PUEBLO OF SANDIA

Pueblo of Sandia Projects 15.01, 15.02, 15.03, 15.04, 15.05

Post-treatment Monitoring Report

2021

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NMFWRI

CORONADO Soil and Water Conservation District

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)
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 2.1
NRCS	Natural Resource Conservation Service
PC	Plot center
PoS	Pueblo of Sandia
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 assessments performed on five non-native phreatophyte removal projects submitted by the Pueblo of Sandia Environment Department Bosque Program and the Coronado SWCD to the Greater Rio Grande Watershed Alliance in 2016. Following a discussion of the ecological context, and our monitoring methods, we present pertinent background, observations, and assessment results for each 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.)

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 2.1 (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. Where appropriate, one waypoint was used for photos taken in multiple directions.

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.

Personnel Involved

2021 New Mexico Forest and Watershed Restoration Institute Monitoring Team:

- Carmen Briones, Crew Logistics and Assistant Manager
- Raymundo Melendez, Education and Outreach Program Assistant
- Alex Makowicki, Ecological Monitoring Technician

2021 New Mexico Forest and Watershed Restoration Institute GIS Team:

- Patti Dappen, GIS Program Manager
- Katie Withnall, GIS Specialist

Other persons contacted:

- Michael Scialdone, Bosque Project Manager, Pueblo of Sandia Environment Department Bosque Program
- Fred Rossbach, Field Coordinator, Greater Rio Grande Watershed Alliance

Pueblo of Sandia Projects

The Pueblo of Sandia is a 39 square mile reservation located north of Albuquerque and south of Bernalillo, New Mexico, at the base of the Sandia Mountains. The Rio Grande is the historical western boundary of the Pueblo and the Pueblo is the steward of one of the largest remaining intact stretches of Rio Grande bosque in the area. The bosque has a long history of ecological and cultural importance for the Pueblo, but in recent years it has been subject to the same stressors discussed above, especially drought, the impact of the 2011 Las Conchas fire, and fires on Pueblo lands (e.g. the 2012 Romero Fire). Human modifications to the river are easily observed on aerial maps – side channels including the Albuquerque Main Canal, the Corrales Main Canal, the Albuquerque Riverside Drain, the Alameda Drain, the Bernalillo Interior Drain, the Atrisco Feeder Canal, and the Sandia Acequia, among others intersect and diverge from the river throughout the western side of the Pueblo (MRGCD, n.d.).

Particularly in the last decade or two, a number of bosque restoration efforts have been led by the Pueblo's Environment Department in collaboration with agencies and organizations including the Bureau of Reclamation, the Middle Rio Grande Conservancy District, the US Army Corps of Engineers and the Greater Rio Grande Watershed Alliance.

2015 is the third year the Pueblo of Sandia has collaborated on nonnative phreatophyte removal projects with the GRGWA. In 2013, project numbers 13-02, 13-03 and 13-04 worked on restoration after the Romero Fire; in 2014, project 14-01 worked at Sandia Lakes; projects 14-03 and 14-04 worked in the

Bosquecito, projects 14-05 and 14-06 worked in the Sandia Wash area, and project 14-07 worked in the Riverside Drain. This year project numbers 15-01 through 15-05 are distributed the length of the Pueblo.

The elevation at the Village of Sandia Pueblo is just over 5,000 feet. The area receives an average of 10 inches of rainfall per year, with temperatures ranging from an average high of 91 degrees Fahrenheit in July to an average low of 20 degrees Fahrenheit in January (City Stats, 2016). According to the NRCS Web Soil Survey there are several soil map units in the area of the Pueblo of Sandia, but most soils are sand and clay loams; the dominant ecological sites are R042XA057NM Bottomland and R042XA055NM Salty Bottomland (USDA NRCS, 2013).

The Bottomland ecological site is dominated by either giant sacaton or alkali sacaton. Vinemesquite grass and sideoats grama may also be present. Reduced cover and hummocking of these grasses characterize initial stages of degradation, typically due to overgrazing and/or changes in hydrology. Transitions to first tobosa- and then to burrograss-dominated states may occur in response to the redistribution of run-in water from overgrazing and subsequent erosion and gullying. Shrub invasion is not usually observed (USDA NRCS n.d.)

Salty Bottomland can support a range of plant communities which typically include cottonwood, salt cedar, 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). Typically, the vegetation consists of a shrub/grass mixture characterized by fourwing saltbush and greasewood. Tall, mid-grass, and short grasses are present. Blue grama, foxtail, sand dropseed, spike dropseed, giant dropseed, New Mexico feathergrass and tansymustard are common. When the plant community deteriorates, there is an increase in amounts of shrubs and short grasses (USDA NRCS n.d.)

2021 Pueblo of Sandia Projects

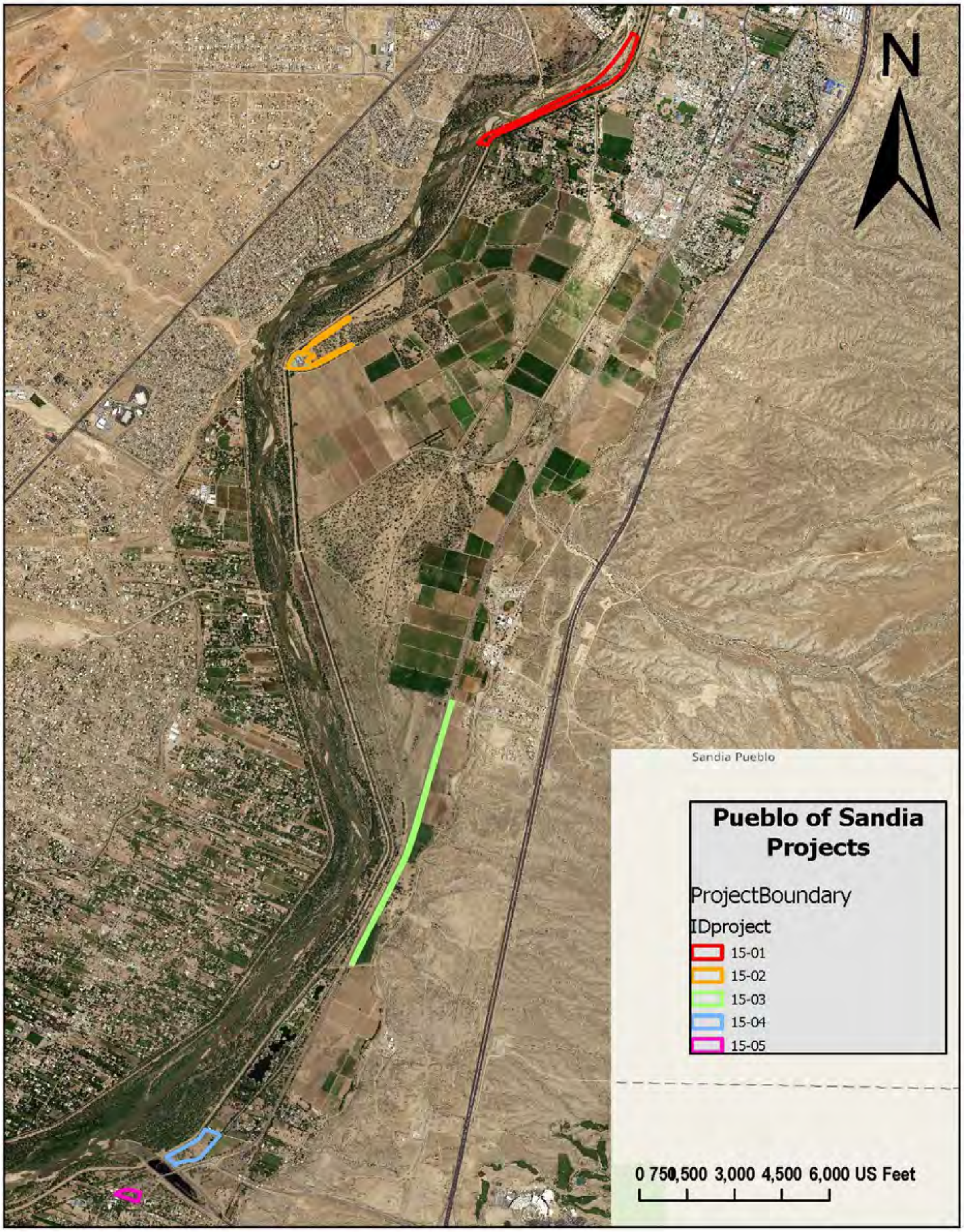

Figure 1. 2021 Pueblo of Sandia projects.

Project 15.01 – North-end Re-Treatment

Post-treatment monitoring occurred on September 24th, 2021. The project is located on the Pueblo of Sandia within Sandoval County, NM, north of the city of Albuquerque (Figure 1). It is on the east side of the Rio Grande near the Corrales Ditch and the Riverside Drain. The project was sponsored by the Coronado SWCD and the Pueblo of Sandia Environment Department Bosque Program. Planned treatment included removal by extraction and mastication of Siberian elms (common in the southern portion of the project), as well as salt cedar and Russian olives (present more in the north). Stated restoration goals are to supplement Bureau of Reclamation restoration projects and failed plantings following a 2001 fire, preserve existing native vegetation, and enhance bosque condition.

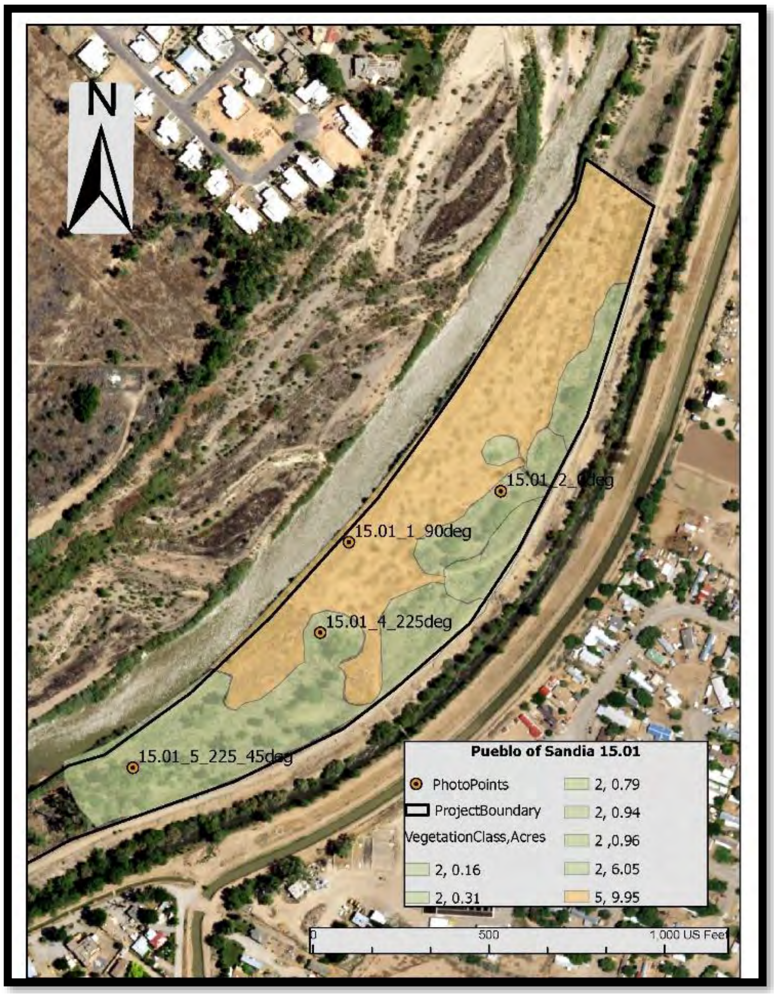

Figure 2. 15.01 in geographic context. 'Deg' indicates the compass direction photos were taken

According to the NRCS Web Soil Survey, the project area is comprised of about 4% Peralta loam, 1 to 3 % slopes, unprotected, and 96% water. This information is included only for reference, as the soil survey is not accurate at this scale, and the fact that the river moves should be considered. Ecological sites within this project include water and R042XA057NM Bottomland (USDA NRCS, 2016).

This site was observed to have beaver sign and cottonwood seedlings. Native vegetation including Rio Grande cottonwood, black willow, seepwillow, and coyote willow was noted in abundance; some cottonwoods appeared to have been burned in the Romero Fire and a patch of high mortality among willows, cottonwoods and salt cedar was observed near the Bureau of Reclamation fence line. The reason for this mortality was unclear at the time of the site visit. An old channel was present on site with wetland characteristics; the western edges of the project had the most hydrophilic vegetation. Sunflowers were abundant in the burned areas. In general, overstory was somewhat sparse, resulting in patchy shade. Other native species observed included New Mexico olive, dropseed grass, rough cocklebur and silverleaf nightshade. Exotic species observed on the site included Russian thistle (tumbleweed), Russian olive, salt cedar, tree-of-heaven, and sacred datura.

Metrics for 15.01 (September 24, 2021)	**2021 Score**	**2015 Score**
Relative Native Plant Community Composition	2	1
Vegetation Horizontal Patch Structure	3	3
Vegetation Vertical Structure	1	3
Native Riparian Tree Regeneration	3	2
Exotic Invasive Plant Species Cover	1	1
Project Biotic Score (based on above ratings)	1.9	1.9
Project Biotic Rating	C/Fair	C/Fair
Soil Surface Condition	2	2
Surface Fuels	0.74	0.75

Table 1. Side-by-side comparison of 2015 and 2021 metrics for plot 15.01.

The lowest scores for this project were the Invasive Exotic Plant Species Cover and Vertical Vegetation Structure. Vertical Vegetation Structure differs from 2015 observations due to the decrease in vegetation structure diversity. In 2015 15.01 contained three vertical vegetation structure types: Type 1 High Structure Forest, Type 5 Tall Shrubs and Type 6H, Herbaceous, defined as woody species representing less than ten percent of the area. In 2021 the monitoring team observed only two Vertical Vegetation Structure types; Type 2, Low Structure Forest with little or no understory and Type 5, Tall Shrub Stands. The Exotic Invasive Plant Species Cover score remained the same due to the presence of Siberian Elm, White Mulberry and Tree of Heaven. The Relative Native Plant Community Composition score increased because there were few invasive species in the overstory, though the understory still contained non-native invasive plants like in 2015. The score for the entire site remained 1.9, which is a “C” or “Fair” biotic range.

Project 15.02, Riverside Drain

Monitoring was conducted at this project site on September 24th, 2021. The project is east of the Riverside Drain and west of the Corrales Ditch (Figure 3). The project was sponsored by the Coronado SWCD and the Pueblo of Sandia Environment Department Bosque Program. Planned treatment includes removal of large Russian olive trees as well as Siberian elms and salt cedar. Restoration goals are to preserve native bosque, allow for managed grazing, and continue previous landowner restoration efforts.

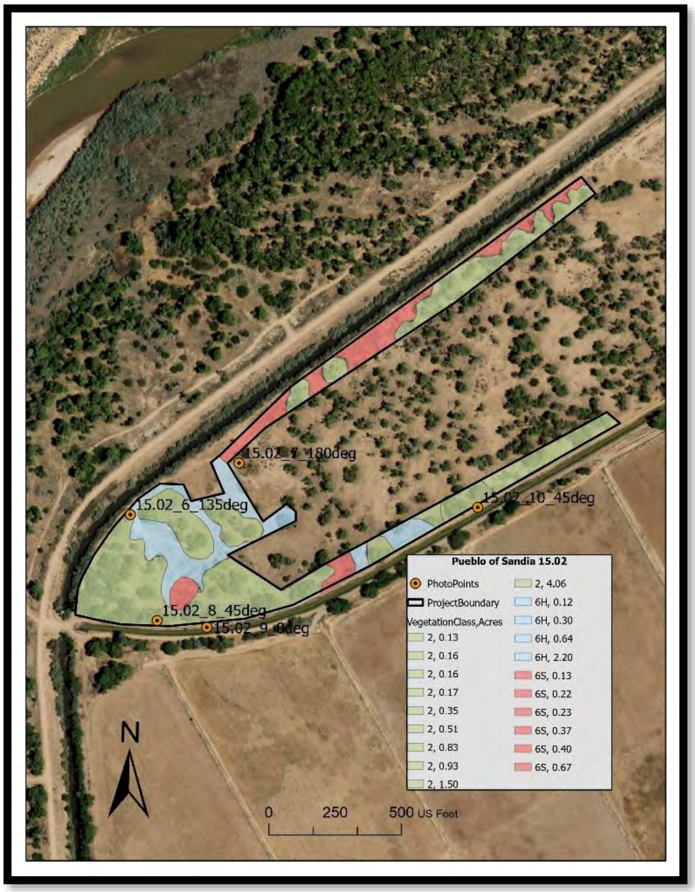

Figure 3. 15.02 in geographic context with photopoints

The project at this time is planned to be 13 acres. The delineation of this project was based on the distribution of Siberian elms and Russian olives, which explains its unusual shape. Other exotics observed included tamarisk and Russian thistle. Native species noticed in abundance included cottonwood, juniper, silverleaf nightshade, globemallow and sage. This site supported more xeric plant communities than did project 15-01.

Metrics for 15.02 (September 24, 2021)	2021 Score	2015 Score
Relative Native Plant Community Composition	2	1
Vegetation Horizontal Patch Structure	4	1
Vegetation Vertical Structure	1	2
Native Riparian Tree Regeneration	1	1
Exotic Invasive Plant Species Cover	1	1
Project Biotic Score (based on above ratings)	1.9	1.1
Project Biotic Rating	C/Fair	D/Poor
Soil Surface Condition	2	2
Surface Fuels	0.35	0.75

Table 2. Side-by-side comparison of 2015 and 2021 metrics for plot 15.02.

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 (estimated at over 50% of the site). The amount of surface fuels is due largely to the presence of weedy species like Russian thistle. The project scored best in the vertical and horizontal structure metrics, because of the variety of communities and the dominance of high-structure forest. This is reflected in the vegetation polygon map (Figure 5). This site scored a 1.9 out of 4, which is a “C” or “Fair” biotic rating. Most metrics were average or above average in comparison to the other 2016 Pueblo of Sandia sites.

Project 15.03, Rail Road Right of Way

Photos were taken at this 9.6-acre project site on September 24th, 2021. It is located on the railroad right-of- way along NM Highway 313 (Figure 5). The project was sponsored by the Coronado SWCD and the Pueblo of Sandia Environment Department Bosque Program. Planned treatment includes removal by extraction and mastication of large Siberian elm trees as well as Russian olives and salt cedar. Restoration goals are to remove trees from the right-of-way, reduce fire hazard as well as non-native seed source for adjacent areas (bosque and agricultural fields).

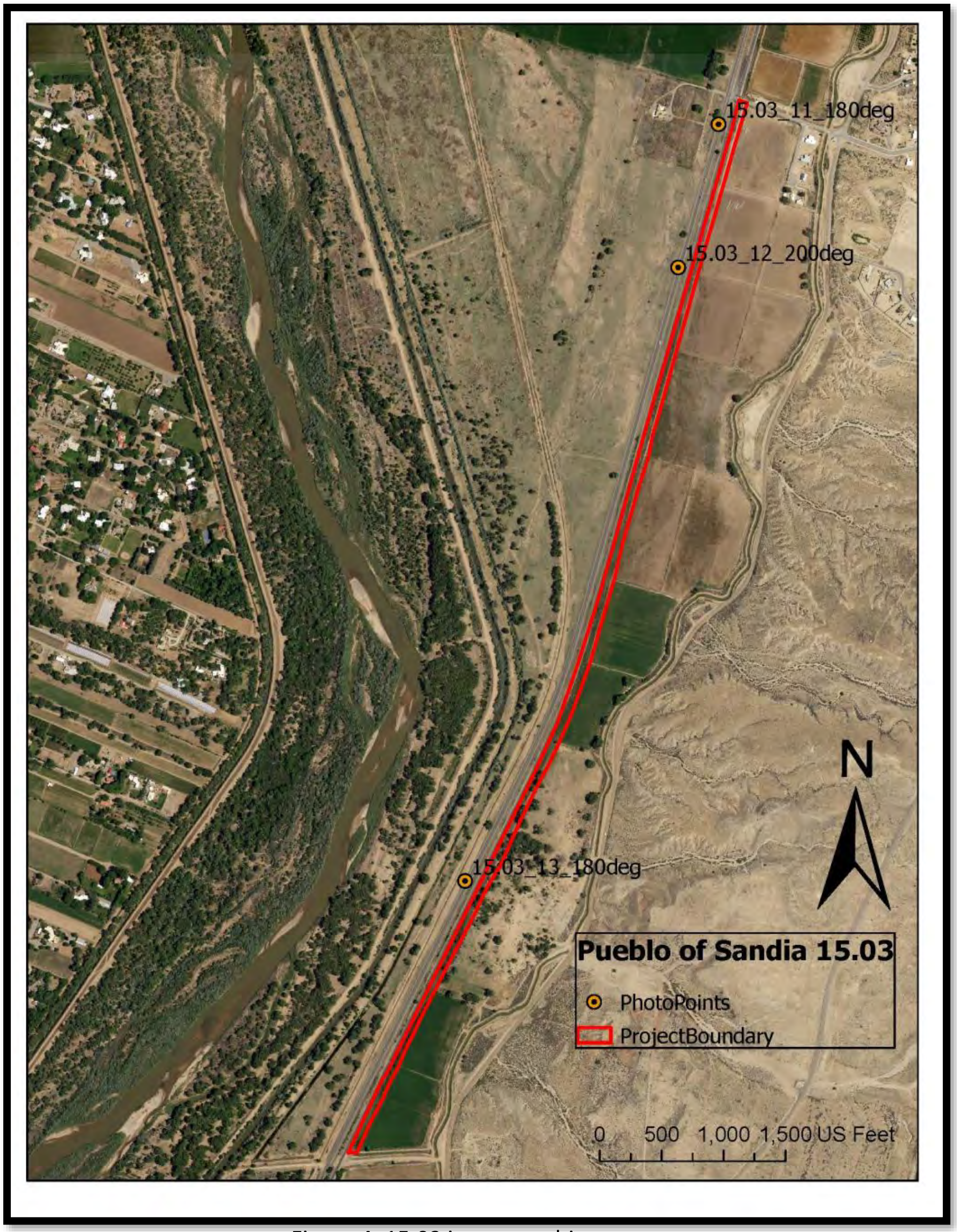

Figure 4. 15.03 in geographic context.

Due to the expense and complication involved in accessing the right-of-way (insurance, safety certifications, railroad personnel, etc), as well as the proximity to the highway, the only monitoring accomplished on this site was the selection of three photo points, reflected in Figure 4, above. It is notable that the site has several large Siberian elms on the northern portion and on the southern end, with fewer towards the middle. In 2021, only photos were collected.

Project 15.04, Farm Field Hwy 313 Round-about Area

Post-treatment monitoring was conducted at this site on October 14th, 2021 as part of a restoration project targeting non-native phreatophytes scheduled for 2015-2016. The project is located within the Pueblo of Sandia, on Highway 313 near the north side of Albuquerque in Sandoval County, NM (Figure 9). The project is on the east side of the Rio Grande with the Riverside Drain as the western boundary. The project was sponsored by the Coronado SWCD and the Pueblo of Sandia Environment Department Bosque Program. Planned treatment includes extraction of Siberian elms which have become established along abandoned irrigation ditches and fence lines, as well as sparse salt cedar, Russian olive, and a patch of tree-of-heaven. Restoration goals are to remove invasive phreatophytes as well as their seed source to allow the farm field to return to production.

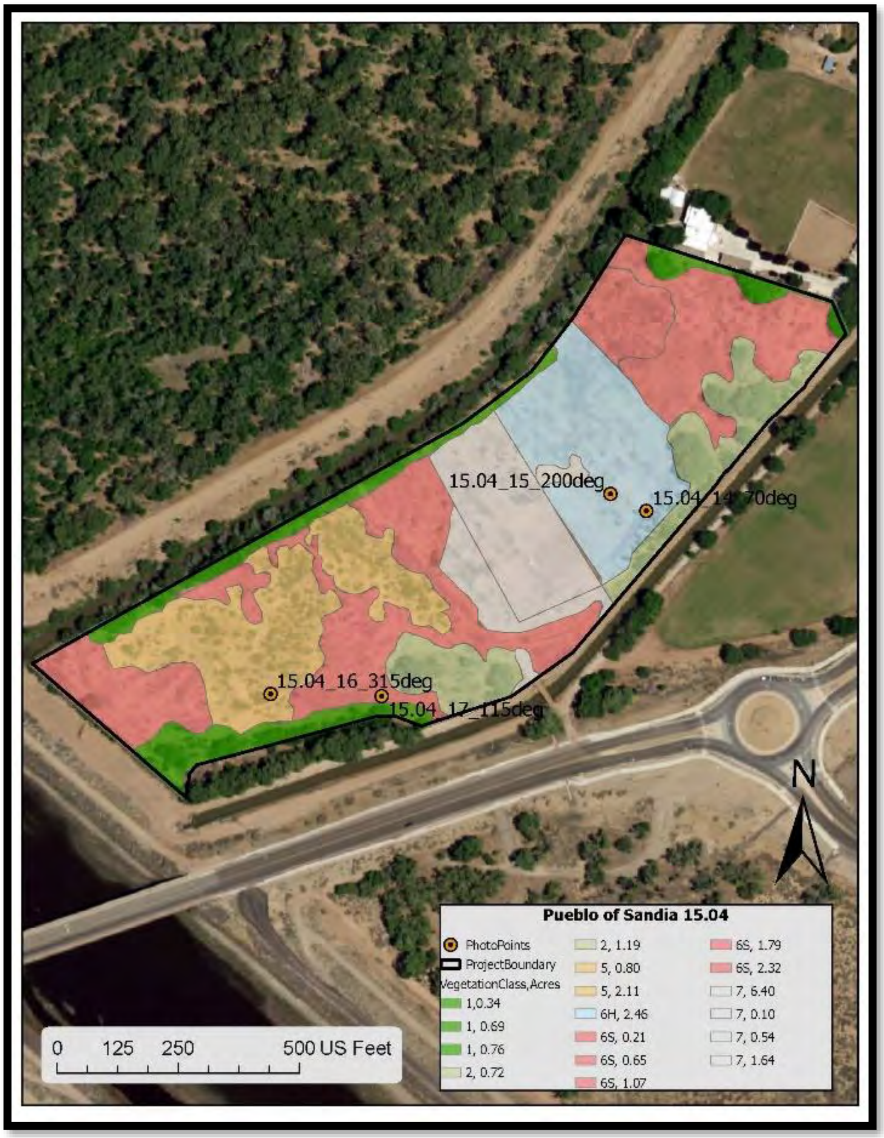

Figure 5. 15.04 in geographic context.

This site is an abandoned farm field where many Siberian elms have grown up along old irrigation ditches. Some salt cedar is present as well as one patch of tree-of-heaven. Alternative methods were discussed for treating tree-of-heaven, including extraction, but at this time they have not been explored. Other exotic species observed include Russian thistle, kochia, and Siberian elm. Native species observed in abundance include cottonwood, cota, sunflower, silverleaf nightshade, amaranth, and winterfat.

Metrics for 15.04 (September 9, 2021)	2021 Score	2015 Score
Relative Native Plant Community Composition	2	1
Vegetation Horizontal Patch Structure	4	2
Vegetation Vertical Structure	1	3
Native Riparian Tree Regeneration	3	1
Exotic Invasive Plant Species Cover	1	1
Project Biotic Score (based on above ratings)	2.1	1.6
Project Biotic Rating	C/Fair	D/Poor
Soil Surface Condition	2	2
Surface Fuels	0.20	0.75

Table 3. Side-by-side comparison of 2015 and 2021 metrics for plot 15.04.

Low scores for this project came from Invasive Exotic Plant Species Cover and Vegetation Vertical Structure. Exotic Invasive Plant Species Cover increased 30%; Siberian elm was the most abundant exotic plant followed by tumbleweed which could be taking advantage of the open spaces created during restoration. Previous monitoring in 2015 also observed Siberian Elm to be the dominant species. Vertical Vegetation Structure score dropped from 2015 due to a larger percentage of the sample area being vegetation structure type 6S. In 2015 Vertical Vegetation Structure was dominated by Type 6H and Type 1 which is characterized as a high structured forest with a well-developed understory. This change makes sense because of the loss of tree species such as Russian Elm, Salt Cedar and Tree-of-Heaven during restoration. The loss of an overstory would create suitable habitat for shrub species to invade and could explain the dominance of 6H structure type observed in 2021. Overall, the score rose from a “D” or “Poor” rating to a “C” or “Fair” rating.

Project 15.05, Buffer Property, Hwy 313, 2nd & 4th Street

Post-treatment monitoring was conducted at this 4.2 -acre project site on September 22nd, 2021 as part of a restoration project targeting non-native phreatophytes scheduled for 2015-2016. The project is located on the Pueblo of Sandia within Sandoval County, NM, between 2nd and 4th streets of the city of Albuquerque. The project was sponsored by the Coronado SWCD and the Pueblo of Sandia Environment Department Bosque Program. Planned treatment includes removal by extraction and mastication of Siberian elm trees as well as Russian olives and salt cedar of various sizes. Restoration goals are to return the area to natural bosque and upland vegetation and preserve existing native vegetation.

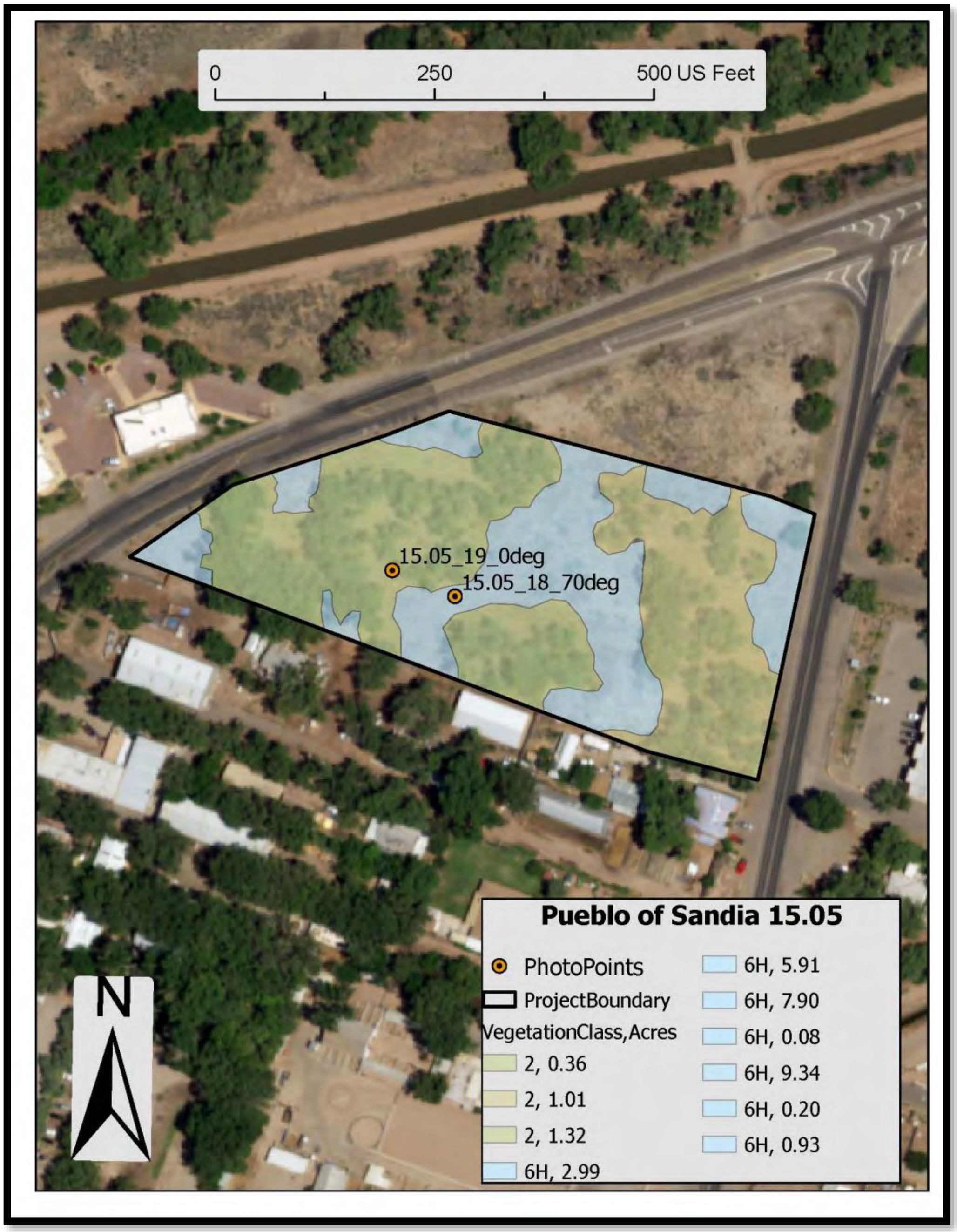

Figure 6 15.05 in geographic context.

This site was recently purchased by the Pueblo. The property is bordered by a fence, though it is incomplete on the northeast side. There is no known development on the property, although there is a two-track road and concrete debris present. There are small to medium Siberian elms present, as well as some Russian thistle. This project has good ground cover, due largely to cottonwood leaves. It also has good canopy cover and shade. Native species observed in abundance included Canada lettuce, Canada wild rye, bursage, cota, and dropseed grass.

Metrics for 15.05 (September 22, 2021)	2021 Score	2015 Score
Relative Native Plant Community Composition	2	2
Vegetation Horizontal Patch Structure	3	2
Vegetation Vertical Structure	2	3
Native Riparian Tree Regeneration	3	1
Exotic Invasive Plant Species Cover	3	1
Project Biotic Score (based on above ratings)	2.5	1.9
Project Biotic Rating	B/Good	C/Fair
Soil Surface Condition	3	3
Surface Fuels	.70	0.55

Table 3. Side-by-side comparison of 2015 and 2021 metrics for plot 15.05

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On average scores increased from 2015. The only score that decreased was Vegetation Vertical Structure, which went from a 3 to a 2. This can be attributed to the loss of Type 1 vegetation structure, which is classified as a tall structure forest with a well-developed understory. Type 1 gave way to Type 2 which is a low structure forest with little to no understory, this could be due to the removal of species like Russian Olive and Tamarisk that would have contributed to a well-developed understory. Type 2 was the dominant vertical vegetation, made up of tall shrubs such as Siberian Elm. Herbaceous cover was the next most dominant vegetation type and includes plants such as dropseed and Alkaline Sakatoon. The site received an overall rating of 2.5 out of 4 which rates it a “B” or “Good”, which is an increase from 2015’s rating of a “C” or “Fair”. Surface fuels increased from 2015. In 2015 they were attributed to leaf litter, it is likely the increase in exotic species cover such as tumbleweed and Redroot Amaranth contributed to the increase in surface fuels.

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).

The goal of 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: Photopoint Table

15.01_1_90deg	9/23/2021 10:12am	100-0066	35.30804538	-106.56151056	90°	Grassy + bareground @24' @90°	Cottonwood stand + Road @290' @90°	-	Olympus Red	CB, RM	Bareground with woody debris, tumbleweed and few grasses
15.01_2_0deg	9/23/2021 11:34am	100-0075	35.30846729	-106.56008259	0°	White Mulberry @43' @10°	Coyote Willow @91' @0°	-	Olympus Red	CB, RM	Fourwing saltbush, tumbleweed and DWD. SE cottonwood
15.01_4_225deg	9/23/2021 12:07pm	100-0077	35.30733833	-106.56178246	225°	Burn Pile @92' @239°	Cottonwood Stand @395' @225°	-	Olympus Red	CB, RM	Exact 225° photo taken and gps location
15.01_4_225deg	9/23/2021 12:17pm	100-0076	35.52763800	-106.78190200	174°	Cottonwood @27' @158°	Jetty Jacks @106' @160°	-	Olympus Red	CB, RM	Matching 2017 photos. Fourwing, tamarix
15.01_5_225_45deg	9/23/2021 1:07pm	100-0078	35.30624790	-106.56353975	225°	Siberian Elm @7-12' @225°	Cottonwood Stand, Start-End @44-130' @230°	-	Olympus Red	CB, RM	Elm saplings, lots of DWD. Mature cottonwood
15.01_5_225_45deg	9/23/2021 1:07pm	100-0079	36.30624790	-105.56353975	45°	Siberian Elm @24' @30°	Cottonwoods @301' @60°	-	Olympus Red	CB, RM	Elm saplings. Facing towards Rio Grande River

15.02_7_180deg	9/24/2021 1:58pm	100-0097	35.28245725	-106.593053	180°	NM Olive @14' @180°	Cottonwoods @283' @180°	-	Olympus Red	CB, RM	NM olive saplings, very open and dry

15.02_6_135deg	9/24/2021 2:54pm	100-0098	35.28191689	-106.5944126	135°	Dirt road @17' @135°	Cottonwood stand @400 @135°	-	Olympus Red	CB, RM	NM olive, road interception news next to water
15.02_8_45deg	9/24/2021 3:21pm	100-0099	35.2807563	-106.594188	45°	NM Olive @13' @45°	Cottonwoods @500' @45°	-	Olympus Red	CB, RM	Next to road, DWD on bank
15.02_9_0deg	9/24/2021 3:37pm	100-0101	35.28077175	-106.5934126	0°	Laying over cottonwood @15' @0°	Cottonwood in back @70' @0°	-	Olympus Red	CB, RM	Matched to 2017, next to road, goat corral to the right
15.02_10_45deg	9/24/2021 3:37pm	100-01012	35.2820393	-106.5900126	45°	Side of road @13' @45°	Cottonwood with hole @181' @45°	-	Olympus Red	CB, RM	Side of road, facing N, cottonwood
15.03_11_180deg	9/2/2021 11:50am	100-0002	35.25086067	-106.5778334	180° S	Road @1' @180°	Elm Tree @210' @180	-	Olympus Red	CB, RM	PC on edge of road next to bobwire fence. Traffoce. Way in back of fence mountains
15.03_12_200deg	9/3/2021 9:19am	100-0003 & 100-0004	35.24769761	-106.578862	200° S	Fence @66' @200° Road @1' @154°	Cottonwood @2000' @200° Cottonwood @2000' @152°	-	Olympus Red	CB, RM	200° is more to the right next to fence + grassland. To the left 313 road + train track, matched photo to 2017 actual 200° photo taken too!
15.03_13_180deg	9/3/2021 9:53am	100-0005	35.23400393	-106.584361	180° S	Road @10' @180°	Cottonwood @440' @180°	-	Olympus Red	CB, RM	313 road, then train track. Cottonwood, dead + live

15.04_14_70deg	9/3/2021 11:37	100-0014	35.21142844	-106.6023407	70deg E	Kochia 21' Sibian 24' @70deg	Siberian Elm @ 300' @70deg	-	Olympus Red	CB, RM	Picture taken right @ 70deg
15.04_14_71deg		100-0015			48deg E	Siberian elm 63' @48deg	Cottonwood @140' @48	-	Olympus Red	CB, RM	Matched photo to both years @ 48deg
15.04_15_200deg		100-0017/ 100-0018	35.21153687	-106.6025885	200deg S	Cornfield @ 111' @200 deg	Cottonwood @ 407' @200deg	-	Olympus Red	CB, RM	Have taken 2 photos 1 @ 200' and another to match 2015 photo
15.04_17_115deg	9/9/2021 11:25	100-0050	35.21033695	-106.6041508	115deg E	Tumbleweed @11.3' @ 12deg	Sign road @500' @115deg	-	Olympus Red	CB, RM	Taken looking @ 115deg
15.04_17_115deg		100-0053			88deg E	Tumbleweed @38' @88deg	Tree of Heaven @141' @88deg	-	Olympus Red	CB, RM	Taken matching 2017 photo
15.04_16_315deg	9/9/2021 12:07	100-0055	35.21037045	-106.6049264	315deg	ULPU @ 51' @315 deg	ULPU @154' @315deg	-	Olympus Red	CB, RM	ULPU stand, DWD slash, some open patchy areas

15.05_18_70deg	9/22/2021 9:55	100-0056	35.20707154	-106.6106522	70deg	Cottonwood @20' @70deg	Line of Cottonwood @250' @85deg	-	Olympus Red	CB, RM	DWD cottonwood 35' and Sagebush @ 101' @75-94deg
15.05_19_0deg	9/22/2021 10:14	100-0057	35.20711819	-106.6108939	0deg	Cottonwood @18' @20deg	3 Branch Cottonwood @79' @8deg	-	Olympus Red	CB, RM	Cottonwood stump broken to p @ 76' @ 3deg, Road @ 9odeg

Appendix II: All current bosque monitoring options

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/ 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 III: 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.

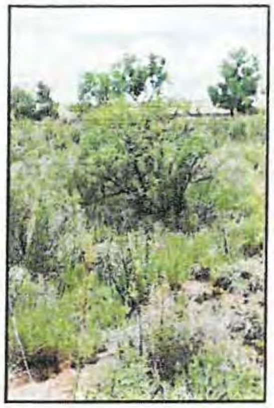
Type 2 - Low Structure Forest with little or no understory.

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 (1.5-5 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.

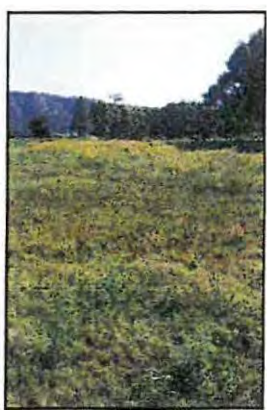


Type 6S- Short Shrub Stands.

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.