Pueblo of Acoma Rinconada Creek 17-16

Pre-treatment Monitoring Report

2017

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Contents

Acronyms and Abbreviations

Acronym, Abbreviation, or Term	Explanation or Definition as used by NMFWRI
BEMP plots	Bosque Ecosystem Monitoring Program, small rectangular plot types
GIS	Geographic Information Systems
GRGWA	Greater Rio Grande Watershed Alliance
LIDAR	Light detecting and ranging, a remote sensing technique using light to gather elevation data
NMFWRI	New Mexico Forest and Watershed Restoration Institute
NMRAM	New Mexico Rapid Assessment Method, version 2.0
NRCS	Natural Resource Conservation Service
PC	Plot center
SWCD	Soil and Water Conservation District
USDA	United States Department of Agriculture

Purpose of Report

This report covers the low-intensity and high-intensity pre-treatment vegetation monitoring assessments performed on a non-native phreatophyte removal project submitted for the Pueblo of Acoma Rinconada Creek to the Greater Rio Grande Watershed Alliance in 2017. Following a discussion of the ecological context, and our monitoring methods, we present pertinent background, observations, and assessment results for the project.

Ecological Context of Bosque Restoration

Neither the challenges nor the importance of working in the bosque and other riparian areas in New Mexico today should be underestimated. According to the New Mexico Department of Game and Fish Conservation Division, wetlands and riparian areas comprise approximately 0.6 percent of all land in New Mexico (2012). Despite this small percentage, estimates of New Mexican vertebrate species depending on wetland and riparian habitat for their survival ranges from 55% (New Mexico Department of Game and Fish Conservation Services Division, 2012) to 80% (Audubon New Mexico, 2013). These areas also provide flood mitigation, filtration of sediment and pollutants, and water for a variety of purposes including groundwater recharge (Audubon New Mexico, 2013). In addition, native vegetation such as cottonwoods have cultural significance to many communities.

As much as these areas are disproportionately important to ecosystems and human communities, they are equally disproportionately impacted by disturbance. Anthropogenic impacts with major consequences for our riparian areas include dams, reservoirs, levees, channelization, acequias and ditches, jetty jacks, riprap and Gabion baskets, urbanization, removal of native phreatophytes, grazing by domestic livestock, excessive grazing pressure by native ungulate populations absent natural predation cycles, beaver removal, logging, mining, recreation, transportation, introduction and spread of invasive exotic species, groundwater extraction, altered fire and flood regimes drought and climate change (Committee on Riparian Zone Functioning and Strategies for Management, et al., 2002). Statewide, it is estimated that as much as 90% of New Mexico's historical riparian areas have been lost (Audubon New Mexico, 2013), and approximately 39% of our remaining perennial stream miles are impaired (New Mexico Department of Game and Fish Conservation Services Division, 2012).

New Mexico *is* fortunate enough to have the Middle Rio Grande Bosque, the largest remaining bosque in the Southwest (USDA USFS, 1996). However, over the past two decades, the number of fires in the bosque has been increasing. Historically, the primary disturbance regime in the bosque has been flooding, not fire, which means the system is not fire-adapted. In fact, native species like cottonwood resprout from their roots after floods and need wet soils to germinate from seed. Flooding also promotes decomposition of organic material and keeps the soil moist which reduces the likelihood of fire. Today, overbank flow is uncommon in many areas of the Rio Grande due to the heavy alteration of the channel and flow regimes (two obvious examples are the structures defining the upper and lower extent of the Middle Rio Grande: Cochiti Dam and Elephant Butte Reservoir). This has led to low fuel moisture content and high fuel loads, as well as increased human presence in the riparian area. As a result, bosque fires are more common and more severe: they kill cottonwoods and other native species, creating spaces which are filled by non-native species such as salt cedar, Russian olive, Siberian elm, and Tree-of-Heaven. We are constantly learning more about how these species can exploit and encourage a riparian fire regime, in addition to many other changes they bring to ecosystems.

Efforts geared toward the removal of these nonnative species can help to reduce fire risk, preserve native vegetation, and be part of a larger effort to restore the bosque and the watershed as a whole to a more natural and functional ecosystem. The Greater Rio Grande Watershed Alliance (GRGWA) has been working on these issues with a variety of collaborating organizations and agencies within the Rio Grande basin for several years. Since 2013, the New Mexico Forest and Watershed Restoration Institute (NMFWRI) has been working with GRGWA and the Claunch-Pinto Soil and Water Conservation District (SWCD) to begin construction of a geodatabase for all of GRGWA's non-native phreatophyte removal projects as well as to perform the formal pre- and post-treatment monitoring, utilizing the field methods explained below as well as LIDAR analysis where appropriate and available.

Monitoring and Field Methods

Low intensity Field Methods

Low intensity pre-treatment vegetation monitoring was done using an adapted version of the biotic portion of the New Mexico Rapid Assessment Method (NMRAM), v 2.1, updating recommendations made in the Field Manual for Greater Rio Grande Watershed Alliance (GRGWA) Riparian Restoration Effectiveness Monitoring and the GRGWA Monitoring Plan, developed by Lightfoot & Stropki of SWCA Environmental Consultants in 2012. (For a brief overview of both low and high intensity monitoring methods used by the NMFWRI on GRGWA projects, please see Appendix III.)

For those not familiar, NMRAM was developed by the New Mexico Environment Department Surface Water Quality Bureau Wetlands Program and Natural Heritage New Mexico as a "cost effective, yet consistent and meaningful tool" (Muldavin, 2011) for wetland ecological condition assessment in terms of anthropogenic disturbance as negatively correlated with quality and functionality. The portions of NMRAM we utilized are Level 2 "semi-quantitative" field measurements taken at less detail than plot level (Muldavin, 2011).

Measurements taken included relative native plant community composition, vegetation horizontal patch structure, vegetation vertical structure, native riparian tree regeneration, and invasive exotic plant species cover. The underlying method for these biotic assessments was a version of the 1984 Hink and Ohmart vertical structure classification system, modified for use in the NMRAM for Montane Riverine Wetlands version 2.0 (see Appendix IV). First, vegetation communities were mapped out by patch (polyon) according to the Hink and Ohmart system. Next, the presence of (state-listed) invasives, wetland species, and the two dominant species in each strata ("tree" >15 ft, "shrub" 4.5-15 ft, and "herbaceous" <4.5 ft) were recorded for each plant community. The native/exotic ratio in each of the patches was scored and weighted based on the percent of the project area each patch comprised. These scores were then combined with the additional biotic metrics of vertical and horizontal diversity, native tree regeneration, and overall (listed) invasive presence. The NMRAM rating system is based, on all levels, on a scale of 1 to 4, where 4 is considered excellent condition, 3 good, 2 fair, and 1 poor.

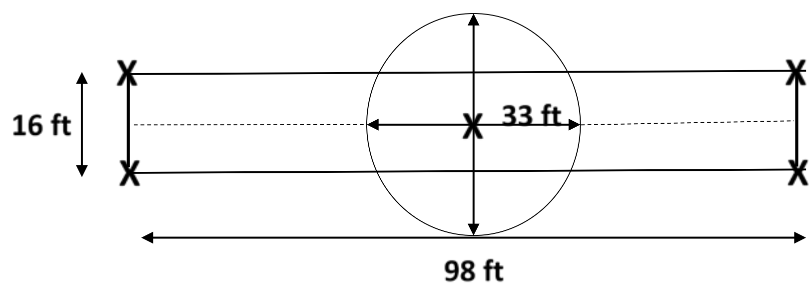
We also assessed soil surface condition, which is a metric typically included in the abiotic section of the NMRAM, as well as the presence of surface fuels, which is not part of the NMRAM. Unlike the other 6 metrics we used, surface fuels were recorded on a rating scale from 0 to 1.0 where 1.0 is a continuous fuel matrix.

Photopoints were established to capture images where vegetation shifts were observed and/or at representative locations throughout the site. Waypoints were marked with a Garmin GPS unit and named sequentially by site. Photos were taken facing north, east, south and west at each point. Information about the photopoints was collected according to the methods laid out in David Lightfoot's Forest Thinning Project Repeat Photo Points for Restoration Effectiveness Monitoring (David Lightfoot, 2014). Photopoints are shared with the permission of Shirley Piqosa Pueblo of Acomoma Forester, Department of Natural Resources.

Prior to entering the field, we created a map with the project boundaries as provided by GRGWA. We combined these polygons with recent aerial imagery and identified relevant roads and other landscape features. Once on the ground, the vegetation community polygons (as determined by the modified Hink and Ohmart classification system) were hand-drawn onto this map and served as the basis for other biotic metric assessments. Upon return to the office, this polygon map and the photopoints were digitized by the monitoring technician and/or specialist.

High-intensity Field Methods

High-intensity monitoring was also done, in part, on this site. We used an adapted Bosque Ecosystem Monitoring Program (BEMP) style plot. These are 16 x 98-foot rectangles, placed approximately parallel to the river. Within these plots, we measure canopy and species, and vegetation and ground cover. We also used Brown's transects to measure surface fuels.



Personnel Involved

2016 New Mexico Forest and Watershed Restoration Institute Monitoring Team:

- Kathryn R Mahan, Ecological Monitoring Specialist
- Ernesto Sandoval, Ecological Monitoring Technician
- Daniel Hernandez, Ecological Monitoring Technician

2016 New Mexico Forest and Watershed Restoration Institute GIS Team:

- Daniel Hernandez, Ecological Monitoring Technician

Other persons contacted:

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- Marcos Valdez, East Rio Arriba Soil and Watershed Conservation District

- Schirley Piqosa, Pueblo of Acoma Department of Natural Resources
- Ray Vicente, Pueblo of Acoma Department of Natural Resources

Pueblo of Acoma Rinconada Creek Project

Project 17-16 is approximately 2 miles east of the McCarys community on the Pueblo of Acoma. The lower portion of Rinconada Creek, is just north of Fatima Hill Road, which runs along with a raised bed of the BNSF Railroad tracks. Within the proposed site it includes a thin stretch of salt cedar between Fatima Hill Road and the raised grade of the BNSF Railroad track, which extends approximately one mile east from the intersection of Rinconada Creek and Fatima Hill Road. The Rinconada Creek flows runs south off the flank of Mt. Taylor, located just east of Horace Mesa, between Lobo Canyon to the west and Water Canyon to the east. There are two landowners and the site is divided in two sections. Section 25, is located south of interstate 40, and is part of the Pueblo of Acoma lands. Section 24, is up stream of section 25, and is a private section, located under and north of interstate 40. Access to section 25 is from Fatima Hill Road, which runs east-west along the southern boundary of the project. Section 24 can be accessed from State Road 124, which bisects the section.

Pre-treatment was conducted at the Pueblo of Acoma on the 172 Acre area, however the ten acre demonstration site treated last year by GRGWA is within the site, therefore the acreage currently proposed is about 162 acres. On October 18, 2017 crew members from NMFWRI collected data on the project that was proposed in 2017. The projects desired site condition is to restore its grasslands for grazing purposes, as they have the ability to irrigate as needed, and later be able to irrigate for agriculture. The Pueblo has deep strong roots for agricultural traditions. The Lava Soil and Water Conservation District (LSWCD) and the Pueblo of Acoma Department of Natural Resources sponsored the project. Treatment proposed was extraction and mastication, however mastication can be difficult because of burnt stems and cross fencing/ utilities. Conditions noted were salt cedar bettle kill/damage, area was burned and cattle on site. Native plant community found are Rio Grande cottonwood, chamisa and possibly wolfberry. Exotics are salt cedar, Russian olive and halogetan. Halogetan can take over site, priority suggests to pick up where the last treatment left off.

The average annual precipitation in the nearby city of Grants, NM is 10.5 inches. The average high temperature is 91° F in July and the average low is 15° F in December and January (U.S. Climate Data, 2017). According to the NRCS Web Soil Survey, the project area is comprised of 32.7% Glenberg-San Mateo complex, 0 to 2 percent slopes, 24.7% Sparham clay loam, 0 to 2 percent slopes, 10.0% Sparank-San Mateo complex, 0 to 5 percent slopes, 8.9% Mespun loamy sand, 1 to 5 percent slopes, 7.0% San Mateo clay loam, 1 to 3 percent slopes, 5.6% Sparank sandy clay loam, saline, sodic, 1 to 3 percent slopes, 4.3% Hagerman-Bond association, 1 to 10 percent slopes, 3.7% San Mateo sandy clay loam, 1 to 3 percent slopes and 3.2% Zia sandy loam, 1 to 5 percent slopes. Ecological sites within this project include R035XA118NM Bottomland, R035XA115NM Deep Sand, R035XA119NM Clayey Bottomland, R035XA112NM Loamy, R036XB009NM Salt Meadow, R035XA126NM Salt Flats, R035XA117AZ Sandy Loam Upland 10-14" p.z., R035XA118AZ Sandy Upland 10-14" p.z., R035XA113AZ Loamy Upland 10-14" p.z. (Provisional), R035XA112AZ Loamy Wash 10-14" p.z., R035XA104AZ Clay Loam Wash 10-14" p.z. (Provisional), R035XG121NM Shallow Sandstone and R035XA131NM Foothills (USDA NRCS, 2016).

Bottomland occurs most commonly in floodplain areas. It is typically a highly productive warm and cool-season grassland dominated by alkali sacaton and western wheatgrass; blue grama and galleta may be present. Rabbitbrush and saltbush occur as scattered shrubs. Loss of available soil moisture may result in a transition to a less-productive grassland, and extensive disturbance may lead to bare ground and/or a shrub-dominated state (USDA NRCS, n.d.).

The Deep Sand ecological site typically supports a grassland state dominated by Indian ricegrass, blue grama, dropseeds and threeawns, but also can be found in a shrub-dominated state dominated by sand sagebrush, or in a juniper-dominated state (USDA NRCS n.d.).

The Clayey Bottomland ecological site typically supports a grassland state dominated by western wheatgrass, blue grama, galleta, and alkali sacaton. Under stress, rabbitbrush, fourwing saltbush, galleta and other grasses may become dominate. In its most degraded state it may occur as mostly bare, with sparse annual vegetation (USDA NRCS n.d.).

The Loamy ecological site typically supports a grassland state dominated by blue grama, western wheatgrass, galleta, ring muhly, dropseeds, and/or threeawns. It can also be found in a piñon-juniper invaded state (dominated by piñon, juniper, and blue grama), a grass/succulent-mix state (dominated by blue grama, cholla and prickly pear), a shrub-dominated state (dominated by rabbitbrush or horsebrush and blue grama), as well as a bare state with sparse grass. (USDA NRCS n.d.).

The Salt Meadow ecological site typically supports a grassland state dominated by alkali sacaton and inland saltgrass; fourwing saltbush is the dominant shrub. In a deteriorated state, the site supports a plant community dominated by inland saltgrass, seepweed, iodinebush, salt cedar and bare ground. Other common grasses may include saltsedge, foxtail barley, mat muhly, western wheatgrass, nuttall alkaligrass and alkali cordgrass (USDA NRCS N.M. n.d.).

The Salt Flats ecological site type is typically dominated by alkali sacaton along with western wheatgrass, blue grama, vinemesquite grass, galleta, inland saltgrass, and spike muhly. Dominance of grass species is determined by salt; salty sites are dominated by alkali sacaton while areas with less salt tend to have more blue grama and galleta. Shrubs include fourwing saltbush, shadscale, and greasewood and are typically scattered when grass is dominant. However, a shrub-dominated state is possible with overgrazing and/or drought. A gullied state is also possible as a site deteriorates and changes in cover lead to changes in hydrology. The changes in hydrology in turn result in an increase of surface salts and downcutting. In this state, shrubs and salt-tolerant forbs are dominant while grasses are absent (USDA NRCS n.d.).

The Sandy Loam Upland ecological site type occurs in elevations from 4800 to 6300 feet on the Colorado Plateau. Common grass species include Stipa (needle) grasses, Indian ricegrass, blue grama, black grama, and galleta. Shrubs such as winterfat, fourwing saltbush and cliffrose may also be present. Trees are not a major component of this site (USDA NRCS).

The Sandy Upland ecological site type is commonly found on the Colorado Plateau. The plant community may vary but in its climax state is considered to be a native grassland with scattered shrubs (i.e. Indian ricegrass, needleandthread, black grama, fourwing saltbush, rabbitbrush and Mormon tea). Grazing pressure, drought, lack of fire and/or soil disturbance can transition the site toward one of several more shrub-dominated states, characterized by the dominance of sand sagebrush, Mormon tea, dune broom, frosted mint, rabbitbrush, and/or fourwing saltbush. Grasses present may include blue grama, needleandthread, sandhill muhly, sand dropseed, galleta, black grama and Indian ricegrass. With prolonged drought, unmanaged grazing, and frequent soil disturbance, the site may transition to a sand sagebrush state, dominated by sand sagebrush and other shrubs, perennial grasses, scattered forbs and infrequent juniper; bare ground may be 60-80% of the site. Disturbance may also create a juniper state where cover by juniper exceeds 10% and the site is otherwise dominated by mixed shrubs and few perennial grasses; nonnative annuals may be common (i.e. Russian thistle, cheatgrass). At its most degraded, an annuals state is also possible, where the site is dominated by both native and nonnative annual forbs, along with shrubs and annual grasses. Russian thistle is common on this site in this state (USDA NRCS, n.d.).

The Loamy Upland ecological site type supports a native perennial grassland in its climax state. This state is dominated by warm and cool season grasses such as blue, black and sideoats grama, squirreltail, Indian ricegrass, and galleta, as well as winterfat and fourwing saltbush shrubs. The relative dominance of the woody and herbaceous species in this state depends on factors such as grazing, droughts, and fire regimes. The site may degrade into a juniper-dominated state where juniper canopy is >10% and understory is either grasses or shrubs. Also possible is an invaded annuals state, where the community is dominated by annual grasses and forbs such as Russian thistle, cheatgrass, stickseed, globemallow, and nightshade among others (USDA NRCS, n.d.).

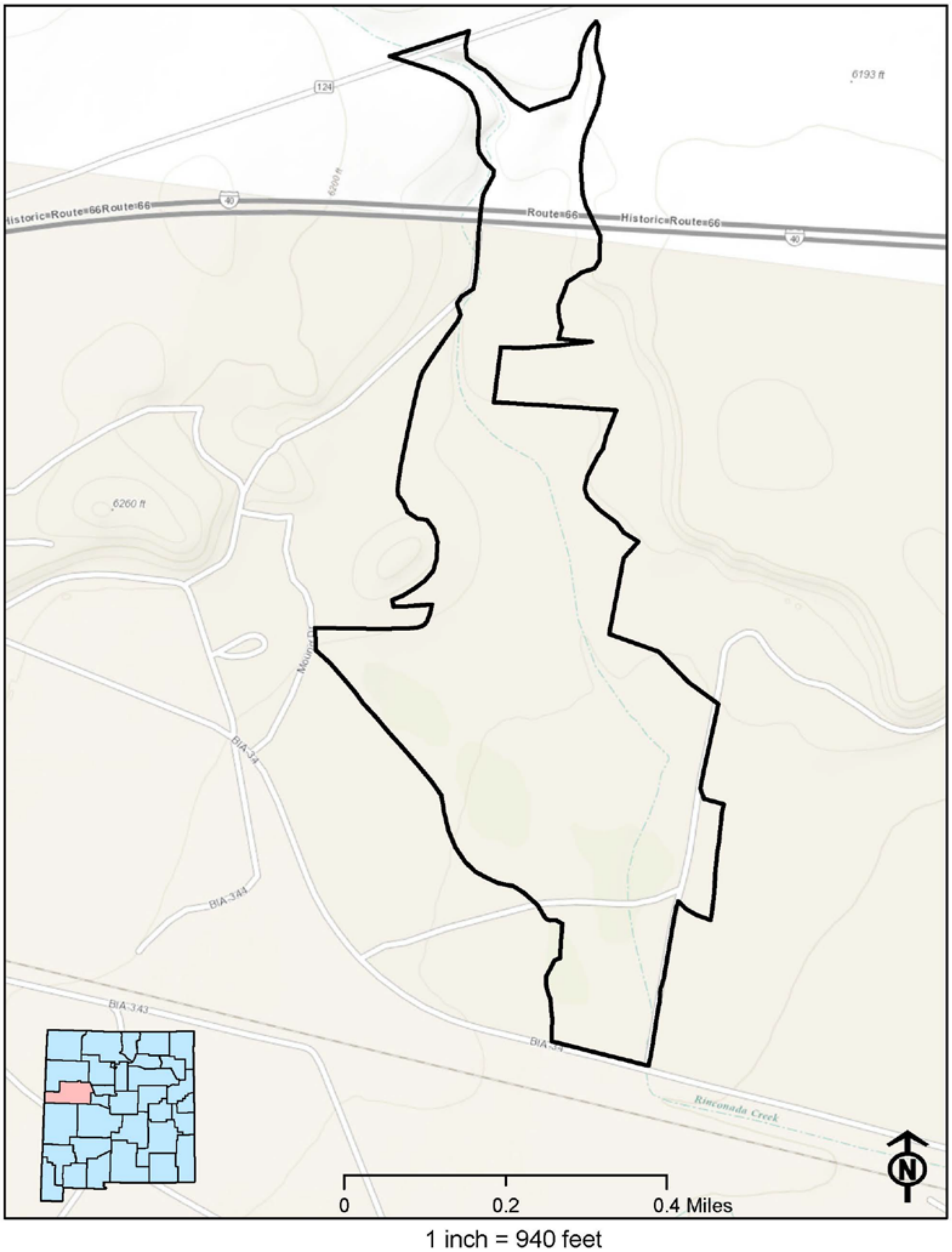
R035XA112AZ Loamy Wash 10-14” p.z. Data was not available for this ecological site time at the time of this report (2.21.18).

The Clay Loam Wash ecological site type is typically dominated by alkali sacaton, western wheatgrass, fourwing saltbush, and/or galleta. Ecological stresses such as heavy grazing, drought, lack of fire, or the establishment of nonnative annuals may lead to the dominance of rabbitbrush, blue grama, galleta, and alkali sacaton along with native and nonnative annuals. Continued stresses may lead to an eroded/invaded state where shrubs such as salt cedar, greasewood, rabbitbrush, and camelthorn dominate (USDA NRCS, n.d.).

The Shallow Sandstone ecological site type is dominated by grasses such as sideoats grama, blue grama, little bluestem, Indian ricegrass, New Mexico feathergrass, and galleta. Shrubs found in this site type include Bigelow sagebrush and fourwing saltbush. Other common shrubs include sand sagebrush, rubber rabbitbrush, winterfat, and mountain mahogany. In its reference condition, piñon and juniper are scattered across this site type, however, grasses are dominant with fairly uniform cover and few large bare areas present. Scattered shrubs and trees may comprise a canopy cover averaging 10%. Evidence of erosion such as pedestalling of grasses, rills and gullies is infrequent. Sideoats grama, little bluestem, many cool-season grasses, mountain mahogany, and winterfat typically decrease in response to overgrazing resulting in a blue-grama/galleta community or even a piñon-juniper dominated community when overgrazing is combined with fire suppression/lack of fine fuels and mild summers paired with wet winters which favor juniper establishment (USDA NRCS n.d.).

The Foothills ecological site type occurs in rolling to steep hills, slopes of high mesas and foot slopes of mountains. It typically supports sideoats grama, blue grama, galleta, shrubs and piñon-juniper. Fire suppression may result in a transition to a piñon-juniper dominated community with sparse grass and large, bare interspaces (USDA NRCS, n.d.).

17-16 Riconada Creek



Project 17-16 Rinconada Creek, is located in Cibola county aproximately two miles east of the MCCartys community on the Pueblo of Acoma. It constitutes the lower portion of Rinconada Creek, just north of Fatima Hill Road. The proposed area includes a thin stretch of salt cedar between Fatima Hill road and the raised grade of the BNSF Railroad track and extends for approximately one mile east from the intersection of Rinconada Creek and Fatima Hill Road.
A small portion of the project area, approximately two acres, crosses over I-40. The desired condition of the entire site is as a restored grassland for grazing, which can then be irrigated as needed.

Figure 1. Project 17-16 in geographic context.

17-16 Rinconada Creek

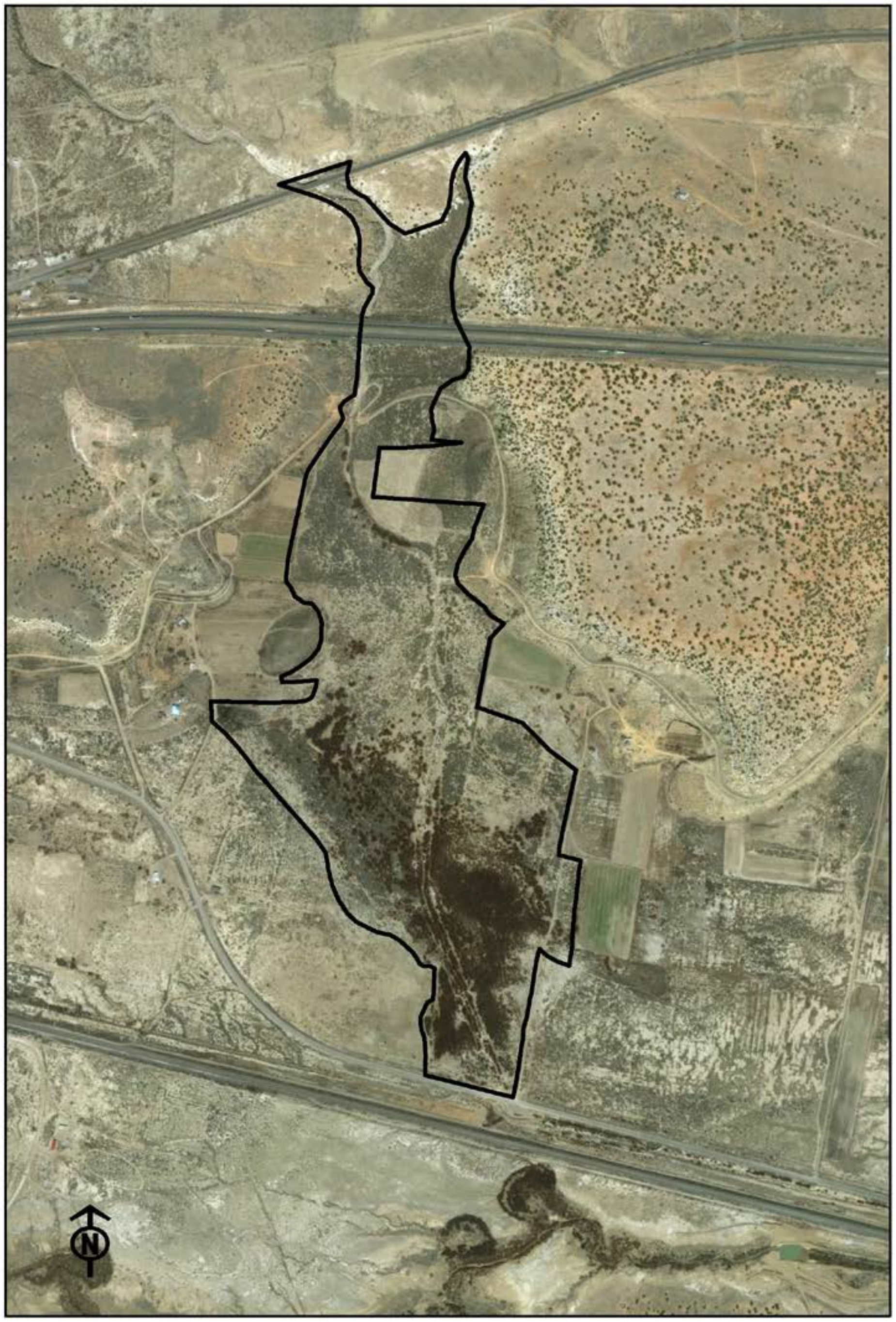


Figure 2. 17-16 Rinconada Creek project outline.

Table 1. NMRAM Scores for 17-16.

Metric 17-16, 18 Oct 17	**Score**
Relative Native Plant Community Composition	1
Vegetation Horizontal Patch Structure	4
Vegetation Vertical Structure	2
Native Riparian Tree Regeneration	3
Exotic Invasive Plant Species Cover	1
Project Biotic Score (based on above ratings)	2
Project Biotic Rating	C/ Fair
Soil Surface Condition	3
Surface Fuels	0.51-0.75

The lowest scores for this project came in the Relative Native Plant Community Composition and Exotic Invasive Plant Species Cover metrics, due to the high percentage of invasive plants. The surface fuel metric comes largely from the presence of litter and duff. The project scored best in the vegetation horizontal and vertical structure metrics, because there are several different plant communities distributed across the landscape and a dominance of overstory structure. Vegetation polygons are represented by structure type in the map, Figure 3. This site project scored a 2 out of 4 overall, which is a “C” or “Fair” biotic rating.

This site also had one plot established, at this plot, we collected data on vegetation cover and fuel loading using Submethods 1 and 2 outlined in Appendix III, the BEMP plots and the Brown’s transects.

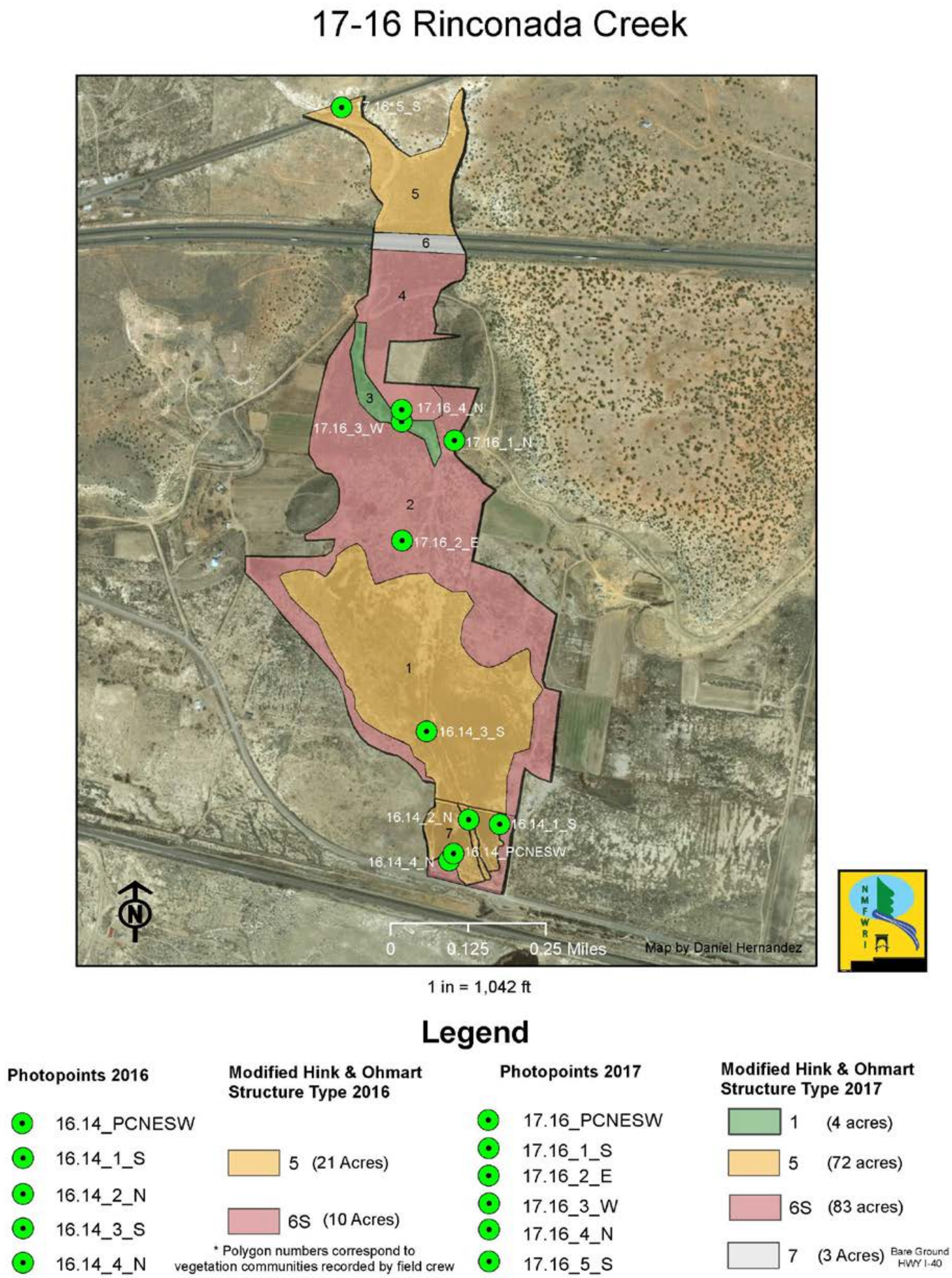


Figure 3. 17-16 Rinconada Creek project vegetation polygons

Table 2. 17-16 Average surface fuels from 2 transects on plot.

Fuel	Average tons/acre
1-hr	0.12
10-hr	0.92
100-hr	0
1000-hr	0
All woody fuels	1.03
Fuel	Avg depth (inches)
Duff	0
Litter	0
Total	0

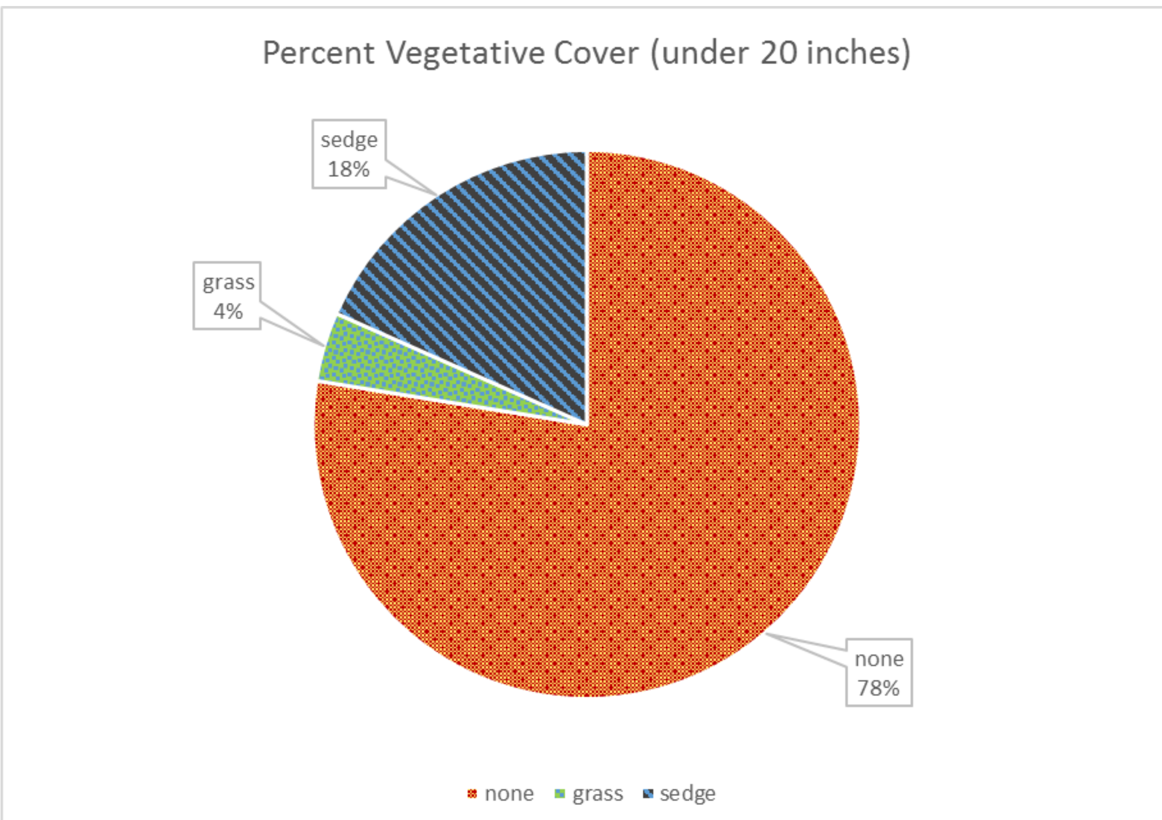


Figure 4. Percent Vegetative Cover for plot on 17-16.

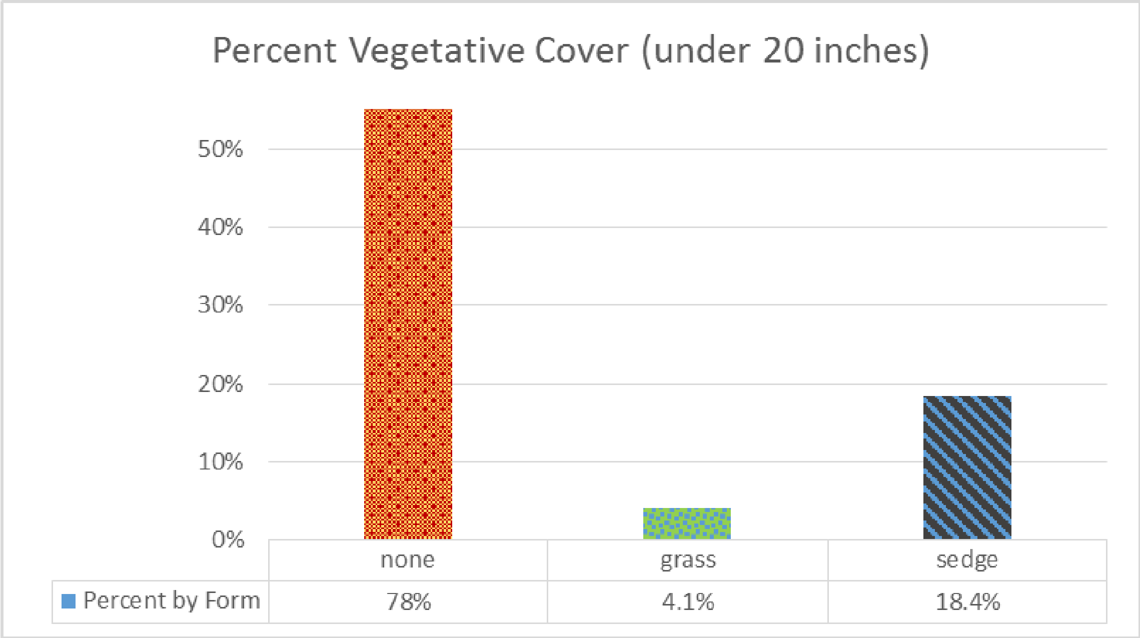


Figure 5. Percent Vegetative Cover for plot on 17-16.

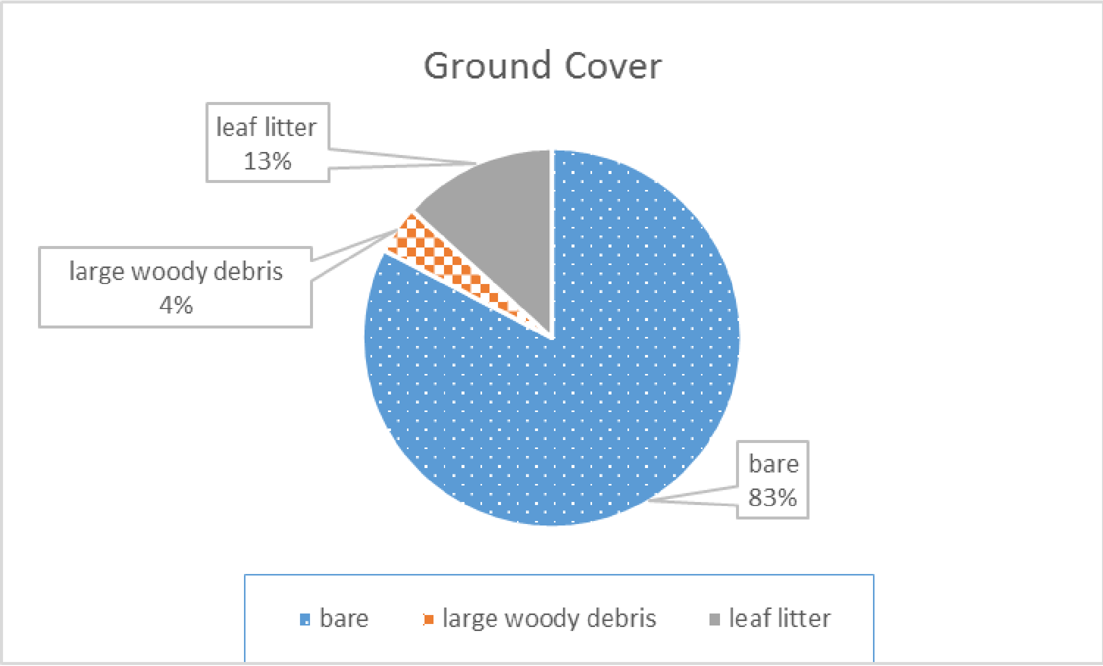


Figure 6. Percent ground cover for plot on 17-16.

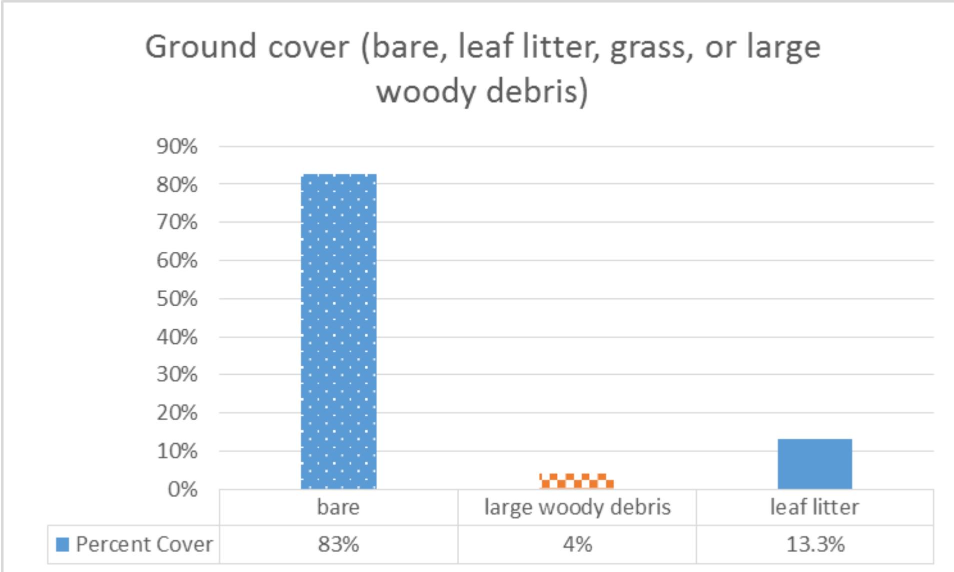


Figure 7. Percent ground cover for plot on 17-16.

Discussion

We would like to clarify that we are adapting these NMRAM metrics for our own purposes. That is, we are using them both inside and outside their intended site ranges, including on larger sites (NMRAM is designed to handle a site around 100 x 200 meters), sites further from the river (NMRAM is currently in use primarily for assessing riverine wetlands), and sites defined by exotic vegetation presence rather than hydrologic boundaries and upland vegetation indicators/apparent wetland extent. Site delineation and size is likely to be variable for a number of other reasons, including landowner participation, available funds, proposals received from contractors, etc – many of which cannot be directly correlated to site disturbance or ecological function. For this reason, we do not use the entire NMRAM assessment, or place confidence in the weighted score roll-ups that are typically part of an NMRAM report. Should one be interested, rationale for the weighting in the NMRAM score roll-up can be found in the yet-to-be-published field manual for version 2.1. For more information, contact Maryann McGraw of the NMED or NMFWRI.

While we provide a biotic site score and rating for your reference, we recommend comparisons be done with individual metrics from pre-treatment and post-treatment assessment from the same site, rather than across multiple sites. Also of note is that statistical analysis is not appropriate for NMRAM, or other low intensity, rapid field methods.

Please note that should the project area change significantly from what was originally proposed and monitored, all metrics will lose some amount of confidence on comparison as it is impractical to re-examine the original site assessment scores using new boundaries. This is an issue of concern of which GRGWA should be aware. We recommend that GRGWA attempt to minimize alterations in project boundaries once pre-treatment monitoring data has been approved for collection. Another, somewhat alternative, recommendation is that the initial monitoring regime include high-intensity modified BEMP-type plots which could be repeated in their exact initial locations, allowing collection of comparable data regardless of boundary change. We recognize that this is not always practical: boundaries change for a number of reasons and time and cost constraints can necessitate the sole use of a rapid assessment method for monitoring. We have reason to hope our outlined assessment method will still be a satisfactory indicator for site function improvement or degradation primarily because metrics in rapid assessment methods such as this are set up to have relatively low sensitivities (i.e. for a change to be reflected in the metrics, either positive or negative, disturbance on site has to be significantly altered).

From here on out, the goal of the GRGWA/ NMFWRI is that all sites will be revisited for post-treatment monitoring in 5-year intervals. It is our intention and expectation that the data collected in these intervals will reflect any significant changes in disturbance and ecological function of the site.

References

Audubon New Mexico. (2013). Water Matters: Water for New Mexico Rivers. Albuquerque, New Mexico: Utton Transboundary Resources Center.

Brown, J. K. (1974). Handbook for Inventorying Downed Woody Material, USDA Forest Service General Technical report INT-16. *Handbook for Inventorying Downed Woody Material*. Ogden, Utah: USDA Forest Serivce Intermountain Forest and Range Experiment Station.

Bureau of Land Management. (2006). *Grazing Management Processes and Strategies for Riparian-Wetland Areas, TR 1737-20 .*

Claunch-Pinto Soil and Water Conservation District on behalf of the Greater Rio Grande Watershed Aliance. (2015). *Request for Proposals for Greater Rio Grande Watershed Alliance Riparian Restoration Projects.* Mountainair, NM: Claunch-Pinto Soil and Water Conservation District.

Committee on Riparian Zone Functioning and Strategies for Management, et al. (2002). *Riparian Areas: Functions and Strategies for Management.* Washington, D.C.: National Academy Press.

David Lightfoot. (2014). *Forest Thinning Project Repeat Photo Points for Restoration Effectiveness Monitoring.* Albuquerque: SWCA Environmental Consultants.

Lightfoot, D. &. (2012). *Greater Rio Grande Watershed Alliance Riparian Restoration Effectiveness Monitoring Plan.* Albuquerque, NM: SWCA Environmental Consultants.

Lightfoot, David & Stropki, C. (2012). *Field Manual for Greater Rio Grande Watershed Alliance Riparian Restoration Effectiveness Monitoring.* Albuquerque, NM: SWCA Environmental Consultants.

Lizarazo, I., & Elsner, P. (2009). Fuzzy segmentation for object-based image classification. *International Journal of Remote Sensing, 30*.

Muldavin, E. B. (2011). New Mexico Rapid Assessment Method: Montaine Riverine Wetlands. Version 1.1. Final report to the New Mexico Environment Department, Surface Water Quality Bureau. 90 pp. and appendices.

New Mexico Department of Game and Fish Conservation Services Division. (2012). *Bridge and Road Construction/Reconstruction Guidelines for Wetland and Riparian Areas.*

U.S. Climate Data. (2017). *Climate New Mexico*. Retrieved from U.S. Climate Data: http://www.usclimatedata.com/climate/new-mexico/united-states/3201

USDA NRCS. (2016, 8 10). *Web soil Survey.* Retrieved from https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm

USDA NRCS. (n.d.). *Ecological Site Description Sandy Loam Upaldn 10-14" pz.* Retrieved from https://esis.sc.egov.usda.gov/ESDReport/fsReport.aspx?id=R035XA117AZ&rptLevel=general&approved=yes&repType=regular&scrns=&comm=

USDA NRCS n.d. (n.d.). *Ecological Site Description Gravelly R035XG114NM .*

USDA NRCS n.d. (n.d.). *Ecological Site Description Clayey Bottomland R035XA119NM .*

USDA NRCS. (n.d.). *Ecological Site Description Bottomland.* Retrieved from https://esis.sc.egov.usda.gov/ESDReport/fsReport.aspx?id=R035XA118NM&rptLevel=all&approved=yes&repType=regular&scrns=&comm=

USDA NRCS. (n.d.). *Ecological Site Description Clay Loam Wash 10-14" p.z.* Retrieved from https://esis.sc.egov.usda.gov/ESDReport/fsReport.aspx?approved=yes&rptLevel=all&id=R035XA104AZ

USDA NRCS n.d. (n.d.). *Ecological Site Description Deep Sand R035XA115NM .*

USDA NRCS. (n.d.). *Ecological Site Description Foothills.* Retrieved from https://esis.sc.egov.usda.gov/ESDReport/fsReport.aspx?approved=yes&rptLevel=all&id=R035XA131NM

USDA NRCS n.d. (n.d.). *Ecological Site Description Loamy R035XA112NM .*

USDA NRCS. (n.d.). *Ecological Site Description Loamy Upland 10-14" p.z.* Retrieved from https://esis.sc.egov.usda.gov/ESDReport/fsReport.aspx?approved=yes&rptLevel=all&id=R035XA113AZ

USDA NRCS n.d. (n.d.). *Ecological Site Description Salt Flats R035XA126NM.*

USDA NRCS. (n.d.). *Ecological Site Description Sandy Upland 10-14" pz.* Retrieved from https://esis.sc.egov.usda.gov/ESDReport/fsReport.aspx?approved=yes&rptLevel=all&id=R035XA118AZ

USDA NRCS n.d. (n.d.). *Ecological Site Description Shallow Sandstone R035XG121NM .*

USDA NRCS N.M. n.d. (n.d.). *FOTG-Section II - Ecological Site Description (WP2) Salt Meadow R036XB009NM.*

USDA USFS. (1996, September). Ecology, Diversity, and Sustainability of the Middle Rio Grande Basin, RM-GTR-268. (D. M. Finch, & J. A. Tainter, Eds.) Fort Collins, Colorado.

Appendix I - Photopoint Table

Name	Latitude	Longitude
17.16_1_N	35.07167	-107.63567
17.16_2_E	35.06922	-107.63789
17.16_3_W	35.07199	-107.63814
17.16_4_N	35.07227	-107.63815
17.16_5_S	35.07934	-107.63902

Appendix II - Photos

Pueblo of Acoma Rinconada Creek 17.16_1_S View facing south inside of polygon 2 and 1. Foreground Landmark is a power line overhead.

17.16_2_E View facing east inside of polygon 2.

17.16_3_W View facing west inside of polygon 3 and 2.

17.16_4_N View facing north inside of polygon 4, 6, and 5.

17.16_5_S View facing south inside of polygon 5, 2, and 1.

17-16 Plot Photos

N from PC

E from PC

S from PC

W from PC

Plot Center

Appendix III – Current monitoring methods available

Low-intensity methods

- Where: happens on all sites with GRGWA projects
- Method name: NMRAM (New Mexico Rapid Assessment Method v 2.1)
- Time required: 3 hours – half day/ site
- Repeat: done once pre-treatment and in 4-5 year intervals post-treatment
- Basics: mapping vegetation communities (by vertical and horizontal structure), recording dominant vegetation in each strata (trees, shrubs, herbaceous), assessing fuel load, noting soil surface condition and native/exotic ratio at all vegetation levels, photo points
- Any on-site impacts or materials: none

High-intensity methods

- Where: happens on select sites, in addition to low-intensity monitoring

Submethod name 1: BBIRD or BEMP vegetation plots (depends on treatment area size)

- Time required: approx. 2 hours/site
- Repeat: both pre-treatment and in 4-5 yr intervals post-treatment
- Basics: larger plots and transects documenting vegetation, photo points
- On-site impacts or materials: rebar and cap

Submethod name 2: Brown's transects

- Time required: 1-1.5 hours/site
- Repeat: both pre-treatment and in 4-5 yr intervals post-treatment
- Basics: transects to calculate fuel loading and fire behavior, photo points
- On-site impacts or materials: rebar and cap

Submethod name 3: BEMP-adapted Groundwater Well Monitoring

- Time required:
  - Initial installation: 1-2 hours/ well (ideally 2+ wells/site)
    - Repeat: maintenance as needed, should be minimal
  - Data offloading: 10-20 minutes/well
    - Repeat: at least annually (this is when we anticipate datalogger will be full and batteries will need to be changed)
- Basics: install a well with a sensor which records groundwater level and temperature once an hour year round; this will reflect changes due to seasonal variation, vegetation growth, irrigation, etc.
- On-site impacts or materials: shallow monitoring well (consists of capped PVC pipe extending into the ground about 3 feet below the water table and above ground approx. 2 feet (can be painted earth tones); well contains a datalogger (pressure transducer) suspended on a cable into the water); well should be protected from cattle grazing (so may require rebar around pvc visible above ground)

Appendix IV - Modified Hink and Ohmart categories, from NMRAM

The following is pages 39-41 in Muldavin et al.'s 2014 NMRAM for Montane Riverine Wetlands v 2.0 Manual (draft, not yet published)

Vegetation Vertical Structure Type Definitions for NMRAM

Multiple-Story Communities (Woodlands/Forests)

Type 1- High Structure Forest with a well-developed understory.

Tall mature to intermediate-aged trees (>5 m [>15 feet]) with canopy covering >25% of the area of the community (polygon)and understory layer (0-5 m [0-15 feet]) covering >25% of the area of the community (polygon). Substantial foliage is in all height layers. (This type incorporates Hink and Ohmart structure types 1 and 3.) Photograph on Gila River by Y. Chauvin, 2012.

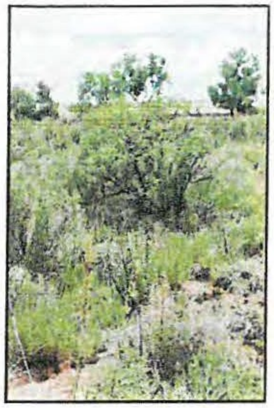
Type 2 -Low Structure Forest with little or no understory.

Tall mature to intermediate-aged trees (>5 m [>15 feet]) with canopy covering >25% of the area of the community (polygon) and understory layer (1-5 m [3-15 feet]) covering <25% of the area of the community (polygon). Majority of foliage is over 5 m (15 feet) above the ground. (This type incorporates Hink and Ohmart structure types 2 and 4.) Photograph on Diamond Creek by Y. Chauvin, 2012.

Single-story Communities (Shrublands, Herbaceous and Bare Ground)

Type 5 -Tall Shrub Stands.

Young tree and shrub layer only (15-5 m [4.5-15 feet]) covering >25% of the area of the community (polygon). Stands dominated by tall shrubs and young trees, may include herbaceous vegetation underneath the woody vegetation. Photograph on San Francisco River by Y. Chauvin, 2012.

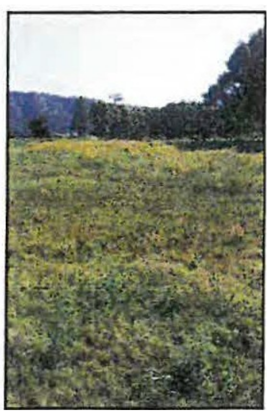


Type 6S- Short Shrub Stands.

Short stature shrubs or very young shrubs and trees (up to 1.5 m [up to 4.5 feet]) covering >10% of the area of the community (polygon). Stands dominated by short woody vegetation, may include herbaceous vegetation underneath the woody vegetation. Photograph on Lower Pecos River by E. Lindahl, 2008.

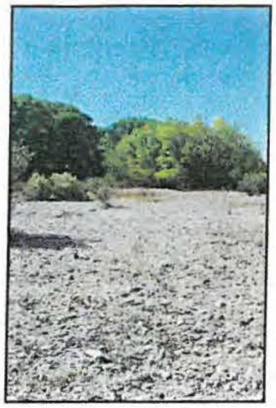
Type 6W- Herbaceous Wetland.

Herbaceous wetland vegetation covering >10% of the area of the community (polygon). Stands dominated by obligate wetland herbaceous species. Woody species absent, or <10% cover. Photograph of *Carex nebrascensis* meadow on upper Rio Santa Barbara by Y. Chauvin, 2009.



Type 6H- Herbaceous.

Herbaceous vegetation covering >10% of the area of the community (polygon). Stands dominated by herbaceous vegetation of any type except obligate wetland species. Woody species absent or <10% cover. Photograph on Diamond Creek by Y. Chauvin, 2012.



Type 7–Sparse Vegetation/Bare Ground.

Bare ground, may include sparse woody or herbaceous vegetation, but total vegetation cover <10%. May be natural in origin (cobble bars) or anthropogenic in origin (graded or plowed earth) Photograph on Lower Gila River by Y. Chauvin, 2012.