dominate the plot. There was a large decrease in Western Wheatgrass

and an increase in Foxtail barley, the two may be related. Foxtail barley invades on saturated soils, and soon after, Western Wheatgrass dies out from too much water. More on this can be seen in the State-Transition Wetland Model in this report.

Valley Cross Section 2-2, 84 points

| Species | Common Name | cover 2010 | cover 2012 | percent difference |
|---|---|---|---|---|
| *Bouteloua barbata* | six weeks grama | 2% | 2% | 0% |
| *Bouteloua gracilis* | blue grama | 10% | 5% | -5% |
| *Festuca arudinacea* | tall fescue | 5% | 4% | -1% |
| *Elymus smithii* | Western wheatgrass | 14% | 14% | 0% |
| *Grindelia squarosa* | gumweed | 6% | 2% | -4% |
| *Hordeum jubatum* | foxtail barley | 0% | 13% | 13% |
| *Juncus balticus* | baltic rush | 5% | 5% | 0% |
| *Kochia scoparia* | kochia | 39% | 25% | -14% |
| *Melilotus offinalis* | yellow sweet clover | 0% | 0% | 0% |
| *Muhlenbergia asperifolia* | scratchgrass muhly | 2% | 0% | -2% |
| *Muhlenbergia repens* | creeping muhly | 6% | 11% | 5% |
| *Poa pratensis* | Kentucky bluegrass | 5% | 10% | 5% |
| Soil | | 18% | 24% | 6% |

These data indicate a small increase in foxtail barley, which is spreading downstream onto the saturated soils. There was a decrease in Kochia, which was very small this time of year June, about 1 inch high. Higher cover of Kochia would be expected in the fall when it has sprouted up and flowered.

## Overall monitoring results for Reach 2

### Geomorphology

The uppermost portion of Reach 2 had some aggradation of sediment from flood events, and the channel was eliminated due to filling in with sand. This positive result will spread floodwaters across the Big Cebolla Wetland area, and increase the water table at the site, as the spreading floodwaters soak into the soil. The channel and valley cross sections show some changes (narrowing) due to vegetation growth and capture of sediment, but it is not yet very pronounced.

### Vegetation

The vegetation at the site shows both positive and negative changes over time. There was heavy grazing in almost all year since the start of the project, as cattle find their way to the wetland and jump the fence. The year 2013, however, appeared to have the heaviest grazing intensity. Since 2009, there has been grazing, but the cattle have not yet eaten the less palatable Baltic rush, which is thick and fibrous. In 2013, however, the Baltic rush was eaten to the nub, and most stems were 2-3 inches above ground. This is compared with the

thick sward of Baltic rush which persisted in Reach 2 for many years, and is usually 2 feet tall.
The positive changes were an increase in Kentucky bluegrass, which requires a wetter site than upland vegetation, and provides good ground cover. In addition, the area covered by Baltic rush and considered delineated wetland appeared to increase over the last three years (see wetland delineation portion of report).

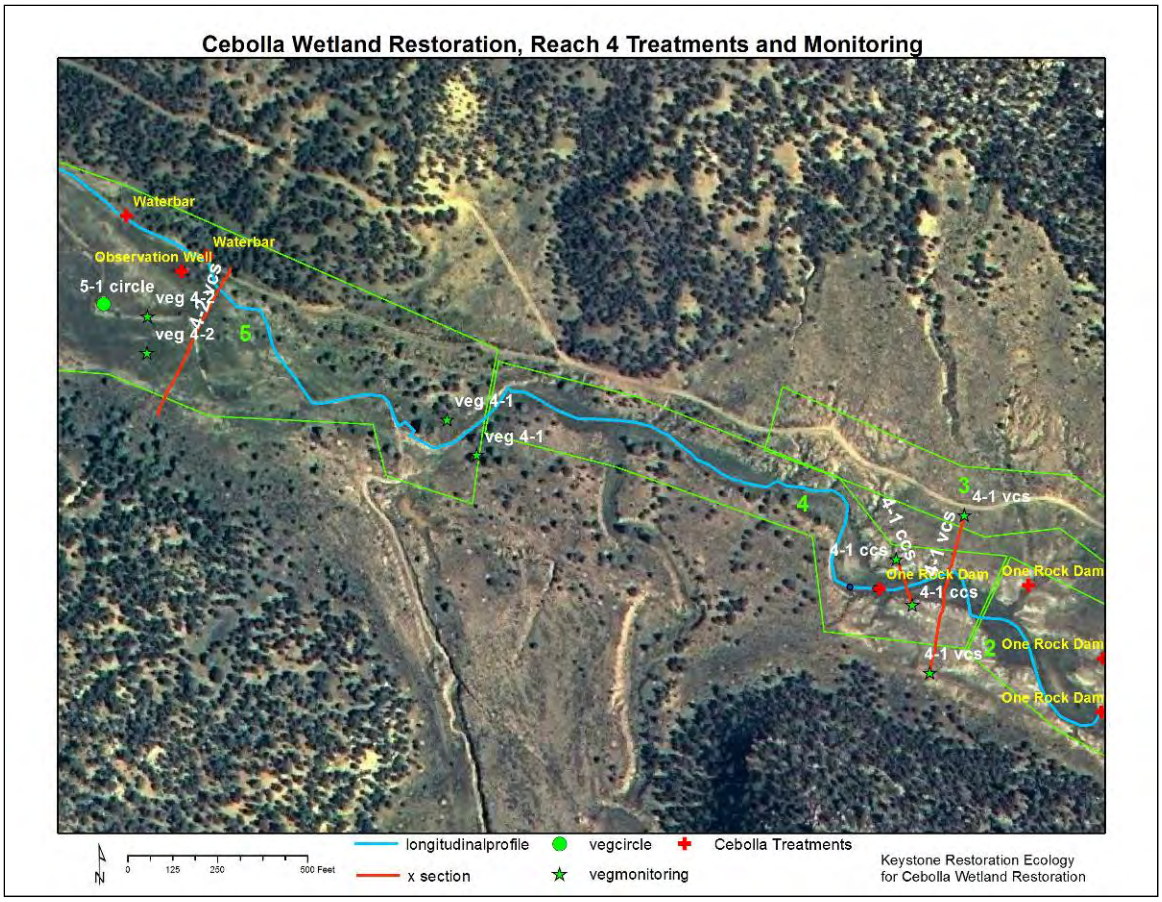
This increase was not large in area, however Baltic rush is now continuous downstream through the reach, even as a narrow fringe of vegetation along the channel. As the one rock dams installed in 2012 begin to capture sediment and raise the water table, this fringe should spread across the valley bottom and increase wetland area. This tough-rooted wetland plant will also buffer the channel from floods, and if left to grow to its natural height of 2 feet or so, capture sediment and litter from upstream, and fill the channel.

Reach 2 vegetation, Baltic Rush fringe along channel in 2013

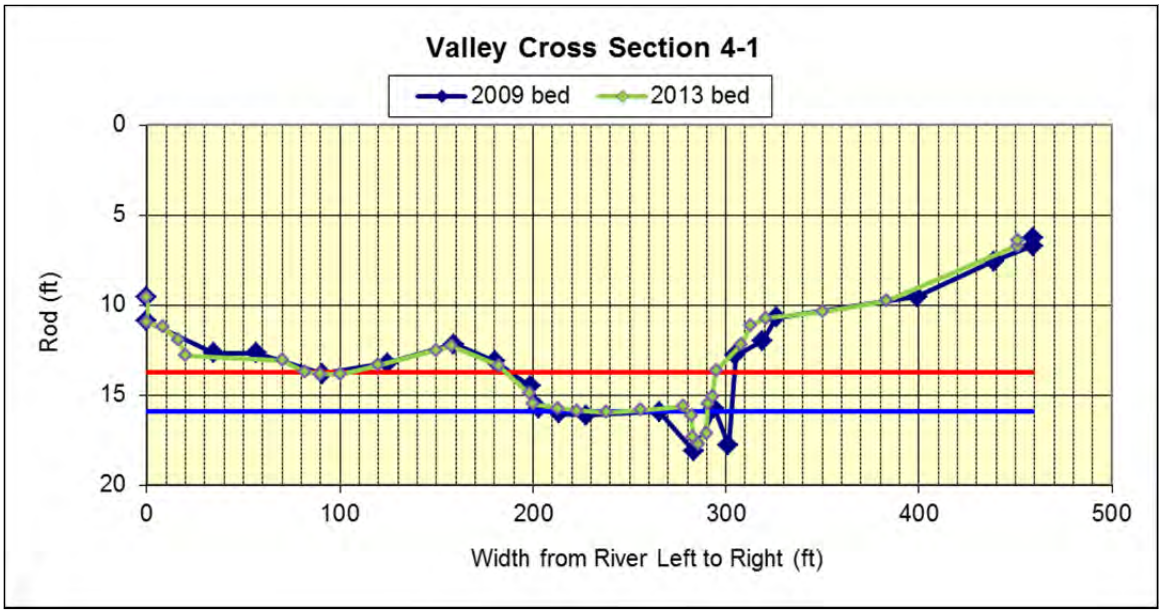
**Treatment and Monitoring Reach 4, Cebolla Creek**

Reach 4 actually begins at the end of Reach 2, as Reach 3 is a gully treatment area on the hillslopes to the North near the road. The monitoring transects downstream were originally believed to be in Reach 4, but are actually in Reach 5. This data will be presented as data for Reach 4, to have consistency with the orginal names of the transects.

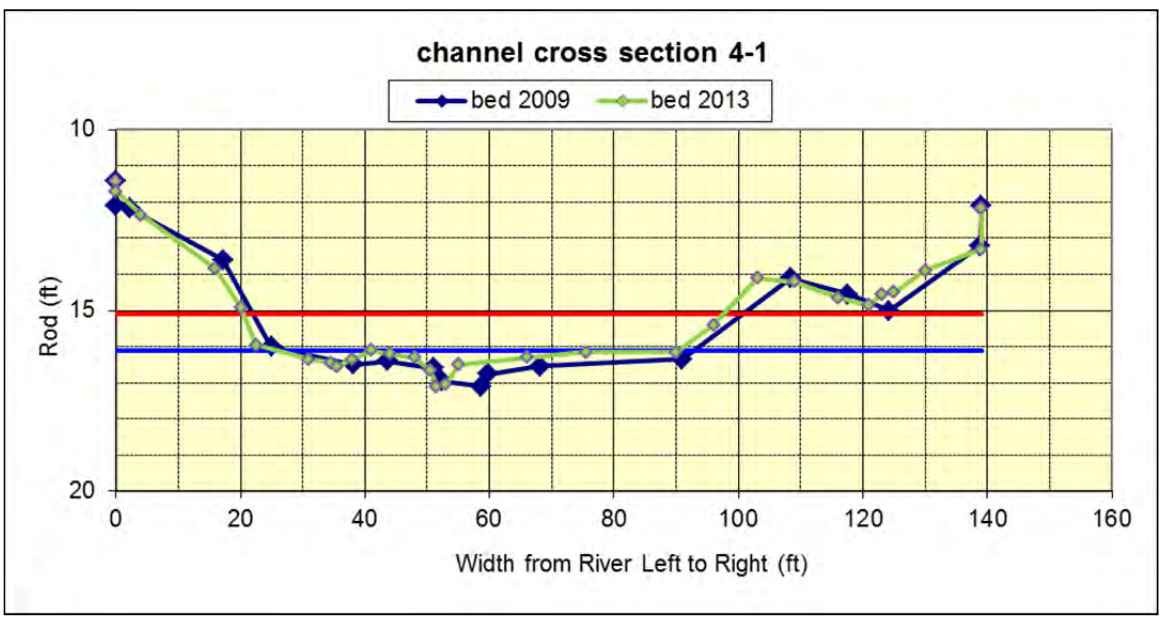
| Treatment | Location | Expected results | Monitoring |
|---|---|---|---|
| One large one rock dam (originally planned as filter dam) | End of valley, beginning of narrow Reach 4 | Increased flooding, capture of sediment, change in vegetation | Valley cross section 4-1, Channel cross section 4-1, Channel cross section 4-1 vegetation |
| Savage Canyon alluvial fan from south, LACK OF TREATMENT as management to provide sediment source | Between Reach 4 and Reach 5 | Capture of sediment, raised water table, more wetland | Veg transect 4-1, 4-2<br>Valley cross section 4-2 geomorphology |


Cebolla Wetland Restoration, Reach 4 Treatments and Monitoring
Waterbar
Waterbar
Observation Well
5-1 circle
veg 4-2
4-2 vcs
veg 4-2
5
veg 4-1
veg 4-1
4
4-1 ccs
4-1 vcs
3
4-1 vcs
4-1 ccs
One Rock Dam
4-1 ccs
One Rock Dam
4-1 vcs
2
One Rock Dam
One Rock Dam
N
0
125
250
500 Feet
longitudinalprofile
x section
vegcircle
vegmonitoring
Cebolla Treatments
Keystone Restoration Ecology
for Cebolla Wetland Restoration

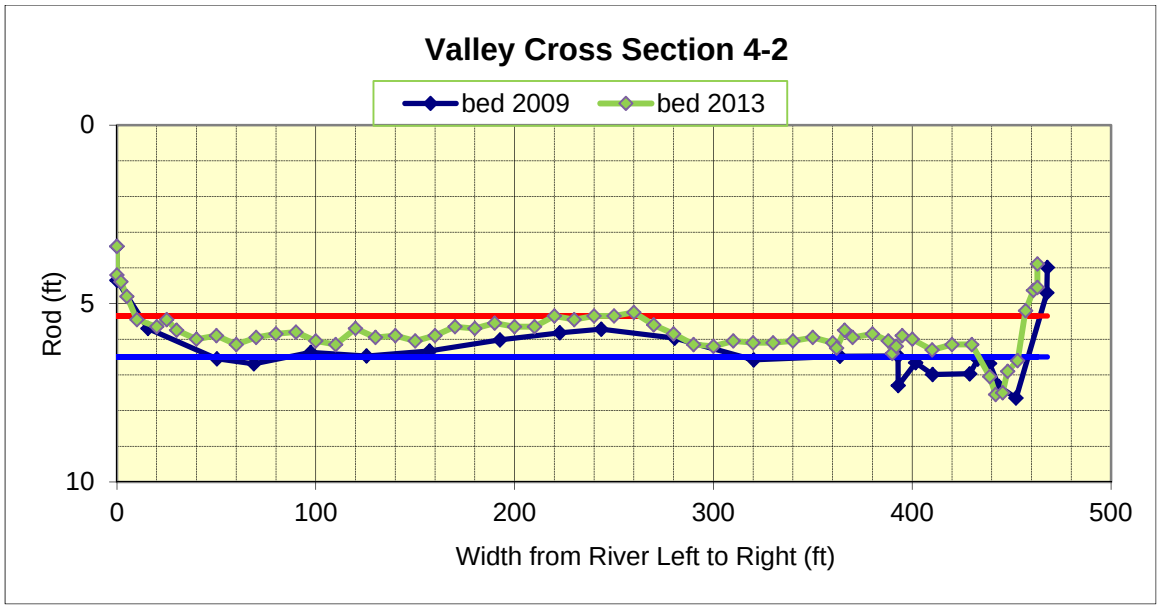
## Geomorphology Results, Reach 4




There were small changes in valley cross section 4-1, but only in the bed of the channel, which filled in with sediment and narrowed to a single channel. This transect was installed to monitor the changes from installation of a 2 foot high filter dam, this was changed to a one rock dam that is one foot high, less change is expected.




Channel cross section 4-1 is downstream from the valley cross section 4-1 and closer to the one rock dam (which replaced the designed filter dam). As seen in the valley cross section, the channel narrowed and gained elevation due to the capture of sediment behind the one rock dam.

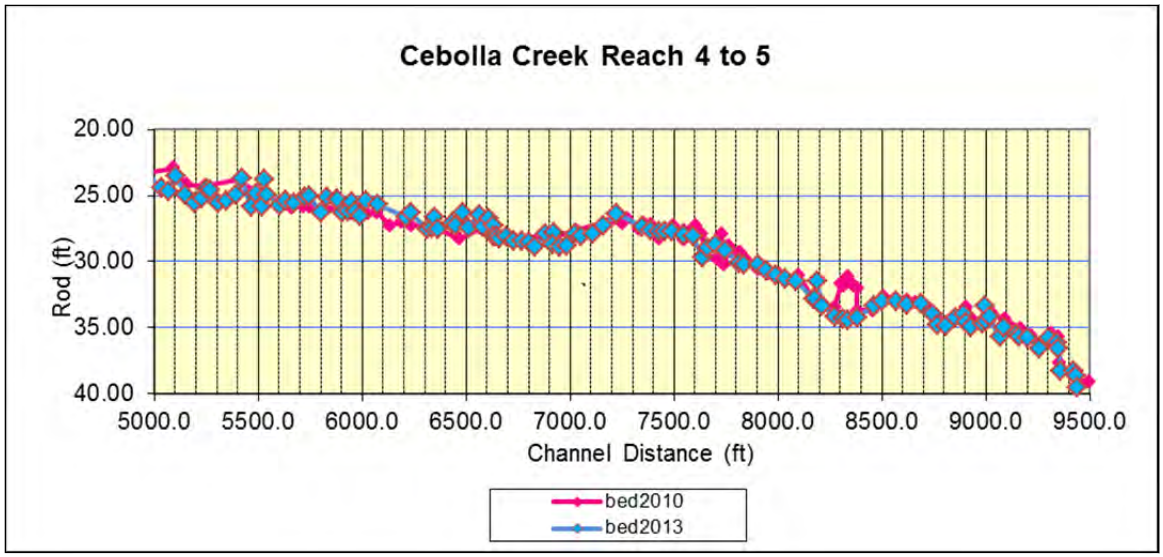



This valley cross section is just downsream from the boundary between Reaches 4 and 5, but was orginally named 4-2, so the name remains. A large amount of sediment from Savage Canyon, a tributary canyon to the south, spills into the channel of Cebolla Creek, causing braiding and an alluvial fan form.

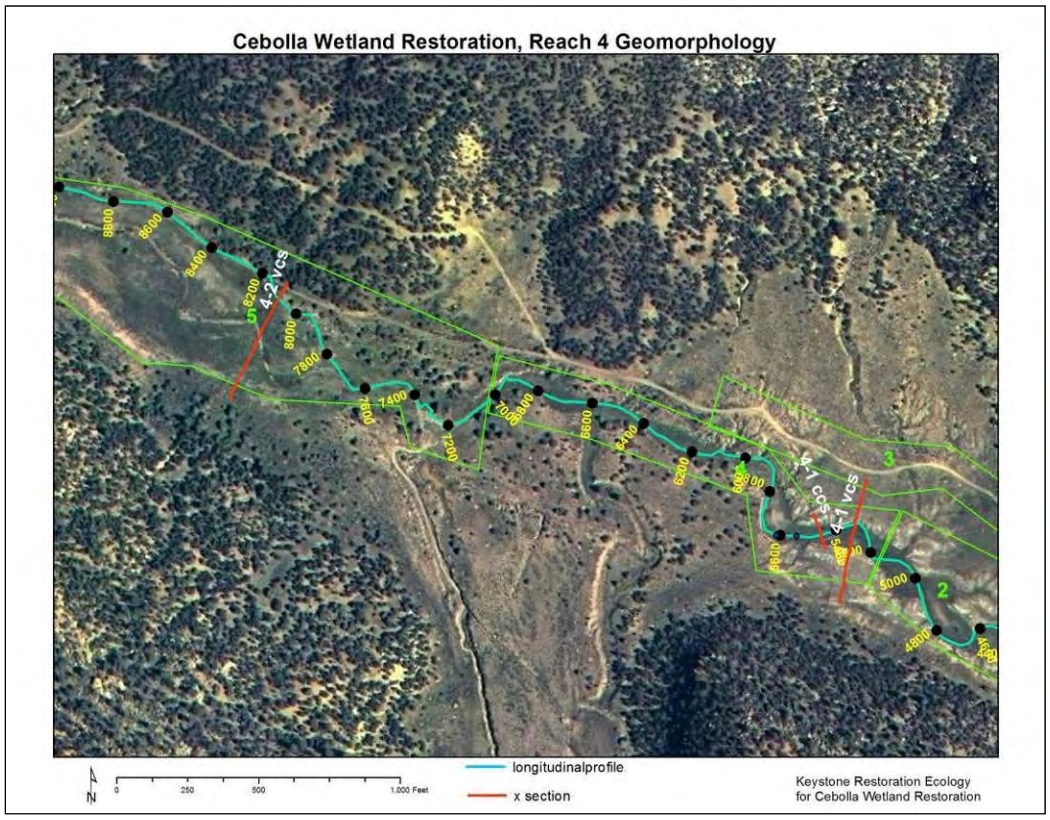
As seen in a typical alluvial fan, the middle of the fan is the highest elevation, with lower channels on both sides of the valley. The deep channel to the right of the valley is the old road, which formed a gully. This gully is filling in due to the installation of a rolling dip/one rock dam downstream from this transect.

Rolling dip road drain looking upstream at valley cross section 4-2

Cebolla Longitudinal Profile, Reach 4-5



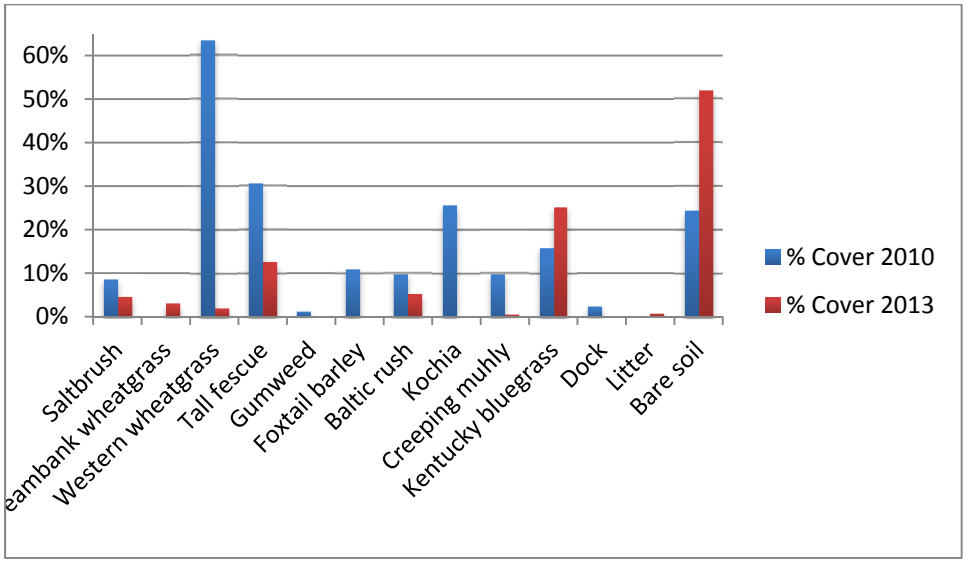

This profile runs from upstream of Reach 4 through Reach 5. The most notable portion of this graph is the area around 7200 on the longitudinal profile. This reach runs "uphill", as the sediment plume from Savage Canyon fills the valley. The large "hump" at 8400 is the rolling dip/one rock dam. The channel has cut around it to the left and needs repair and extension of the one rock dam.



## Vegetation Results, Reach 4

Channel cross section 4-1

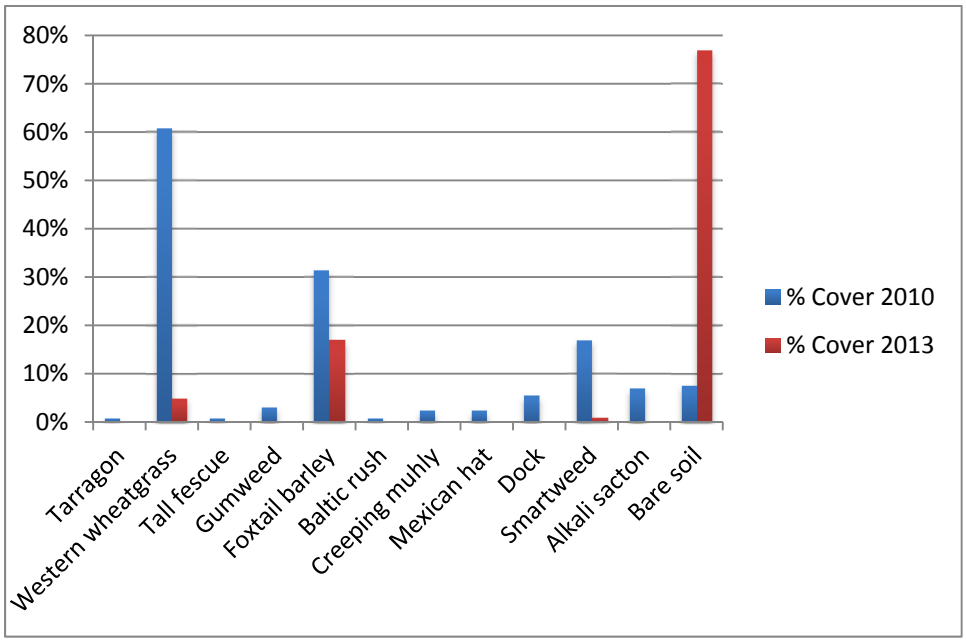
| Vegetation Species | Common Name | Percent of Cover 2010 | Percent of Cover 2013 | Percent Difference |
|---|---|---|---|---|
| *Atriplex canescens* | Saltbrush | 9% | 4% | -4% |
| *Elymus* | Streambank wheatgrass | 0% | 3% | 3% |
| *Elymus smithii* | Western wheatgrass | 63% | 2% | -61% |
| *Festuca arudinacea* | Tall fescue | 30% | 13% | -18% |
| *Grindelia squarosa* | Gumweed | 1% | 0% | -1% |
| *Hordeum jubatum* | Foxtail barley | 11% | 0% | -11% |
| *Juncus balticus* | Baltic rush | 10% | 5% | -5% |
| *Kochia scoparia* | Kochia | 26% | 0% | -26% |
| *Muhlenbergia repens* | Creeping muhly | 10% | 1% | -9% |
| *Poa pratensis* | Kentucky bluegrass | 16% | 25% | 9% |
| *Rumex crispus* | Dock | 2% | 0% | -2% |
| Organic Matter | Litter | 0% | 1% | 1% |
| Bare Soil | Bare soil | 24% | 52% | 27% |




The results from channel cross section 4-1 show a decrease in the cover of many important species. This transect is very close to Reach 2, and the same patterns can be seen in the data. Western wheatgrass decreased in cover, as did Baltic rush, tall fescue, and foxtail barley. There was also an increase in bare soil on the transect. All of these results can be explained by the heavy grazing pressure in 2013 at the site.

Vegetation transect 4-1

| Vegetation Species | Common Name | Percent of Cover 2010 | Percent of Cover 2013 | Percent Difference |
|---|---|---|---|---|
| *Artemisia dracunculus* | Tarragon | 1% | 0% | -1% |
| *Elymus smithii* | Western wheatgrass | 61% | 5% | -56% |
| *Festuca arudinacea* | Tall fescue | 1% | 0% | -1% |
| *Grindelia squarosa* | Gumweed | 3% | 0% | -3% |
| *Hordeum jubatum* | Foxtail barley | 32% | 17% | -15% |
| *Juncus balticus* | Baltic rush | 1% | 0% | -1% |
| *Muhlenbergia repens* | Creeping muhly | 2% | 0% | -2% |
| *Ratibida tagetes* | Mexican hat | 2% | 0% | -2% |
| *Rumex crispus* | Dock | 5% | 0% | -5% |
| *Rumex species* | Smartweed | 17% | 1% | -16% |
| *Sporobolus airoides* | Alkali sacton | 7% | 0% | -7% |
| Bare soil | Bare soil | 8% | 77% | 69% |

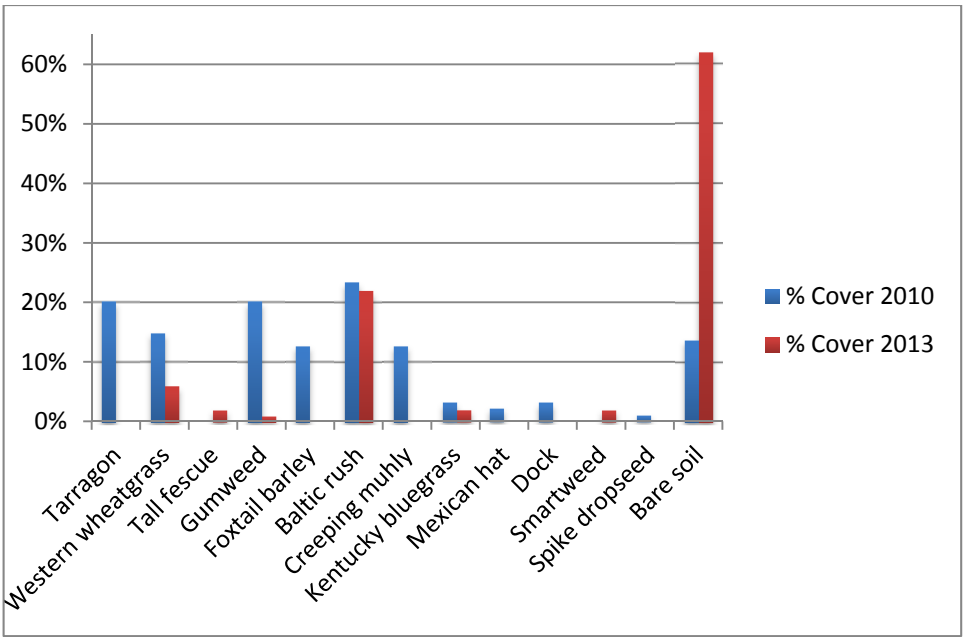



Vegetation transect 4-1 was just upstream from the sediment plug from Savage Canyon. This causes this transect to be in a ponded area, and a large amount of sedimetn from Cebolla Canyon and Savage Canyon drops out of suspension. There was a decrease in almost every species, as this transect was mostly sand deposited a foot deep on top of vegetation seen in 2010.

Vegetation transect 4-1 buried under new sediment

Vegetation transect 4-2

| Vegetation Species | Common Name | Percent of Cover 2010 | Percent of Cover 2013 | Percent Difference |
|---|---|---|---|---|
| *Artemisia dracunculus* | Tarragon | 20% | 0% | -20% |
| *Elymus smithii* | Western wheatgrass | 15% | 6% | -9% |
| *Festuca arudinacea* | Tall fescue | 0% | 2% | 2% |
| *Grindelia squarosa* | Gumweed | 20% | 1% | -19% |
| *Hordeum jubatum* | Foxtail barley | 13% | 0% | -13% |
| *Juncus balticus* | Baltic rush | 23% | 22% | -1% |
| *Muhlenbergia repens* | Creeping muhly | 13% | 0% | -13% |
| *Poa pratensis* | Kentucky bluegrass | 3% | 2% | -1% |
| *Ratibida tagetes* | Mexican hat | 2% | 0% | -2% |
| *Rumex crispus* | Dock | 3% | 0% | -3% |
| *Rumex species* | Smartweed | 0% | 2% | 2% |
| *Sporobolus contractus* | Spike dropseed | 1% | 0% | -1% |
| Bare soil | Bare soil | 14% | 62% | 48% |




Vegetation transect 4-2 is just downstream from Valley transect 4-2, which had ½ to 1 feet of sediment deposition from Savage Canyon. The amount of bare soil increased greatly, as did the percent cover of most species. However, Baltic rush, which is a wetland species that thrives under the deposition of wet sediment, decreased by only 1% cover, despite the large amount of sand on top of it. Baltic rush may already be growing up through the new deposition that has buried the rest of the plants in the transect.

## Overall monitoring results for Reach 4

### Geomorphology

Transects valley cross section 4-1 and channel cross section 4-1 both had similar results, with the channel narrowing and gaining elevation slightly. This is due to the growth of Baltic rush along the banks, as well as sediment deposition from upstream. Valley cross section 4-2 had ½ to 1 feet of deposition from Savage Canyon across the entire transect, which should flatten the grade of the channel upstream.

### Vegetation

The vegetation at the site shows both positive and negative changes over time. There was heavy grazing in almost all year long since the beginning of the project. The year 2013, however, appeared to have the heaviest grazing intensity due to the heavy grazing on Baltic rush. Channel cross section 4-1 had the most grazing intensity and showed a marked reduction in species cover. Vegetation transects 4-1 and 4-2 were covered by sediment and also had a decrease in plant cover, however, the effects of sedimentation are positive for the channel of Cebolla Creek.

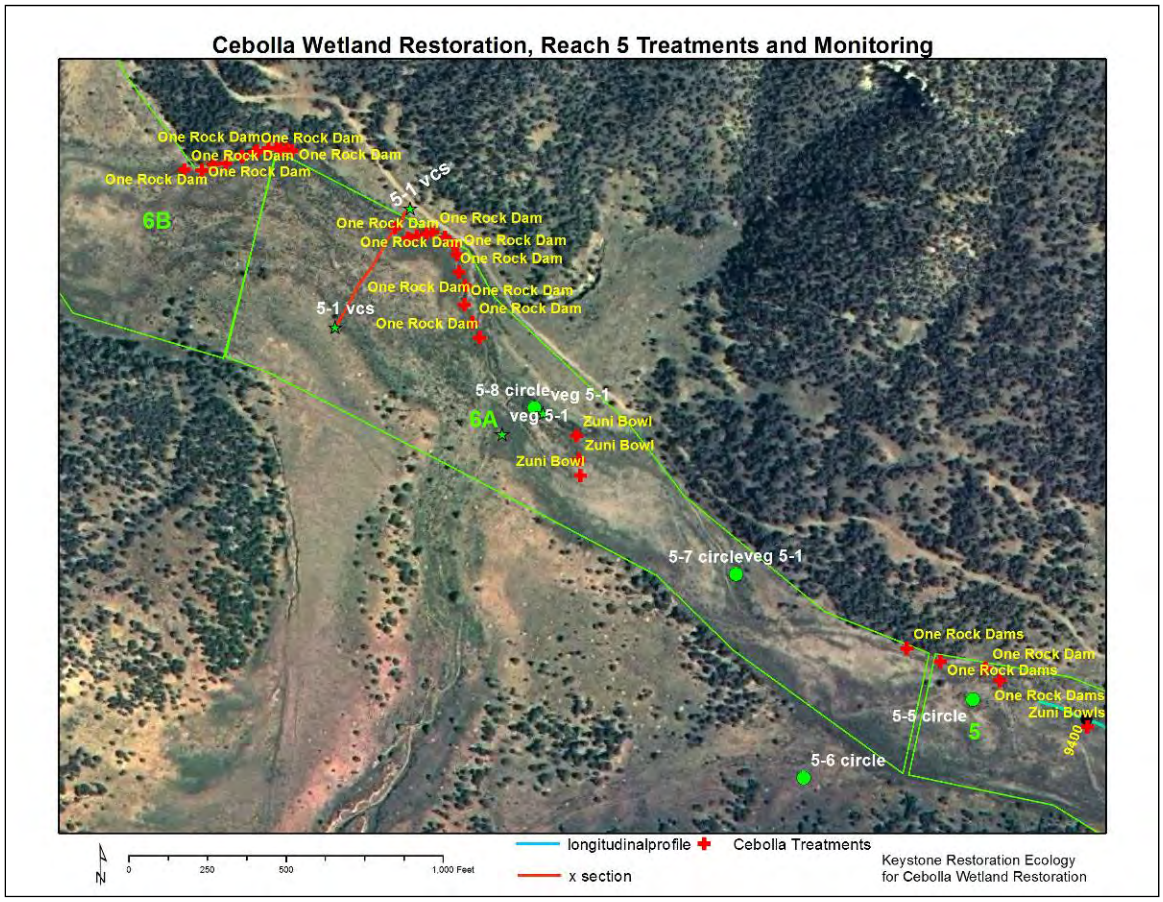
The results of the wetland delineation portion of this report show that Baltic rush is moving downstream and colonizing Reach 5. This will anchor the sediment spilling out

from Savage Canyon, and in the future, most of Reach 4 should fill in as well with sediment from the main channel of Cebolla Creek.

## Treatment and Monitoring Reach 5-6a, Cebolla Creek

Reach 5 extends into Reach 6a, and an old road/cattle trail captures the channel of Cebolla Creek in a gully. A large number of one rock dams were built by youth and volunteers in the channel of this gully.

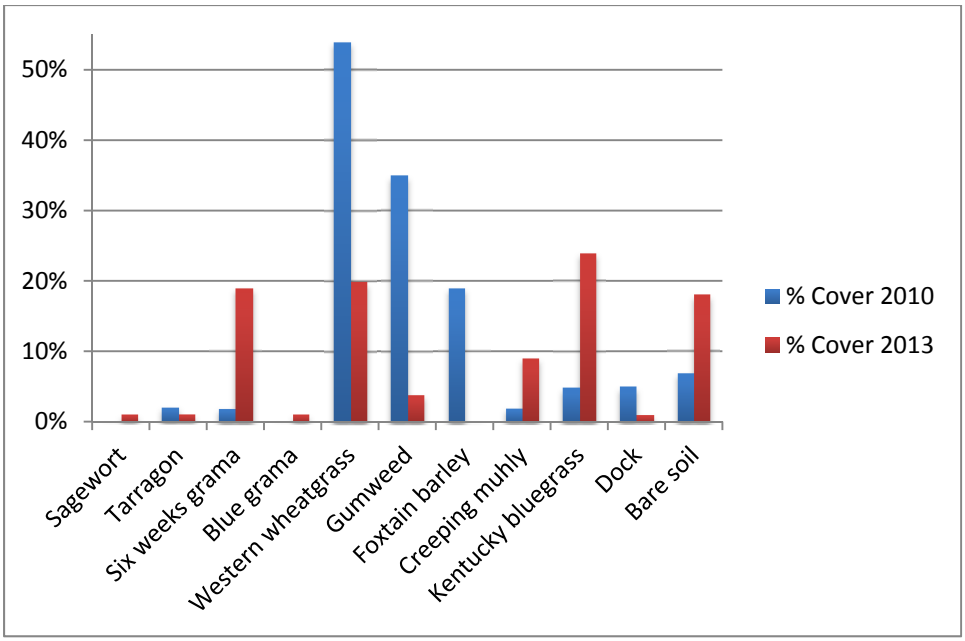
| Treatment | Location | Expected results | Monitoring |
|---|---|---|---|
| Large Zuni Bowls to prevent headcutting of gully up valley | Above vegetation transect 5-1 | Increased flooding, spreading of water across vallely | Vegetation transect 5-1 |
| Thirteen one rock dams in gully | | Raised water table, increased flooding across valley bottom | Valley cross section 5-1, geomorphology and vegetation |



Zuni bowl to prevent gullying upstream, upstream of vegetation transect 5-1

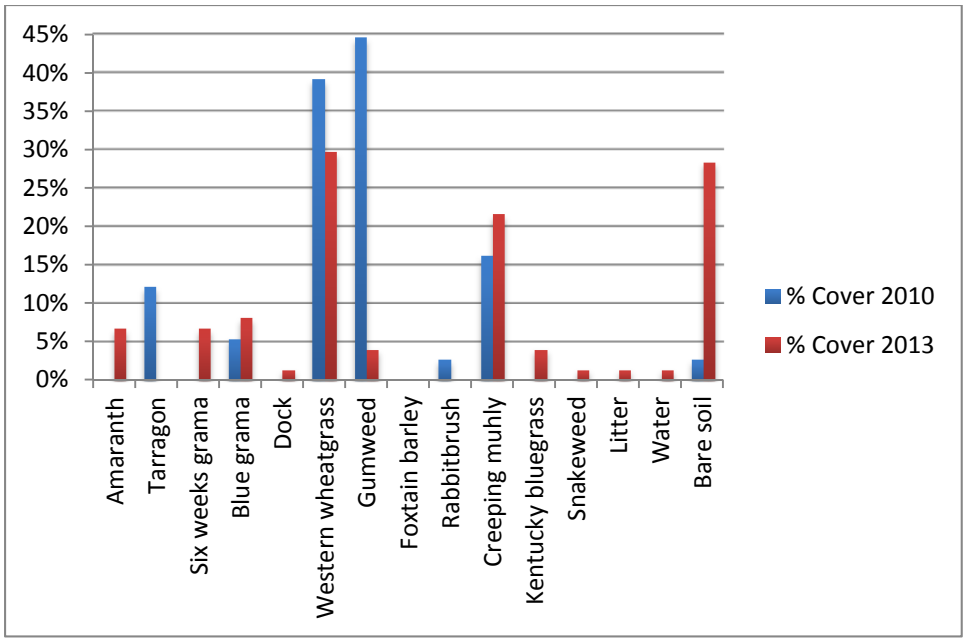
| Vegetation Species | Common Name | Percent of Cover 2010 | Percent of Cover 2013 | Percent Difference |
|---|---|---|---|---|
| *Artemisia frigida* | Sagewort | 0% | 1% | 1% |
| *Artemisia dracunculus* | Tarragon | 2% | 1% | -1% |
| *Bouteloua barbata* | Six weeks grama | 2% | 19% | 17% |
| *Bouteloua gracilis* | Blue grama | 0% | 1% | 1% |
| *Elymus smithii* | Western wheatgrass | 54% | 20% | -34% |
| *Grindelia squarosa* | Gumweed | 35% | 4% | -31% |
| *Hordeum jubatum* | Foxtain barley | 19% | 0% | -19% |
| *Muhlenbergia repens* | Creeping muhly | 2% | 9% | 7% |
| *Poa pratensis* | Kentucky bluegrass | 5% | 24% | 19% |
| *Rumex crispus* | Dock | 5% | 1% | -4% |
| *Bare soil* | Bare soil | 7% | 18% | 11% |

Vegetation transect 5-1 had a decrease in many important species over the time of the study. This area had heavy grazing pressure and a herd of cattle at the site during the montoring session. The positive results seen are in the increase in cover of creeping muhly and Kentucky bluegrass. Both species prefer moderately wet soil and increase at sites that begin as upland species and then are irrigated by additional water.



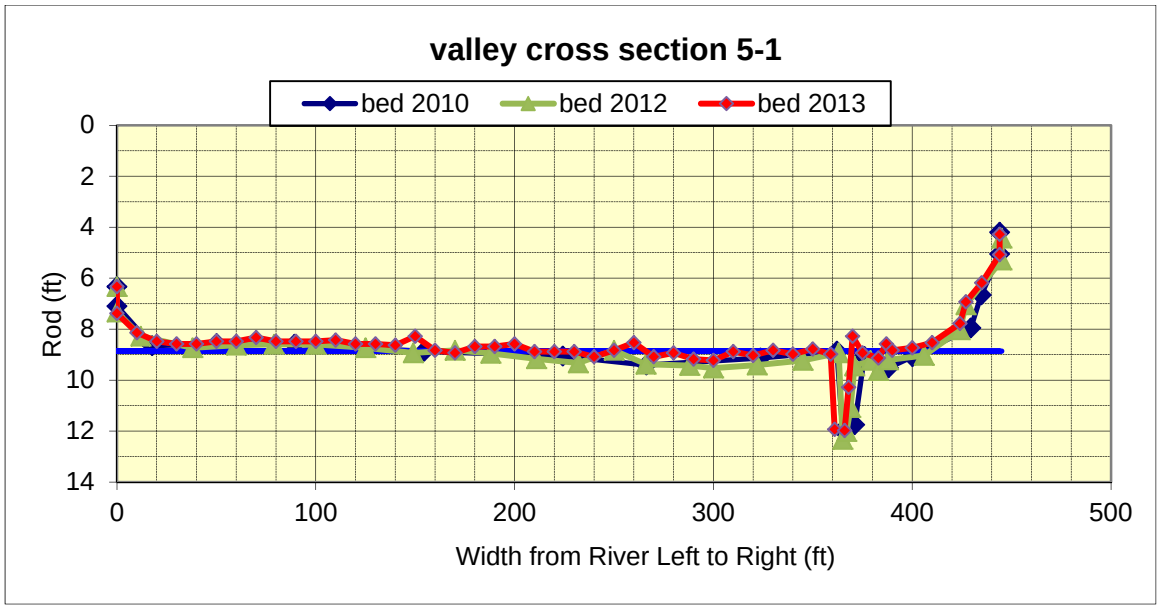

## Valley Cross Section 5-1

| Vegetation Species | Common Name | Percent of Cover 2010 | Percent of Cover 2013 | Percent Difference |
|---|---|---|---|---|
| *Amaranthus spp.* | Amaranth | 0% | 7% | 7% |
| *Artemisia dracunculus* | Tarragon | 12% | 0% | -12% |
| *Bouteloua barbata* | Six weeks grama | 0% | 7% | 7% |
| *Bouteloua gracilis* | Blue grama | 5% | 8% | 3% |
| *Rumex crispus* | Dock | 0% | 1% | 1% |
| *Elymus smithii* | Western wheatgrass | 39% | 30% | -9% |
| *Grindelia squarosa* | Gumweed | 45% | 4% | -41% |
| *Hordeum jubatum* | Foxtail barley | 0% | 0% | 0% |
| *Chrysothamnus nauseosus* | Rabbitbrush | 3% | 0% | -3% |
| *Muhlenbergia repens* | Creeping muhly | 16% | 22% | 5% |
| *Poa pratensis* | Kentucky bluegrass | 0% | 4% | 4% |
| *Gutierrezia sarothrae* | Snakeweed | 0% | 1% | 1% |
| Organic matter litter | Litter | 0% | 1% | 1% |
| Water | Water | 0% | 1% | 1% |
| Bare soil | Bare soil | 3% | 28% | 26% |




The results of valley transect 5-1 show a decrease in the cover of many species of plants, as well as an increase in bare soil. This may be due to heavy grazing pressure, as is seen in the rest of Cebolla Wetland. However, the slight increase in Kentucky bluegrass and creeping muhly may indicate an increase in the moisture at the site.

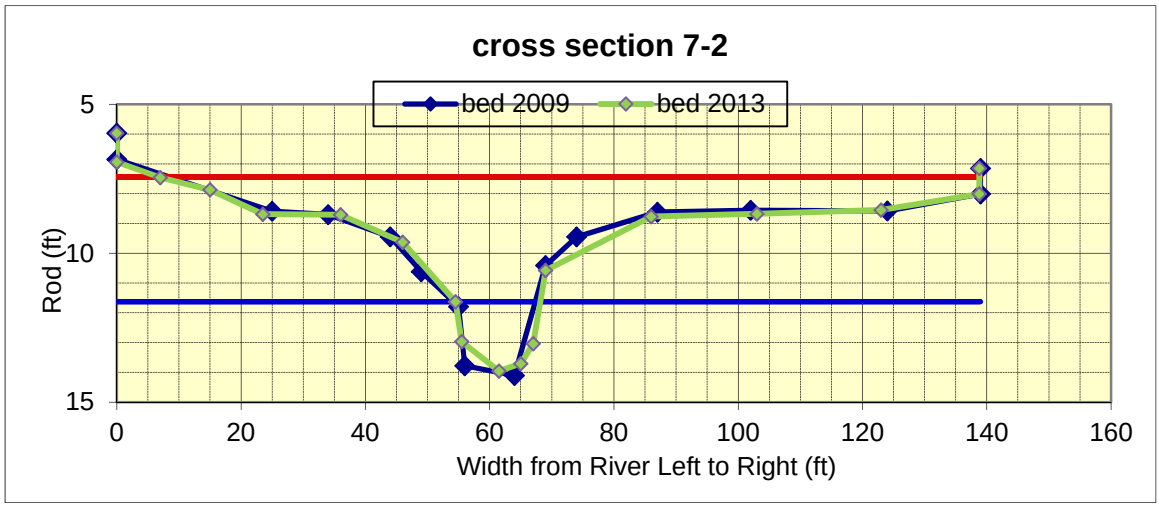
Geomorphology Monitoring in Reach 5-6



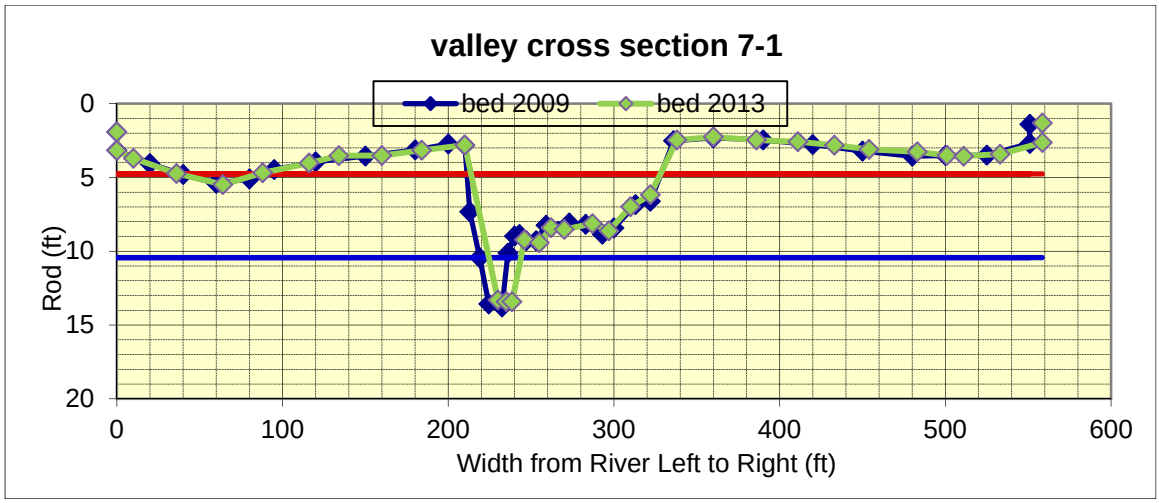

Little changes were seen in valley cross section 5-1 between 2010 and 2013. Small "humps" in the profile are piles of litter (pine needles) from flooding in September 2013.

## Cebolla Reach 7 Monitoring

A longitudinal profile was taken through the entire reach 7 in late fall 2009. This profile was not repeated, as very few treatments were constructed in Reach 7. Two channel cross sections and one valley cross section were taken. Channel cross section 7-2 and valley cross section 7-1 were re-surveyed in 2013.

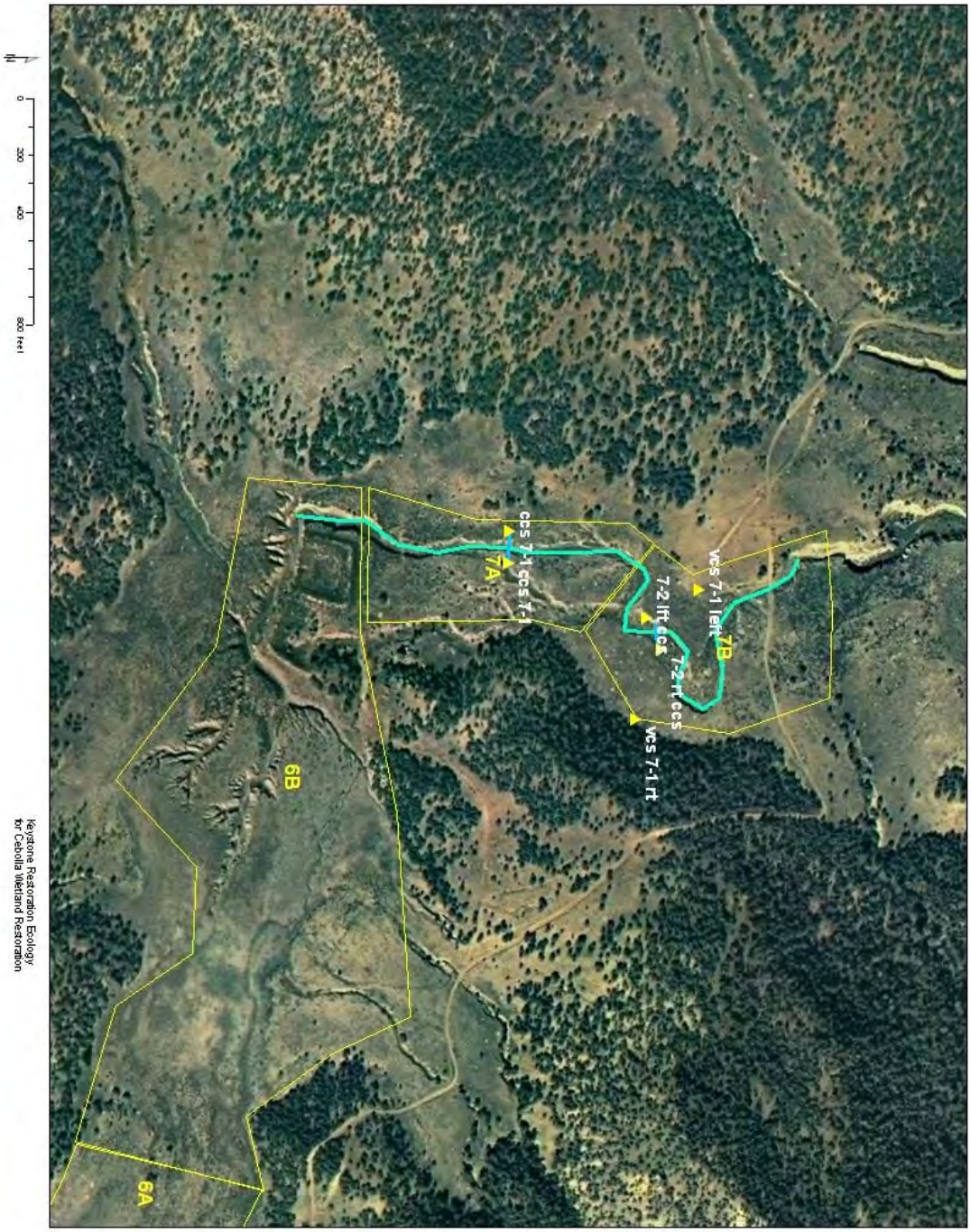



Very little changes were observed over the four years, indicating that this is a stable channel shape.




There appears to be some movement of the channel to the right over the four years, this could be an artifact of the survey itself. No treatments were constructed nearby.

Cebolla Wetland Restoration Geomorphology Reach 7




Keystone Restoration Ecology
for Cebolla Wetland Restoration

## Monitoring at Cebolla Wetland, Final Results and Recommendations

## Geomorphology

The geomorphology of Reach 0 saw some of the largest changes, as could be expected from a project of over 20,000 foot length. Sediment from Cebolla Creek upstream will fill Reach 0 first, and then move downstream through Reaches 2, 4 5, and 6.

### Reach 0, Channel re-location and longitudinal profile 0-2

Due to the enormous floods in September 2013 that saw flooding throughout the Front Range of Colorado, a huge plume of sand came downstream and filled in the channel of Cebolla Creek for thousands of feet. This historic channel is wide and shallow, and now has about 3 feet of sand deposition in it. A healthy meander pattern is developing in this sand, and any headcutting or erosion in this channel is now buried and "fixed".

This deposition of sand washed out two exclosures, at the top and bottom of the Lake Cebolla. These should be repaired (planned for January 2014), and planted with both western wheatgrass seed (cheap and effectively scratched into the sand). Bulrush planting has proven to be successful as well, but it is difficult and stinky work. It is also possible that coyote willows could thrive in this habitat of deep sand over wet clay.

Buried exclosure fence at top of Lake Cebolla in 3 feet of sand, this channel is now only 4 feet from the former wide wetland surface of the valley and may proceed to fill in with no additional treatment, creating 10-20 acres of additional wetland area.

**Downstream end of Lake Cebolla**

The large plug of sediment that created a shallow, 1500 foot long pond that was named "Lake Cebolla", is head-cutting through the bulrush plantings. This appears to be an artifact of the enormous September 2013 flooding. Extremely large events can cause erosion in a channel that can easily carry floods from year to year. Lake Cebolla itself has filled with sand, and remains wetland due to the saturation of the clays below the sands. The exlcosure fence around the bulrush also needs repair; both "break-away" fences at the water gaps broke, as they were designed to.

Bottom of Lake Cebolla in 2013, note channel filled in with wet sand upstream, headcut in picture should be repaired with rock, smaller flood events may fill this in with sand with no treatment. Break-away exclosure fence in middle of picture.

**Plug and Pond in Tributaries of Reach 0**

A NACWA grant has been applied for by the RPA for building plug and pond structures in Reach 0's tributaries and upstream. Some issues were noted that may have an effect on these projects.

1. The main channel of Cebolla Creek should not be plugged for some time, this sediment source is too valuable in Reaches 2-6. In addition, the area around Lake Cebolla is experiencing large, positive changes due to this sediment.
2. Reach 0-SE has a large watershed and flooded much more than Reaches 0-N or 0-SE. There is also evidence of large willows in one of its two tributaries upstream, and this area may be a wetland.
3. Reach 0-E was designed to fill a cattle tank with water, due to the large floods in Sep 2013, it has filled in ½ with sediment, and may need to be dug out by the permittee. In addition, the plug and pond was constructed at the upstream end of the gully (first chance) rather than the lower end (last chance to plug). This has allowed the sediment to fan out, and cause the water from this trib to flow back into the gully. Another small plug could be built in ½ day with a tracked loader to repair this problem.
4. The issue noted in Reach 0-E indicates that plug and ponds should be built from the bottom up, with the lower portion of a gully plugged first, the gully filled with sand, then another plug built at the upstream end of the sediment. The surprising results in this tributary were just how much sediment there was, it filled in the "pond" in one flood, filled in the cattle tank, and caused some of the water to divert back into the gully.

**Reach 2 geomorphology**

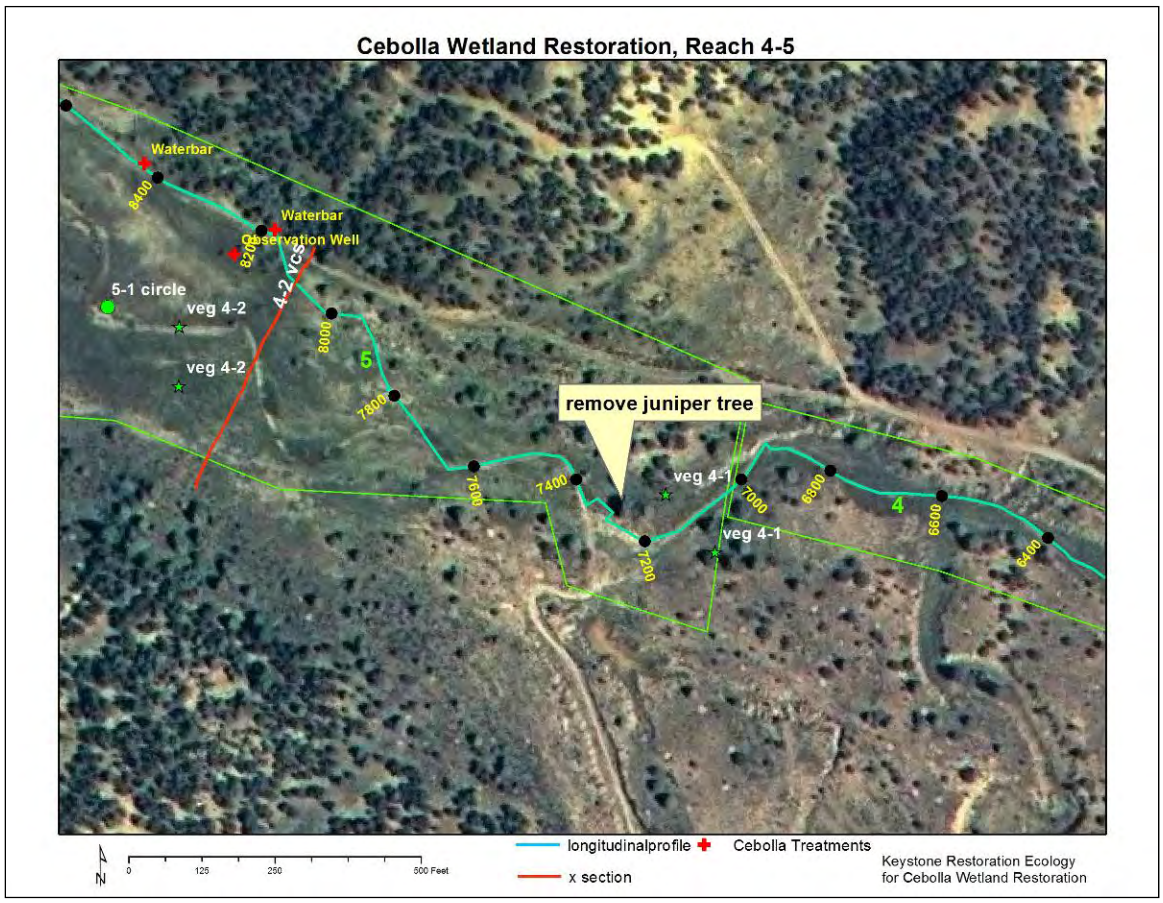
The large flood events in September 2013 caused damage to both the pasture fence at the beginning of Reach 2 and the exclosure fence around the Big Cebolla Wetland. Each fence needs almost complete rebuilding. The sediment plume from this plug moved about 1000 feet into Reach 2, and should move downstream through Reach 2 in one or two years, depending upon precipitation and flood events. Reach 2 has a large number of large one rock dams that should fill in and become sheet flow rather than a narrow, meandering channel.

Reach 2 one rock dams should be plugged with clay and packed tight to raise the water table six inches to a foot and spread it across the floodplain.

## Reach 4 geomorphology

As this sediment moves into Reach 4, it will fill in behind the sediment plug at Savage Canyon (seen on longitudinal profile). This should change all of Reach 4 into a wetland area as it fills in the channel and water from Big Cebolla Spring saturates this area.

One particular area in Reach 4/5 is channelizing the flow from Cebolla Creek and preventing deposition of sediment from Savage Canyon. There is a large Rocky Mountain Juniper tree that is nearly dead from flooding, but continues to shade out the wetland vegetation that would plug the channel. Removal of this tree should cause large changes both upstream and downstream and eliminate the channel entirely in this area.



## Monitoring at Cebolla Wetland, Final Results and Recommendations

## Vegetation Monitoring

Wetland Delineation
The wetland areas at Cebolla Canyon increased over the timeline of the two grant-funded projects. About 4 acres of wetland were gained, in addition, the areas of wetland extended downstream into Reaches 4 and 5, for almost another 1000 feet downstream.

The potential for more expansion is huge, especially around Lake Cebolla. This area was formerly a sheet-flow valley and has filled rapidly from below, near the Big Cebolla Spring. It is possible that a geomorphic threshold has been crossed, and more aggradation will continue to fill the channel and spread water across the valley, however, only time will tell.

Rabbitbrush Mortality Experiment
This experiment proved our hypothesis that the areas of Cebolla Creek with rabbitbrush cover would decrease over time as the valley becomes flooded and saturated. These areas may become wetland over a longer time frame, it is possible that the first noticeable change is the mortality of adult and juvenile rabbitbrush.

Vegetation transects in Reaches 0-6
There were poor results for most of the vegetation transects. The only area that showed an increase in wetland plants were the transects in Reach 1, Big Cebolla Wetland. The other sites, from Reach 0, Reach 2, Reach 4, and Reaches 5-6 all experienced poor to middling results.

The year 2013 had an especially dry winter and early spring, with good rainfall in late summer and early fall. September 2013 had damaging floods across New Mexico and Colorado, and there was a large amount of rainfall and flooding in Cebolla Creek as well. This pattern of rainfall may have some role in the reduction in cover for many species, especially forbs such as Rocky Mountain beeplant (*Cleome serrulata*), which can be dominant on freshly deposited sandy soils, but needs springtime moisture to germinate. The vast fields that were seen in Reaches 0 and 2 in 2010, 2011 and 2012 were missing in 2013, either spring or fall.

Grazing
The year 2013 appeared to have a large amount of grazing pressure. While there has been some presence of cattle during almost every year in Cebolla Canyon, this year there were about 50 cattle in Reach 5 and 6 that also grazed in the wetland areas in Reaches 0, 2 and 4. The intensity of grazing pressure was noticeable in the cover of Baltic Rush, which had never before (from 2010 to 2012) been grazed "to the nub". While other, more palatable plant species had been grazed down, Baltic Rush had remained ungrazed until 2013.

Plant Interactions with Geomorphology

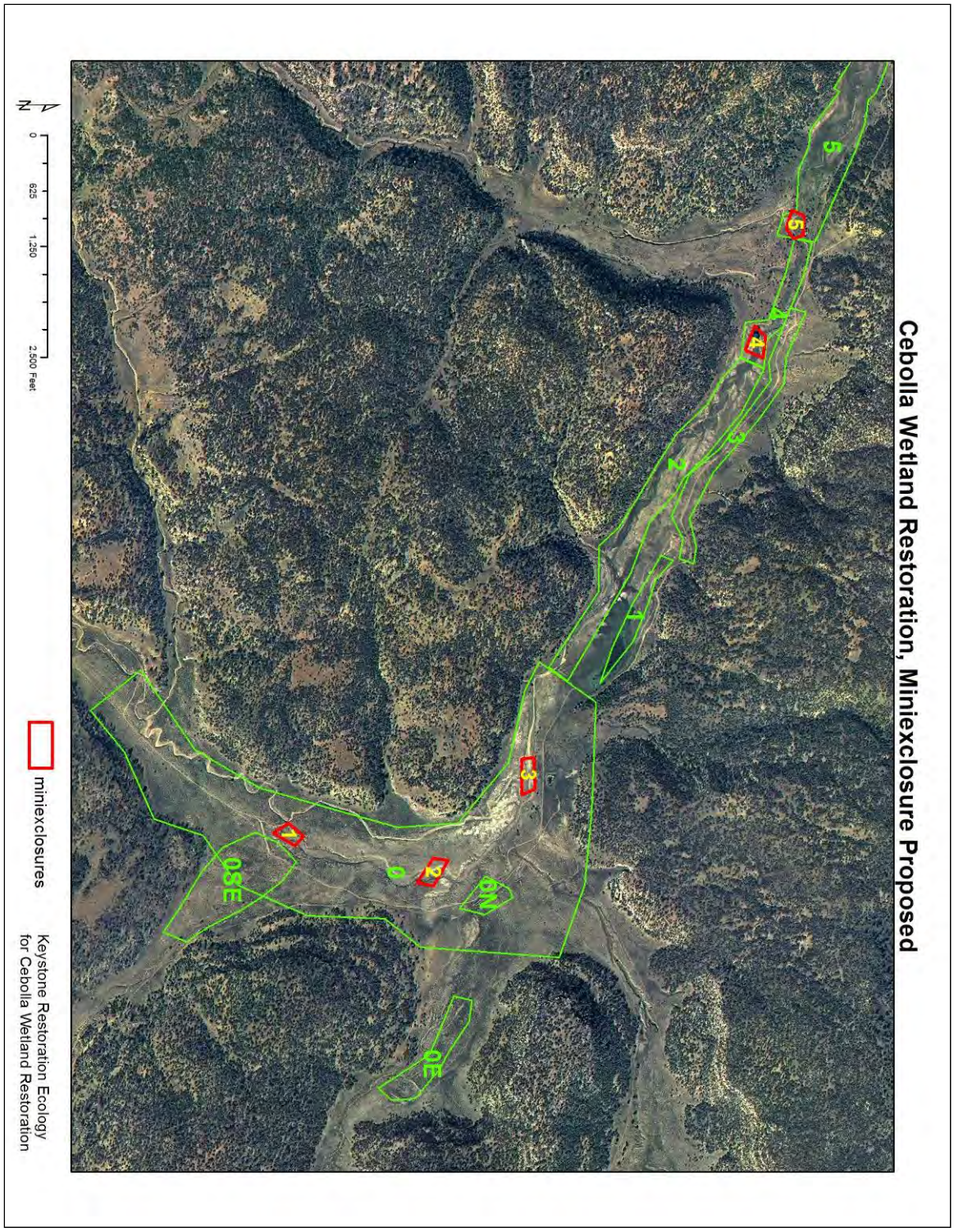
The growth of grass-like plants plays and important role in form and health of wetlands. The expansion of wetland areas at Cebolla Creek are very much dependent on the capture of sediment from Cebolla Crek, which spreads floodwaters, soaks them into the ground, and raises the water table. The channel of Cebolla Creek has almost been eliminated for 1500 feet, between Reach 0 and 2. This creates the potential for wetlands in this area.

Grass-like plants that grow from runners such as western wheatgrass, Baltic rush, common spikerush, Kentucky bluegrass, and chairmaker's bulrush have the ability to capture wet sediment that has been freshly deposited and hold it in place. The wetland plants above can actually growth through even several feet of sediment and hold it in place before the next flood event washes it away. This function of wetland plants is the major reason that wetlands are expanding at Cebolla Canyon.

Heavy, year-long grazing by cattle has the effect of removing these species and preventing their spread. Western wheatgrass, Baltic rush, and nutsedge are the early-successional invaders of wet, freshly deposited sediment. They are also preferred grazing species for cattle.

Three suggestions for managing the effects of grazing at Cebolla Crek

1. A grazing plan for the permittees that excludes cattle from the important areas in Reaches 0, 2, and 4 during the spring. This will allow these cool-season species to green-up and spread. Less grazing in the late-summer and fall would let them go to seed, which is important for western wheatgrass and nutsedge especially.
2. Repair the fences around Cebolla Spring that have been damaged by flooding, cut by members of the public or buried by sediment from Cebolla Creek. This protects the "core" of the wetland and provides seeds and pieces of rhizomes for colonization downstream.
3. Continue to focus on "trigger point" areas that store sediment and water with small exclosures to allow for the growth of vegetation that can capture sediment and fill the channel of Cebolla Creek. Two exclosures were damaged in the September 2013 floods and are planned to be repaired in January 2014 by the BLM.
    1. Mini exclosure around Filter dam and berm breach in Reach 0. This will create wetland area due to the storage of water and sediment. Healthy, un-grazed vegetation will accelerate this process.
    2. Mini exclosure at top of Lake Cebolla, needs repair.
    3. Mini exclosure at bottom of Lake Cebolla, needs repair.
    4. Mini exclosure at large one rock dam between Reaches 2 and 4, this trigger point will fill the valley upstream if allowed to fill in with sediment
    5. Mini exclosure at boundary of Reaches 4 and 5, will grow wetland vegetation and capture more sediment.


Cebolla Wetland Restoration, Miniexclosure Proposed
5
6
4
3
2
1
8
2
0
0N
0E
7
0SE
N
0
625
1,250
2,500 Feet
miniexclosures
Keystone Restoration Ecology
for Cebolla Wetland Restoration

**Species List for Cebolla Wetland**

| | | |
|---|---|---|
| *Achillea millefolium* | ACMI | yarrow |
| *Achnatherum hymenoides* | ACHY | indian ricegrass |
| *Achnatherum robustum* | ACRO | sleepygrass |
| *Artemisia dracunculus* | ARDR | tarragon |
| *Artemisia frigida* | ARFR | sagewort |
| *Atriplex canescens* | ATCA | fourwing saltbush |
| *Bouteloua barbata* | BOBA | 6-weeks grama |
| *Bouteloua gracilis* | BOGR | Blue grama |
| *Bromus tectorum* | BRTE | cheatgrass |
| *Carex praegracilis* | CAPR | Field sedge |
| *Chrysothamnus nauseosus* | CHNA | rabbitbrush |
| *Cleome serrulata* | CLSE | beeplant |
| *Conyza canadensis* | COCA | horseweed |
| *Descurainia pinnata* | DEPI | Western tansy-mustard |
| *Eleocharis palustris* | ELPA | spikerush |
| *Eleocharis quinqueflora* | ELQU | Few-flowered spikerush |
| *Elymus smithii* | ELSM | western wheatgrass |
| *Epilobium ciliatum* | EPCI | Epilobium |
| *Erigeron divergens* | ERDI | margarita |
| *Euphorbia sp.* | EUSP | Euphorbia species(spurge) |
| *Euphorbia spathulata* | EUSP | warty spurge |
| *Festuca arundinacea* | FEAR | tall fescue |
| *Grindelia squarosa* | GRSQ | gumweed |
| *Gutierrezia sarothrae* | GUSA | Snakeweed |
| *Hackelia hirsuta* | HAHI | stickseed |
| *Hordeum jubatum* | HOJA | Foxtail barley |
| *Juncus balticus* | JUBA | Baltic rush |
| *Juncus torreyi* | JUTO | Torrey's rush |
| *Kochia scoparia* | KOSC | Kochia |
| *Lycopus asper* | LYAS | bugleweed |
| *Lycurus phleoides* | LYPH | wolf tail |
| *Melilotus officinalis* | MEOF | yellow sweet clover |
| *Muhlenbergia asperifolia* | MUAS | scratchgrass |
| *Muhlenbergia montana* | MUMO | mountain muhly |
| *Muhlenbergia repens* | MURE | Creeping Muhly |

| | | |
|---|---|---|
| *Opuntia sp.* | OPSP | prickly pear |
| *Plantago patagonica* | PLPA | wooly plantain |
| *Poa pratensis* | POPR | Kentucky bluegrass |
| *Polygonum puncatatum* | POPU | smartweed |
| *Portulaca oleracea* | POOL | Purslane |
| *Prunella vulgaris* | PRVU | “self-heal mint” |
| *Puccinellia airoides* | PUAI | Nuttall’s alkali grass |
| *Ranunculus sceleratus* | RASC | Cursed butter-cup |
| *Ratibida tagetes* | RATA | Mexican hat |
| *Rumex crispus* | RUCR | Dock |
| *Salsola kali* | SAKA | Russian thistle |
| *Schoenoplectus tabernaemontani* | SCTA | bullrush |
| *Sporobolis aeroides* | SPAI | Alkali sacaton |
| *Sporobolus contractus* | SPCO | Spike dropseed |
| *Taraxacum officinale* | TAOF | dandelion |
| *Thelesperma subnudum* | THSU | cota |
| *Thermopsis Montana* | THMO | goldenpea |
| *Tragopogon dubius* | TRDU | salsify |
| *Typha latifolia* | TYLA | cattail |
| *Unknown* | | parsley |
| *Vicia americana* | VIAM | American vetch |
| *Vulpia octoflora* | VUOC | fescue |
| | | |

**Species missing from Cebolla Wetland, Cebollita Spring Visit**

One particular interest of this project is to identify which plant or animal species are missing due to the erosion and manipulation of the Cebolla Spring. A visit was taken with Steve Fischer of the BLM to Cebollita Spring, which is about 12 miles north on BLM and Acoma Pueblo land. Cebollita Spring was much larger, with a stronger flow of many cubic feet per second. This flow spilled down a mountainside for thousands of feet, a much different situation than Cebolla Spring, which is in a flat valley.

One notable Carex species was Carex pellita, wooly sedge. This species is mesic, and occupies the habitat taken up by Kentucky bluegrass on the edge of Cebolla Spring. Large areas of Carex pellita make up acres at Cebollita.

In terms of shrub species, there were a large number of barberry (Berberis fendleri), a clonal species that creates clumps of many square yards. This species was growing together with wild rose (Rosa woodsii) on the edge of the Cebollita Spring.

Transplanting these two species may have large ecological effects. Wooly sedge should colonize a large area of habitat that is now being colonized slowly by Kentucky blugrass, Western Wheat, and other mesic species. Planting this species near the Cebolla Spring will allow it to be spread downstream by flooding.

The barberry should be introduced into alluvial fans, where it will capture sediment and cause the fan to aggrade. This landform/vegetation combination has been seen before in Cuba, NM, on sandstone derived soils like Cebolla Canyon.

Vigorous Sedges:
There were no vigorous sedges at either Cebolla, Little Cebolla, or Cebollita Spring. A species such as Carex nebraskensis or Carex aquatilis would be able to colonize deeper water habitats now occupied by bulrush or cattails and provide forage and another habitat component.

Wooly Sedge (Carex pellita)

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