Valencia SWCD Rio Abajo Project 15-16

Pre-treatment Monitoring Report

2015

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Contents

Acronyms and Abbreviations

Acronym, Abbreviation, or Term	Explanation or Definition as used by NMFWRI
AGL	above ground level; GIS term
BBIRD plots	Breeding Biology Research and Monitoring Database, larger circular plot types
BEMP plots	Bosque Ecosystem Monitoring Program, small rectangular plot types
FEAT	Fire Ecology Assessment Tool
FFI	FEAT/ FIREMON Integrated
FIREMON	Fire Effects Monitoring and Inventory System
FSA	Farm Service Agency, a department of the USDA
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
NAIP	National Agriculture Imagery Program (aerial imagery)
NDVI	Normalized Difference Vegetation Index; GIS term for a band ratio of the visible red and the near infrared spectral bands and is calculated using the following formula: (NIR – Red)/(NIR+Red)
NHNM	Natural Heritage New Mexico
NMDGF	New Mexico Department of Game and Fish
NMED SWQB	New Mexico Environment Department Surface Water Quality Bureau
NMFWRI	New Mexico Forest and Watershed Restoration Institute
NMHU	New Mexico Highlands University
NMRAM	New Mexico Rapid Assessment Method, version 2.0
NRCS	Natural Resource Conservation Service
PC	Plot center
RGIS	Resource Geographic Information System
SWCD	Soil and Water Conservation District
TIFF	Tagged image file format
USDA	United States Department of Agriculture
USGS	United States Geological Survey
WQCC	Water Quality Control Commission
WSS	Web Soil Survey, a soils database of the NRCS

Purpose of Report

This report covers the low-intensity pre-treatment vegetation monitoring assessment performed on a non-native phreatophyte removal project submitted for the Rio Abajo area to the Greater Rio Grande Watershed Alliance. Following an explanation of monitoring methods, we will discuss 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 2.0, 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 (polygon) 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. Waypoints were marked with a Garmin GPS unit and named sequentially by site. Photos were taken in the direction that most effectively captured the diverse vegetation community(ies). Where appropriate, one waypoint was used for photos taken in multiple directions.

Prior to entering the field, our GIS specialist created a map with the project boundaries as provided by GRGWA. She 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 specialist.

Estimating Vegetation Cover using LIDAR and eCognition Software

LIDAR, light detecting and ranging, elevation data were used to estimate vegetation height and canopy characteristics a supplement to field monitoring data for some GRGWA pre-treatment project sites, including this one. This analysis is especially useful in large or difficult-to-access areas, but because of the effort involved, analysis with LIDAR and eCognition is not typically performed on small, easily accessible sites. While this area was easily accessible, it was analyzed as a "test" or calibration of these methods for our GIS and monitoring staff.

To perform the analysis, 2012 LIDAR was provided by Bureau of Reclamation (flown in February). One foot 2014 NAIP (National Agriculture Imagery Program) imagery was acquired to get an estimate of vegetation extent. NAIP is a USDA/FSA program to acquire 'leaf on' aerial imagery during the peak growing season. NAIP imagery for New Mexico can be downloaded by Quarter Quadrangle extent in an uncompressed TIFF format via RGIS –Resource Geographic Information System (http://rgis.unm.edu/).

In order to classify vegetation, the LIDAR point cloud was filtered to isolate first returns and then LIDAR elevations were calculated to represent height above ground level (AGL). Next, the AGL point cloud was exported by height categories that correlate with the Hink and Ohmart height classes as modified for use in the NMRAM (2.0). These separate point clouds were then converted into separate digital surface models and exported as GeoTiffs.

Understory vegetation was classified first. Understory vegetation were classified using first returns of LIDAR elevations less than 15ft and 1 foot 2014 4- band ortho-imagery within eCognition.

eCognition software is an object based image classification system that allows for a semi-automated analysis of high resolution images. This approach divides the image into meaningful homogenous regions, known as image objects. These image objects are groups of pixels that are adjacent to each other and are spectrally similar. Once image objects are created, they provide a great deal of information from which an image classification can be developed.

Image segmentation within eCognition was based on elevation surface models. NDVI (Normalized Difference Vegetation Index) from the ortho-imagery was calculated and incorporated as a threshold to determine vegetation from dead or non-vegetative areas. The resulting classifications were combined into one image representing total understory vegetation.

The understory vegetation layer was used as an input in the multiple story community classifications (Types 1 and 2). A digital surface model for all heights above ground was used to classify single-story Communities (Types 5, 6S, 6H, and 7). This classification incorporated height classes as well as NDVI to identify active vegetation. Once the vegetation was classified by height, the understory vegetation layer was used to identify whether each class had understory vegetation or not and was then classified accordingly.

Personnel Involved

2015 New Mexico Forest and Watershed Restoration Institute Monitoring Team:

- Kathryn R Mahan, Ecological Monitoring Specialist

2015 New Mexico Forest and Watershed Restoration Institute GIS Team:

- Adrienne Miller, GIS Specialist
- Patti Dappen, GIS Specialist

Other persons contacted:

- Fred Rossbach, Field Coordinator, Greater Rio Grande Watershed Alliance
- Madeline Miller, Valencia SWCD

Rio Abajo Project

Project 15-16 is located on Valencia SWCD and MRGCD property near the communities of Belen and Rio Communities, NM.

Belen receives an average of 7.6 inches of rain annually. Temperatures range from an average high of 95 in July, average low of 19 in January (City-Stats, 2015). According to the NRCS Web Soil Survey, the project is over 99% Mixed alluvial land, which correlates to over 99% ecological type R042XA055NM Salty Bottomland. (USDA NRCS, 2013)

Salty Bottomland can support a range of plant communities which typically include cottonwood, tamarisk, mixed exotics (dominated by Russian olive/ Russian knapweed/ etc), saltgrass and saltgrass-sacaton, and bottomland grassland (possibly dominated by saltgrass, giant sacaton, dropseed, muhly, burrograss, alkali sacaton, galleta, vinemesquite, and/or tobosa) (USDA NRCS).

The project is part of the Valencia SWCD Open Space Conservation Area south of Belen, NM in Valencia County (Figure 1). The project is split by a ditch managed by the Middle Rio Grande Conservancy District (MRGCD). The portion of the project east of the ditch is 15-16A. This is owned by the Valencia SWCD. Land east of this, through which the project is accessed, is owned by the NM DGF and contains some archaeological sites. The western portion of the project, 15-16B, is on the east side of Rio Grande and west the (MRGCD) ditch; this part of the project is owned by the MRGCD. A high voltage powerline runs the width of the southern portion of this area, 15-16B Priority Area 1, and the accompanying road serves as a fuel break. All three shapes are reflected in the map, below. The project was sponsored by the Valencia SWCD.

This site was visited on September 2, 2015 but was not monitored in its entirety under typical NMFWRI procedures due to vegetation density, time constraints, and information from the GRGWA on the likelihood of project areas receiving treatment based on bids received from implementation contractors. Instead, monitoring took place in two areas, 15-16A (12.8 acres) and 15-16B Priority Area 1 (6.1 acres). 15-16B Priority Area 2, 44.2 acres, was not monitored on-the-ground but was instead assessed using GIS techniques as outlined above. This project is part of a restoration project targeting non-native phreatophytes scheduled for 2015-2016.

It is also worth noting that there are Bosque Ecological Monitoring Program (BEMP) sites north of this project. The closest BEMP site is the Crawford site which is approximately 3,000 meters north on the west side of the Rio Grande.

Planned treatment on all portions includes removal of salt cedar and Russian olives of various size classes. Restoration goals are to enhance riparian wildlife habitat, reduce fire hazard and erosion, and raise awareness of bosque restoration projects in the local area, as well as maintaining the native understory.

Figure 1. Project 15-16 in geographic context.

The site is at approximately 4800 feet. This site appears to have been burned in the recent past but remains extraordinarily dense, both with salt cedar and Russian olive as well as cottonwood, making foot travel through the bosque difficult. At the time of the site visit, within the project area, there was plentiful tamarisk, as well as some Russian olive and Russian thistle. There was also an abundance of native species including cottonwood, New Mexico olive, willow, bursage, gumweed, helianthus, lambsquarters, senecio, saltgrass, dropseed, and other native grasses. In some areas understory was limited due to lack of sunlight at the ground level.

15-16A

Metric (15-16 A, September 2, 2015)	Score
Relative Native Plant Community Composition	1
Vegetation Horizontal Patch Structure	3
Vegetation Vertical Structure	2
Native Riparian Tree Regeneration	2
Exotic Invasive Plant Species Cover	1
Project Biotic Score (based on above ratings)	1.7
Project Biotic Rating	D/Poor
Soil Surface Condition	4
Surface Fuels	0.75

The lowest scores for this portion of the project came from the high percentage of invasive plants. The surface fuel metric comes largely from the presence of litter and duff, especially cottonwood and tamarisk leaves. The project scored best in the soil surface condition metric, because there site was relatively dense and inaccessible and therefore protected. Vegetation polygons are represented by structure type in the map (Figure 2). Overall, this site scored a 1.7 out of 4 overall, which is a "D" or "Poor" biotic rating.

The LIDAR and NAIP analysis for this project identified 6 acres as Type 1 High Structure Forest with Understory (largely cottonwood and Russian olive), 2.6 acres as Type 5 Tall Shrub, (likely predominantly salt cedar and Russian olive), 2.4 acres as Type 6S Short Shrub, 1.4 acres as Type 6H Herbaceous, 0.6 acres as Type 2 High Structure Forest with no Understory, and 0.2 acres as Type 7 Bare Ground. See Figure 3.

15-16B, Priority 1

Metric (15-16 B – 1, September 2, 2015)	Score
Relative Native Plant Community Composition	1
Vegetation Horizontal Patch Structure	2
Vegetation Vertical Structure	2
Native Riparian Tree Regeneration	3
Exotic Invasive Plant Species Cover	1
Project Biotic Score (based on above ratings)	1.6
Project Biotic Rating	D/Poor
Soil Surface Condition	2
Surface Fuels	0.75

The lowest scores for this portion of the project came from the high percentage of invasive plants. The surface fuel metric comes largely from the presence of litter and duff, especially cottonwood and tamarisk leaves. The project scored best in the riparian tree regeneration metric, because there were young willows and New Mexico olives. Vegetation polygons are represented by structure type in the map (Figure 2). Overall, this site scored a 1.6 out of 4 overall, which is a "D" or "Poor" biotic rating.

The LIDAR and NAIP analysis for this project identified 2.5 acres as Type 1 High Structure Forest with Understory (largely cottonwood and Russian olive), 1.3 acres as Type 5 Tall Shrub (likely predominantly salt cedar), 0.9 acres as Type 6S Short Shrub, 0.6 acres as Type 6H Herbaceous, 0.5 acres as Type 7 Bare Ground, and 0.3 acres as Type 2 High Structure Forest with no Understory. See Figure 3.

15-16B, Priority 2

NMRAM-type field monitoring was not performed on this section of the project.

The LIDAR and NAIP analysis for this project identified 17.2 acres as Type 1 High Structure Forest with Understory (largely cottonwood and Russian olive), 9.9 acres as Type 6S Short Shrub, 7.3 acres as Type 2 High Structure Forest with no Understory, 5.8 acres as Type 5 Tall Shrub (likely predominantly salt cedar), 3.5 acres as Type 6H Herbaceous, and 0.5 acres as Type 7 Bare Ground. See Figure 3.

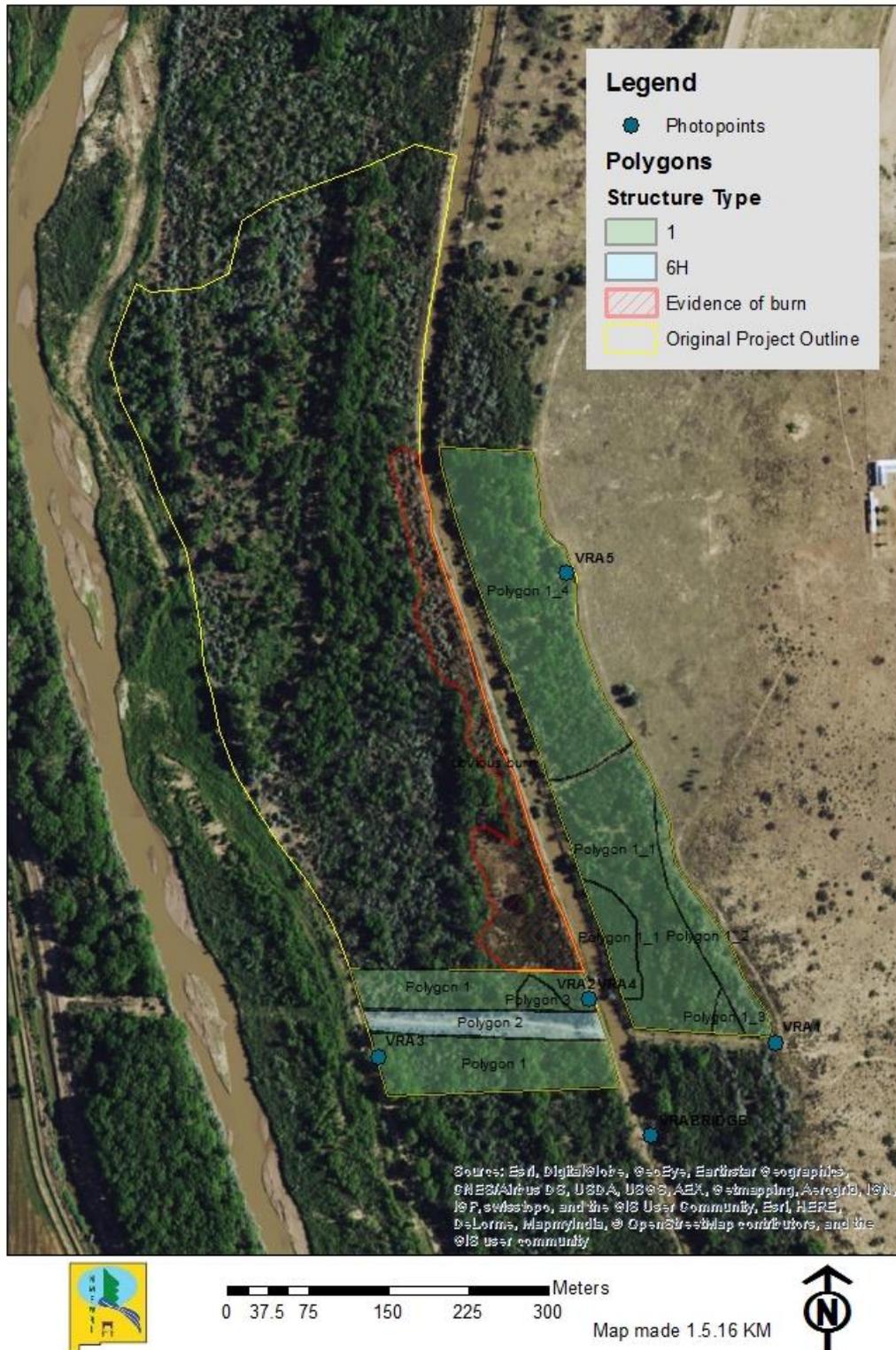15-16 Rio Abajo 6 and 12.8 acre Pre-treatment Vegetation Polygons (9.2.15)

Figure 2. Vegetation monitoring polygons and photopoints for 15-16A and 15-16B-1.

15.16 Rio Abajo
Vertical Structure Type Classification

Acreage	15-16B-2	15-16B-1	15-16A
Type 1	17.23	2.53	5.59
Type 2	7.34	0.34	0.61
Type 5	5.82	1.33	2.6
Type 6H	3.48	0.57	1.37
Type 6S	9.87	0.85	2.44
Type 7	0.45	0.49	0.17

Class Name

Type 1 High Structure with Understory
Type 2 High Structure with no Understory
Type 5 Tall Shrub Stands
Type 6S Short Shrub Stands
Type 6H Herbaceous
Type 7 Bare Ground

0   50   100   200 Meters
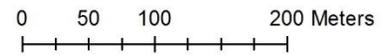
Vegetation types were estimated using eCognition software
with 2014 NAIP Imagery and 2012 LIDAR. These
classificaitons are only general estimates.
Map created by Patti Dappen, 2-25-16

Figure 3. LIDAR and NAIP classification for 15-16.
False color is used for the original imagery to allow the viewer to more easily distinguish classification colors.

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 2.0. 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.

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Appendix I - Photopoints

Project Name	Point number in NMFWRI Gpx files	Direction facing (azimuth)	Description	Coordinates
15.16 Rio Abajo 12.8 ac	VRA1	264	edges of polygon 1_2, looking down powerline cut	34.614572, -106.744177
15.16 Rio Abajo 12.8 ac	VRA4	0/360	polygon 1_3, Russian olives	34.6149028, -106.7460778
15.16 Rio Abajo 12.8 ac	VRA5	260	polygon 1_4, diversity of structure - some burnt trees, some defoliated, etc	34.61845, -106.746387
15.16 Rio Abajo 6 ac	VRA2	12	polygon 3, gauge, burned trees	34.614903, -106.746078
15.16 Rio Abajo 6 ac	VRA3	45	understory in polygon 1	34.614398, -106.748223

Appendix II - Photos

Rio Abajo 12.8 ac (15-16A)

VRA1, edges of polygon 1_ 2, looking down powerline. Several young Russian olives. Taken facing 264 degrees.

VRA4, view of polygon 1_3, Russian olives. Taken facing 0 degrees N.

VRA5, view of polygon 1_4. – cottonwood, Russian olive and tamarisk. Note the diversity in structure, as well as the presence of burned and defoliated trees. Taken facing 260 degrees.

Rio Abajo 6.1 ac (15-16B, Priority 1)

VRA2, view of polygon 3 – stream gauge and burned trees. Taken facing 12 degrees.

VRA3, view of salt cedar and Russian olive understory in polygon 1. Taken facing 45 degrees.

Appendix III – Monitoring Methods currently available

Low-intensity methods

- Where: happens on all sites with GRGWA projects
- Method name: NMRAM (New Mexico Rapid Assessment Method v 2.0)
- 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)

<u>Vegetation Vertical Structure Type Definitions for NMRAM</u>

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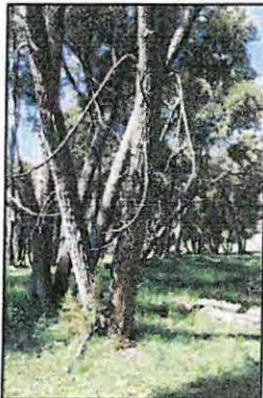
Type 2 – Low Structure Forest with little or no understory.

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.
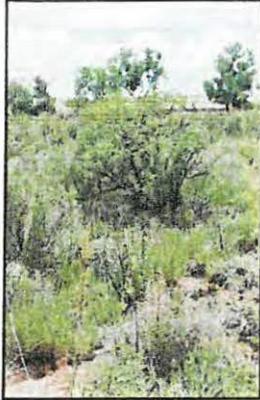
Type 6S- Short Shrub Stands.

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.
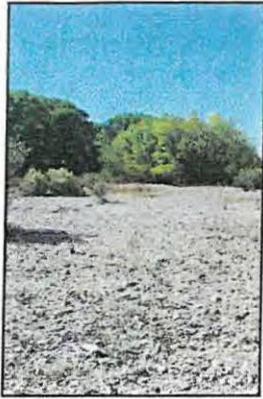
Type 7–Sparse Vegetation/Bare Ground.

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.