Rio Puerco Project 20-03

Pre-treatment Monitoring Report

2020/2021

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New Mexico Forest and Watershed Restoration Institute

conserving natural resources *for our future*

East Rio Arriba Soil & Water Conservation District

Contents

Acronyms and Abbreviations

Acronym, Abbreviation, or Term	Explanation or Definition as used by NMFWRI
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 remote-sensing monitoring assessment performed on a non-native phreatophyte removal project submitted by the East Rio Arriba Soil and Water Conservation District for the Rio Puerco project to the Greater Rio Grande Watershed Alliance in 2020.

Rio Puerco Project

This 66.5-acre project is an initial treatment on private land to remove and treat non-native phreatophyte tree species and down, dead fuels. According to the 2020 Request for Proposals, the focus will be medium-density, pole and, mature Russian olive, salt cedar, Siberian elm and juniper trees, likely by extraction and mastication. The site is located in the riparian zone on both sides of the Rio Puerco and is often flooded in early spring. The Rio Puerco is a source of irrigation water for the community, and treatment work must avoid unnecessary river crossing and herbicides, or runoff of any soil and woody debris into the channel. Treatment is planned to stop 20 feet from the irrigation ditch head gate and that there will be a 25-ft buffer downstream of the project to provide debris catchment to filter chips/mastication material before it can reach a County Road Bridge construction area, which is not participating in this project. Overstory cottonwoods, fence lines, powerlines and vegetation below the ordinary high water mark of the Rio Puerco may also be excluded from treatment. The project goals include restoring the riparian area to a more natural state and promoting native plant species, improving the wildlife corridor, reducing fire hazards, and improving overall long-term watershed health. The project will need maintenance by herbicide spray in subsequent seasons as well as monitoring 5 years after initial treatment to evaluate effectiveness.

Due to the COVID-19 Pandemic, traditional photo points were not collected as travel restrictions and safety issues limited our traditional field season. Remote Sensing methods were used to try to assess the pre-treatment characteristics of the riparian site using LiDAR (Light Detection and Ranging) and Aerial Imagery. These methods and protocols are outlined in Appendix III. Plot coordinates and other project geospatial data can be found in Appendix I.

Site Description

The 20-03 site is located in Rio Arriba County near Youngsville, NM. The nearby city of Abiquiu receives an average annual precipitation of 10.33 inches. The average high temperature is 87 degrees Fahrenheit in July. The average low is 17 degrees Fahrenheit in January. (US Climate Data, 2020)

According to the NRCS Web Soil Survey, the project area is comprised of 78.9% Walrees-Abiquiu complex, 0 to 2 percent slopes, 18.1% Jocity-Gilco complex, 1 to 3 percent slopes, 1.6% Wenota silty clay loam, 1 to 6 percent slopes, 1.4% Los Marios extremely cobbly sandy clay loam, 10 to 35 percent slopes, and 0.1% Hagerman-Silver fine sandy loams, 2 to 7 percent slopes. Ecological sites contained within the project area include Rangeland sites R035XA112NM Loamy, R035XB004NM Clayey, and R036XB010NM Salty Bottomland; the Forestland site F036XA005NM Riverine Riparian was also reported. (NRCS USDA, 2020)

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 Clayey ecological site typically supports a grassland state with a minor shrub and forb component. Grasses commonly include James' galleta, alkali sacaton, blue grama, Indian ricegrass, needle and thread, New Mexico feathergrass, western wheatgrass, threeawn, squirreltail and spike dropseed. Forbs commonly include woolly plantain, locoweed, Cuman ragweed, and threadleaf ragwort. Common shrubs include big sagebrush, fourwing saltbush, yellow rabbitbrush, pale desert-thorn, horsebrush, broom snakeweed, and winterfat. Bare soil may comprise up to 60% of the site. (USDA NRCS, n.d.)

Salty Bottomland is typically dominated by alkali sacaton with subdominant western wheatgrass. Other grasses can include bottlebrush squirreltail, galleta, blue grama, and Indian ricegrass. Inland saltgrass is often found in patches. Fourwing saltbush is the dominant shrub. Other shrubs commonly found may include greasewood, big sagebrush, and other salt bush species. Continuous heavy grazing typically results in a decrease in grasses such as western wheatgrass, Indian ricegrass, and bottlebrush squirreltail (USDA NRCS n.d.).

The Riverine Riparian ecological site is made up of sediments adjacent to perennial streams and vegetation is determined largely by local hydrology. Examples of typical species at different strata include Fremont cottonwood, sandbar willow, Western wheatgrass, and Nebraska sedge (USDA NRCS n.d.).

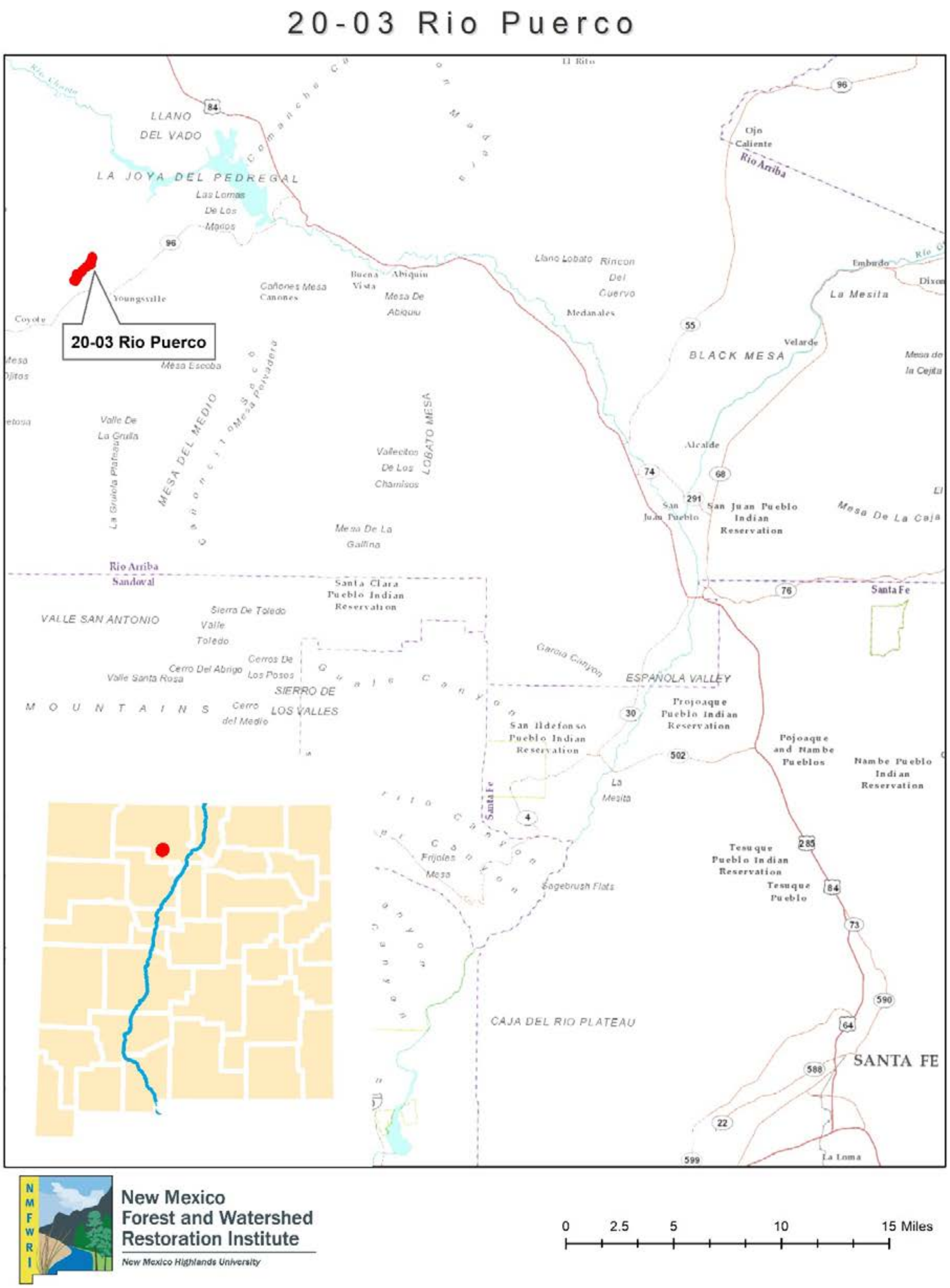

Figure 1. Project 20-03 in geographic context.

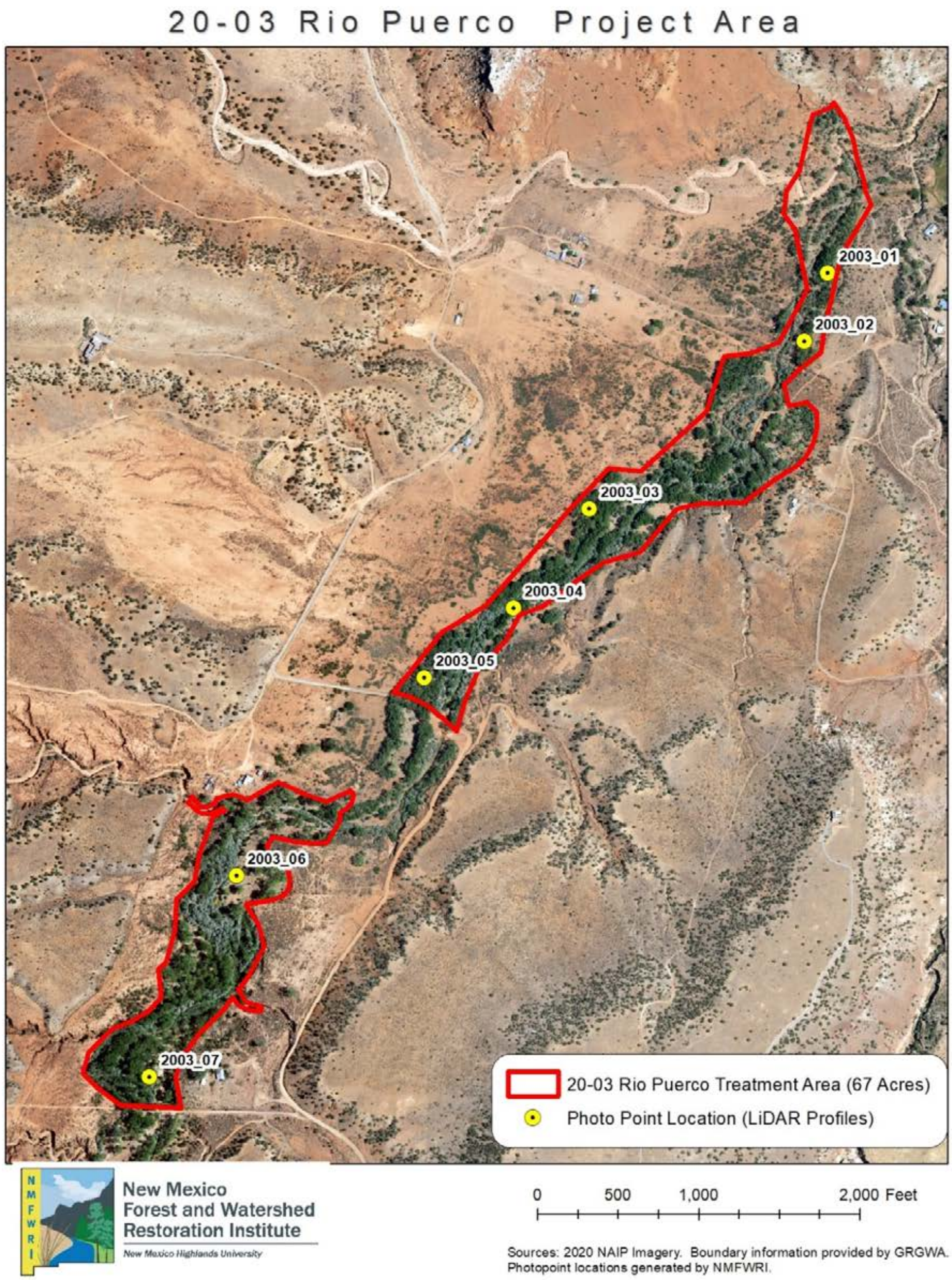

Figure 2. 20-03 Rio Puerco project outline.

Pre-Treatment Monitoring

Vegetation Vertical Structure Type Classification

To develop a vegetation height classification, LiDAR and NAIP imagery were analyzed using eCognition software. An object oriented classification systems was used so that spectral characteristics as well as height above ground values of the vegetation could be incorporated into a robust classification system. (See Appendix III for details.)

20-03 Rio Puerco was classified according to modified Hink and Ohmart defined classes. The acreage for each cover type are provided below keeping in mind that the total acreage for the treatment acres was 67 acres.

Type 1-High Structure Forest with a well-developed understory (24.3 Acres). This represents tall mature to intermediate-aged trees {>5 m [>15 feet]) with canopy covering >25% of the area of the community and understory layer {0-5 m [0-15 feet]) covering >25% of the area of the community. Substantial foliage is in all height layers.

Type 5 -Tall Shrub Stands (15.6 Acres). Young tree and shrub layer only {1.5-5 m [4.5-15 feet]) covering >25% of the area of the community. Stands dominated by tall shrubs and young trees, may include herbaceous vegetation underneath the woody vegetation.

Type 65- Short Shrub Stands (14.4 Acres). 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.

Type 6H- Herbaceous (4 Acres). Herbaceous vegetation covering >10% of the area of the community. Stands dominated by herbaceous vegetation of any type except obligate wetland species. Woody species absent or <10% cover.

Bare Ground (8.2 Acres). Areas of bare soil or bare rock with no vegetative cover.

See Figure 4 on the following page for a map showing the distribution of these structure types.

Vegetation Structure Type	Percent of Total Area
Forest Type 1	36.46%
Type 5 Tall Shrubs	23.51%
Type 6S Short shrubs	21.68%
Bare Ground	12.37%
Type 6H Heraceous	5.99%

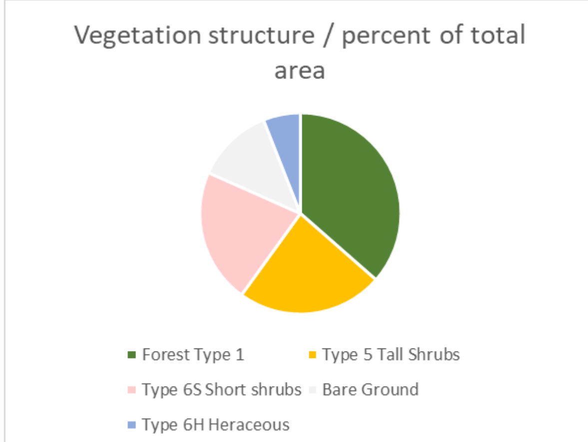

Figure 3. Vegetation Structure Type percents for 20-03.

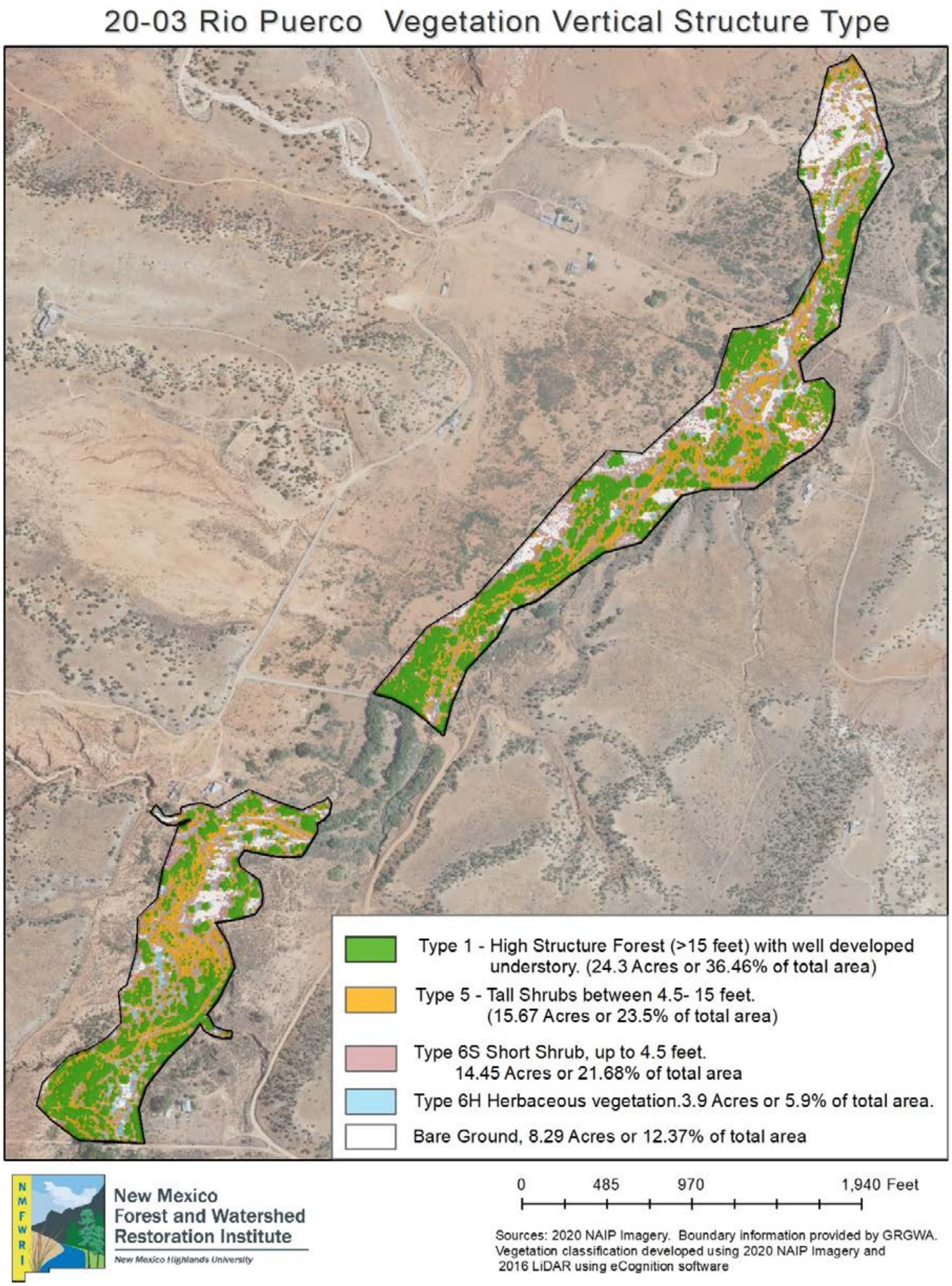

Figure 4. Vegetation structure classification for 20-03.

LiDAR Profiles

In order to visualize the pre-treatment area without photographs, LiDAR profiles were created at each photopoint location. Again, due to the COVID-19 Pandemic, traditional photo points were not collected as travel restrictions and safety issues limited our traditional field season. Seven profiles were created; one at each photo point location. The transects were drawn using the photo point in the center of a 20 x 130 meter window or 65 x 426 feet.

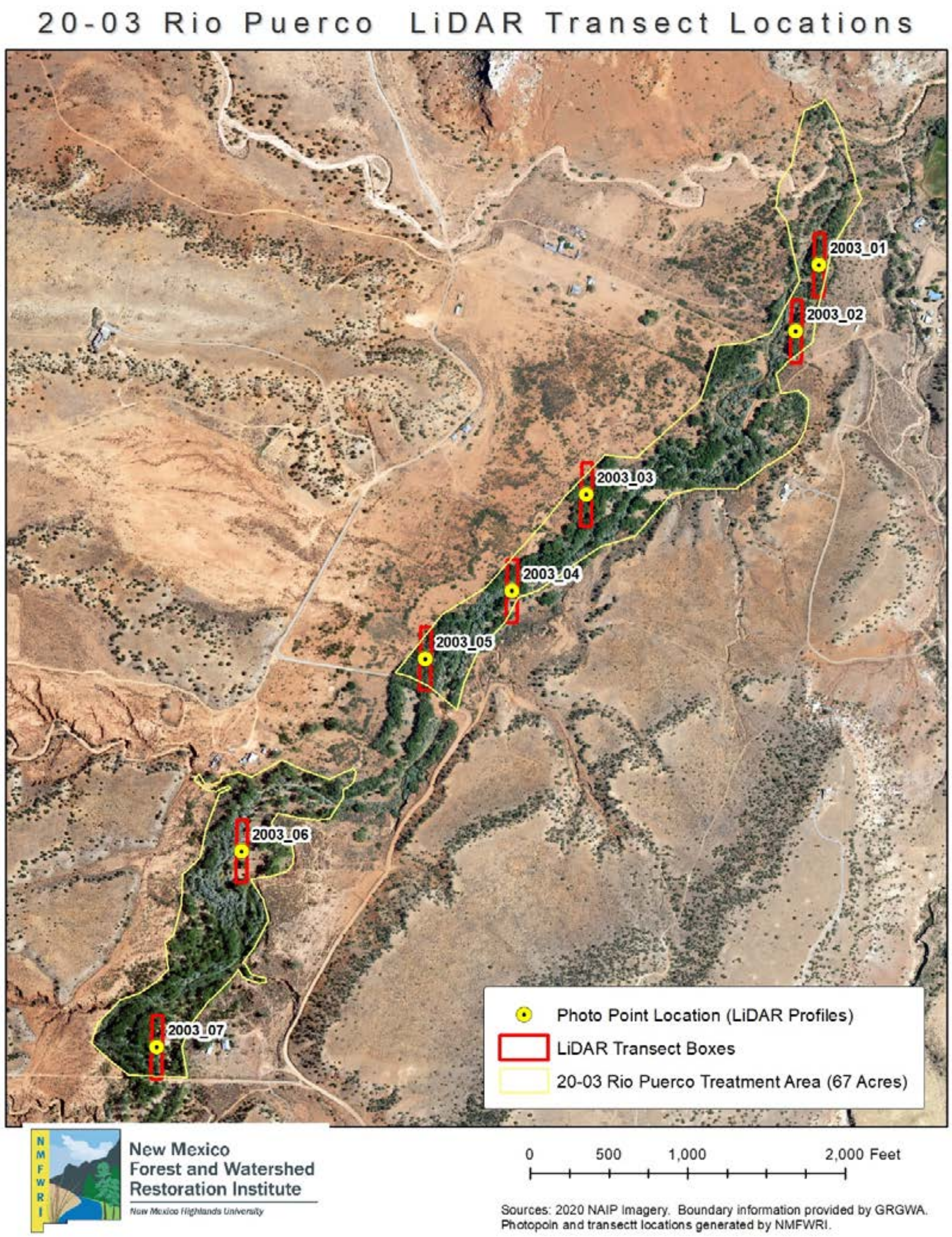

Figure 5. LiDAR Transect Locations for 20-03.

Conclusions & Plans going forward

This project will be re-measured five years post-treatment to monitor the success of treatment in effecting long-term change. The re-measurement plans will include both field measurements on the plots and remote sensing analysis. 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. The water on site will likely support heavy re-sprouts, and treatment maintenance will be key.

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Appendix I – Photopoint and Plot Coordinate Table

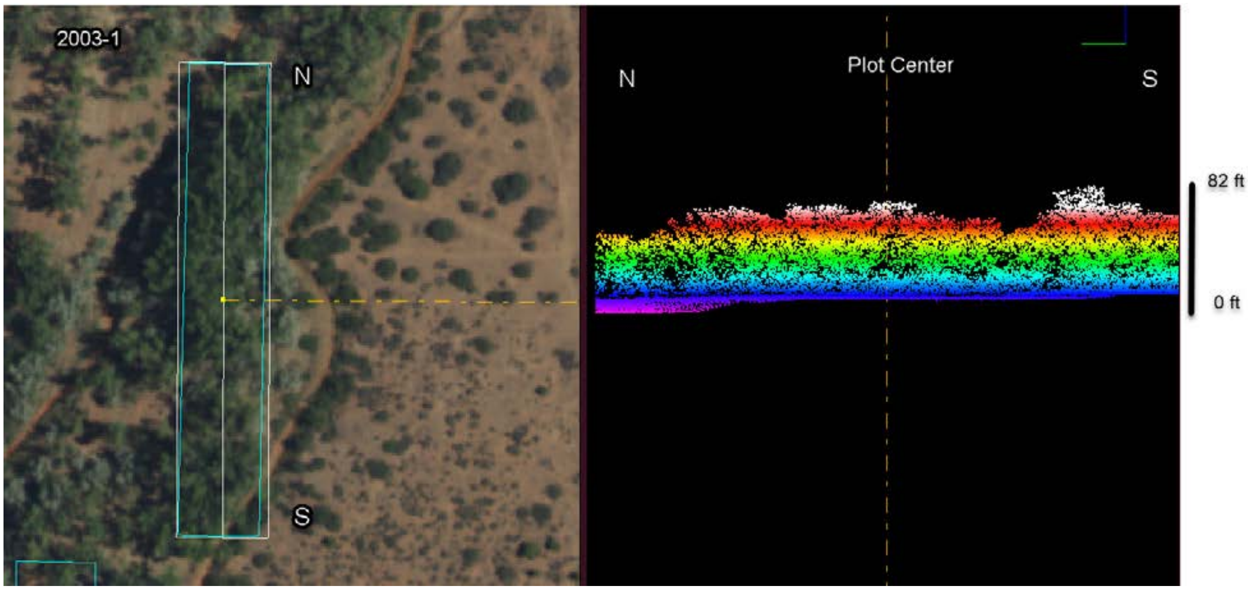
Name	Latitude	Longitude
2003_01	36.20990896760	-106.57804819400
2003_02	36.20874364350	-106.57852257200
2003_03	36.20583526530	-106.58297676600
2003_04	36.20413112340	-106.58454365700
2003_05	36.20292471340	-106.58638680100
2003_06	36.19951184200	-106.59027386800
2003_07	36.19606851530	-106.59202810800

Appendix II – LiDAR Transect Images

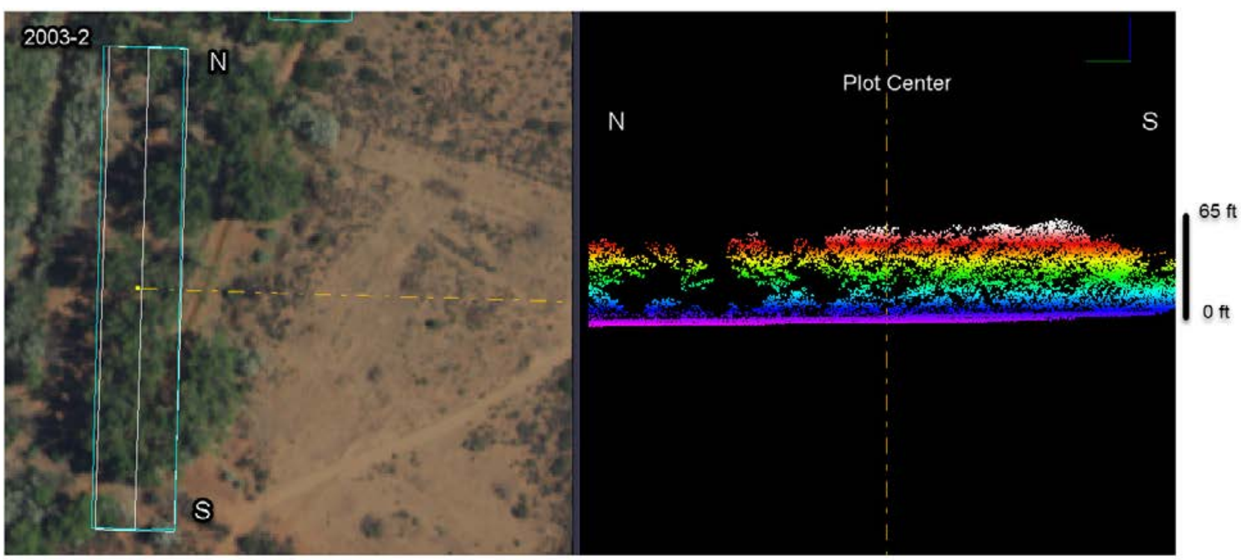
These LiDAR transects were drawn using the photo point in the center of a 20 x 130 meter window (65 x 426 feet). The transects were drawn north to south, and the aerial view of the areas is on the left in the images below. On the right is the LiDAR profile. The scale on the far right of each image represents the vertical height, and is marked from 0 feet (ground level) to the highest object height recorded in each transect.

These transects provide a visual representation of the canopy cover and vegetation structure present on site.

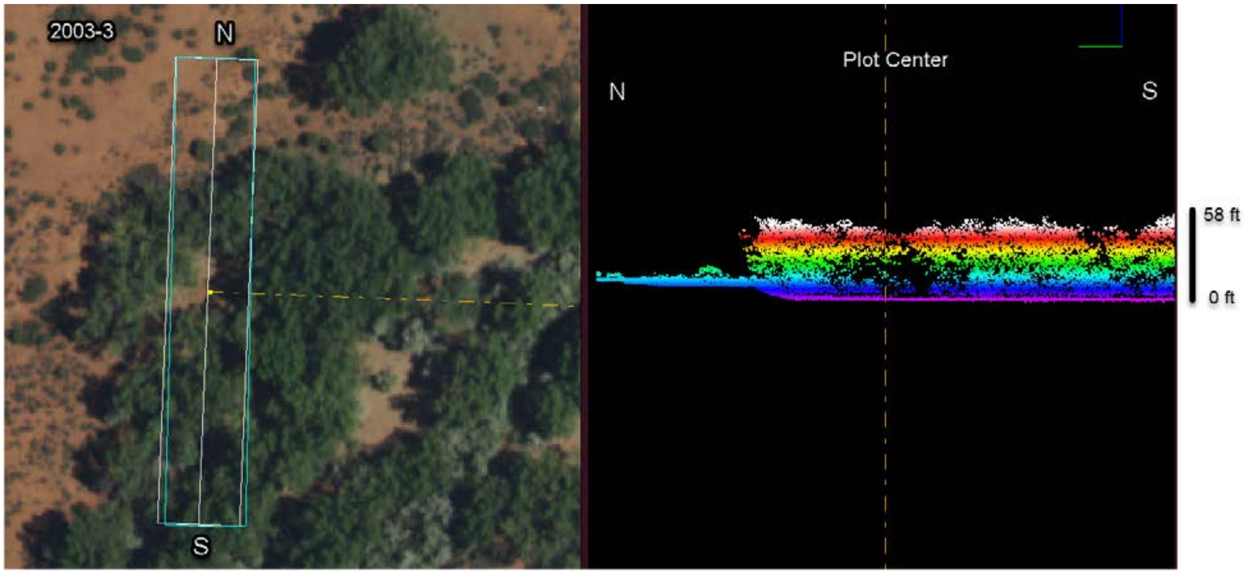
2003 – 1 LiDAR Profile



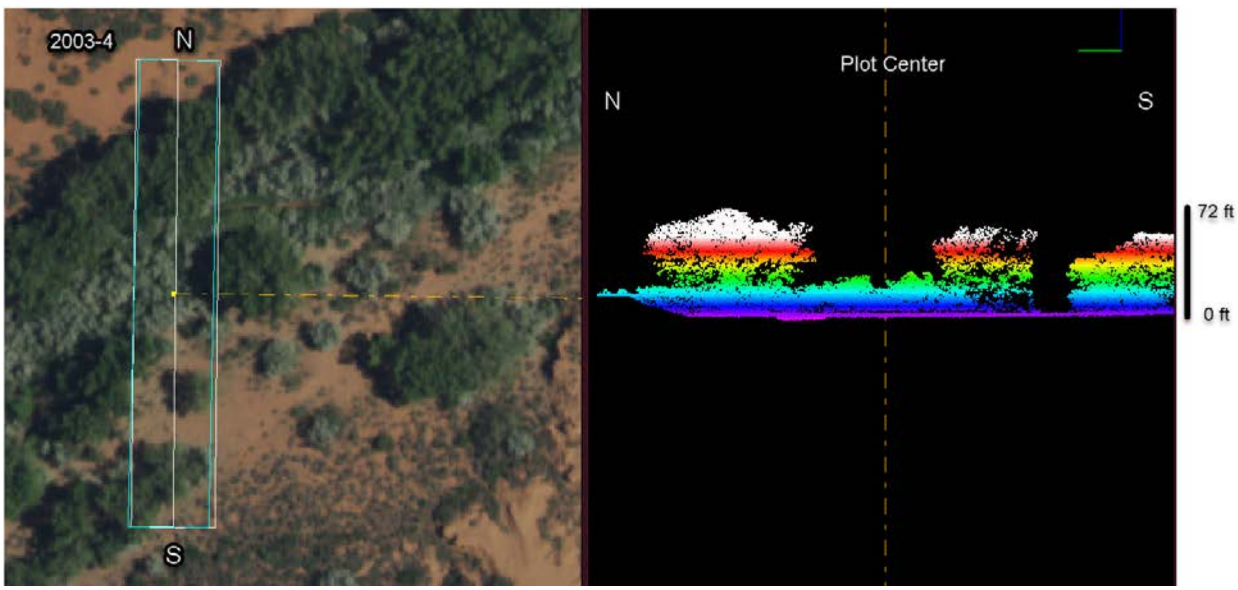
2003 – 2 LiDAR Profile



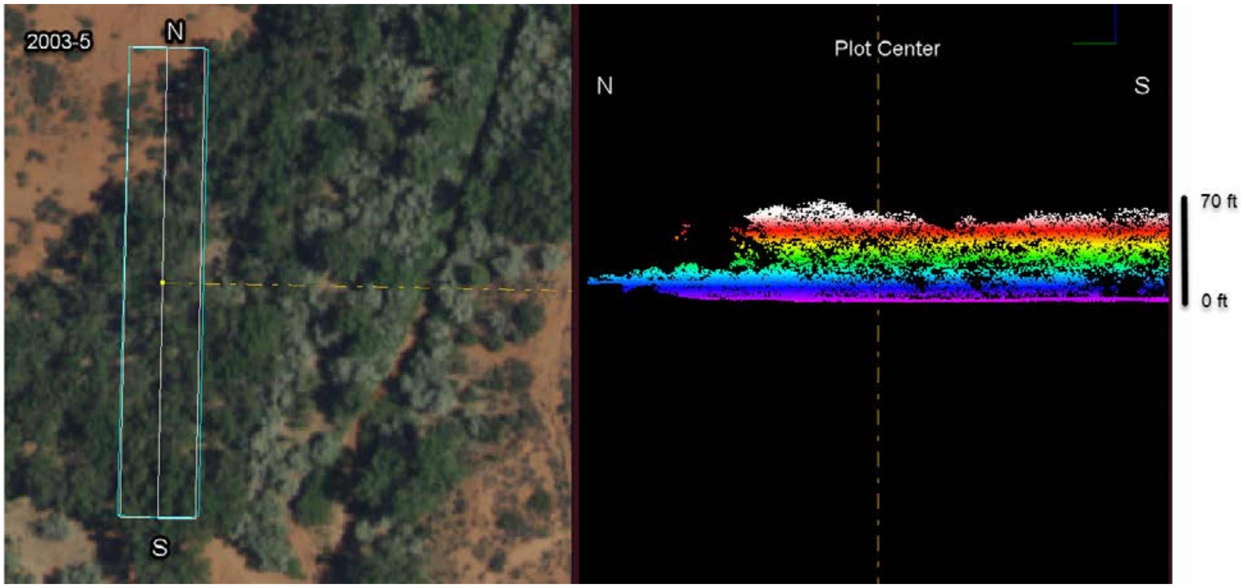
2003 – 3 LiDAR Profile



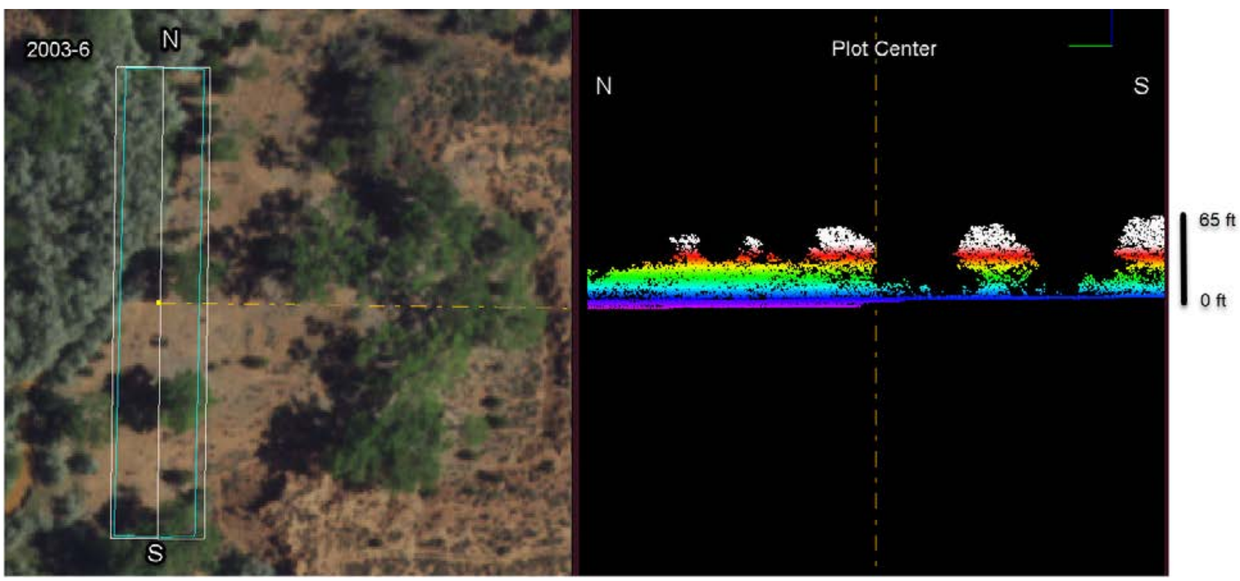
2003 – 4 LiDAR Profile



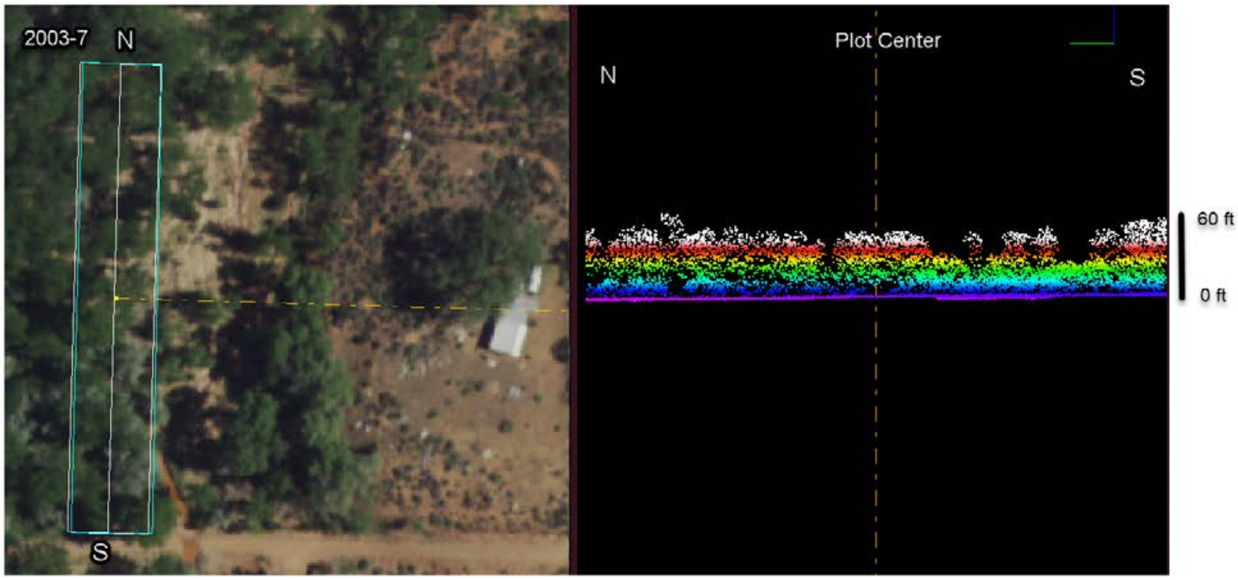
2003 – 5 LiDAR Profile



2003 – 6 LiDAR Profile



2003 – 7 LiDAR Profile



Appendix III – Remote Sensing Monitoring and Analysis Methods

Due to the COVID-19 Pandemic, traditional photo points were not collected as travel restrictions and safety issues limited our traditional field season. Remote Sensing methods were used to try to assess the pre-treatment characteristics of the riparian site using LiDAR (Light Detection and Ranging) and Aerial Imagery.

Using LiDAR, one is able to develop a very accurate elevation model as well as estimating surface feature heights and characteristics by using a multiple return, high density, LiDAR data set. Airborne laser sensors provide information to analyze forests in a 3-D format over large areas. Current LiDAR systems provide georeferenced information of the vertical structure of land cover features. Laser pulses from a sensor carried aboard an aircraft are directed toward the ground to collect ranging data to the top of the canopy, and in some instances, to sub canopy layers of vegetation and to the ground (Popescu, 2002).

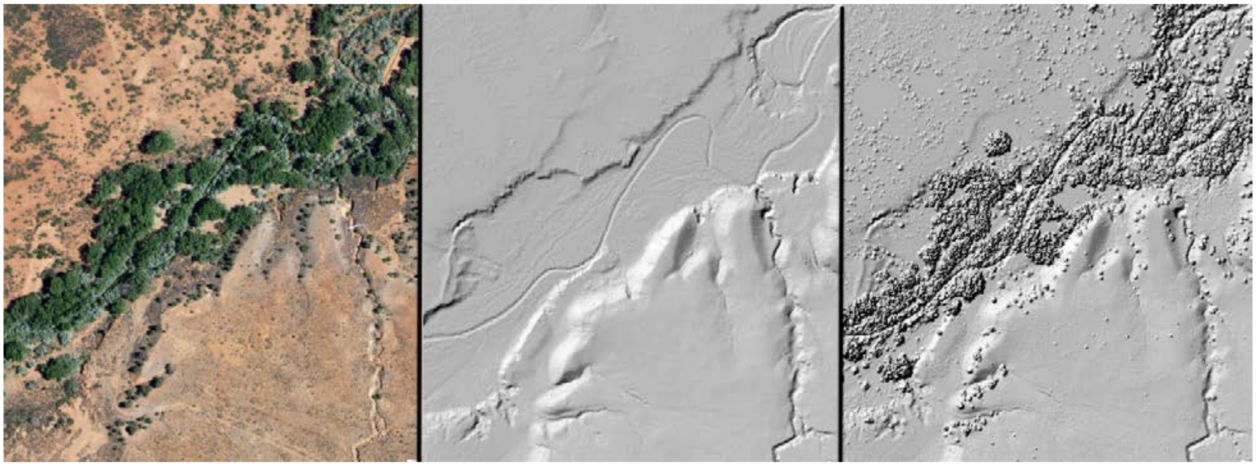
To develop a vegetation height classification, LiDAR and NAIP imagery were analyzed using eCognition software. An object oriented classification systems was used so that spectral characteristics as well as height above ground values of the vegetation could be incorporated into a robust classification system. LiDAR was also used to develop Vegetation Height Profiles for areas around the photo point locations.

LiDAR (Light Detection and Ranging) point clouds for this county were collected in 2016 and 4-Band 2020 Aerial Imagery with the Near Infra-Red band was incorporated to develop a classification stratifying vegetation within height classes. LiDAR was also used to develop Vegetation Height Profiles for areas around the photo point locations.

2016 LiDAR Processing

2016 LiDAR for the Rio Puerco site was downloaded from The National Map (https://usgs.gov/NationalMap/LidarExplorer) in LAZ format and then were converted to LAS.

Using the 2016 LiDAR, A Digital Terrain Model (DTM) was created by filtering only the point clouds classified as ground and then only those ground point clouds were converted to a raster DTM. Next, LiDAR first returns were filtered and selected to represent surface features. Only those first returns were converted to a raster Digital Surface Model (DSM). Bird and other noise that were not surface features were removed before creating the raster DSM. In order to get true heights above ground the Digital Surface Model was subtracted from the Digital Terrain model creating a Normalize Digital Surface Model (nDSM). The values of the nDSM were heights above ground in meters.



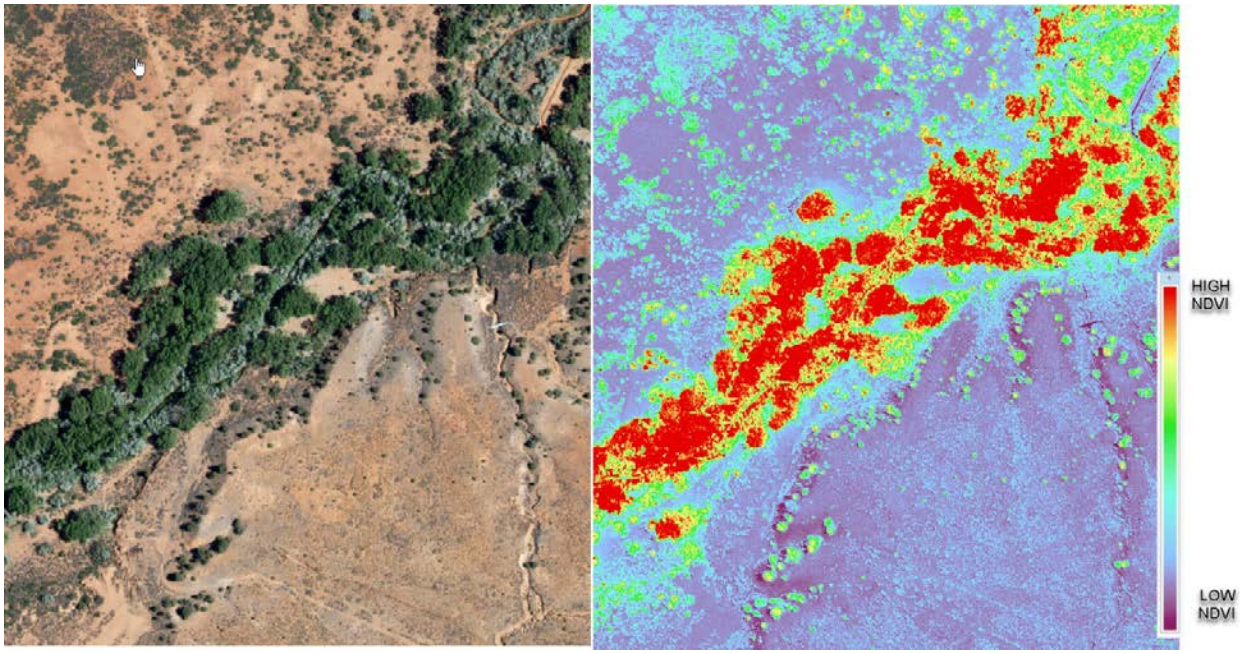
2020 NAIP *LiDAR Derived Digital Terrain Model* *LiDAR Derived Digital Surface Model*

2020 National Agriculture Imagery Program (NAIP) Imagery

The other input to this classification was the 2020 National Agriculture Imagery Program (NAIP) digital ortho photography. The National Agriculture Imagery Program (NAIP) acquires aerial imagery during the agricultural growing seasons in the continental U.S. A primary goal of the NAIP program is to make digital ortho photography available to governmental agencies and the public within a year of acquisition.

The 4-Band 2020 NAIP for Rio Puerco was downloaded from Earth Explorer (https://earthexplorer.usgs.gov/)

The 2020 NAIP ortho photography are 4-Band images. Band 1 is Visible Red, Band 2 is Visible Green, Band 3 is Visible Blue, and Band 4 is Near-InfraRed. Having the Near-InfraRed band is very important for vegetation assessments and necessary to calculate the Normalized Difference Vegetation Index (NDVI). This index is widely used to assess vegetation health and leaf structure. NDVI takes into account the amount of red energy that is absorbed by chlorophyll and the amount of near-infrared energy that is reflected by the cellular structure of the leaf (because the red and near infrared measurements are normalized in an indirect measure of vegetation health). The formula is (NIR – Red)/(NIR + Red), where NIR is the Near Infrared Band, and Red is the Red Band (Carlson & Ripley, 1997).



Normalized Difference Vegetation Index NDVI Calculation

Vegetation Vertical Structure Classification using eCognition (modified Hink and Ohmart)

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.

Having height information with LiDAR greatly increases the accuracy of the classification. Though the use of traditional remote sensing is an effective means of mapping and monitoring land cover, the mapping of small shrubs and trees based only on spectral information is challenged by the fact that shrubs and trees often spectrally resemble grassland and thus cannot be safely distinguished and classified. With the aid of LiDAR-derived information, such as height, the classification of spectrally similar objects can be improved (Hellesen & Matikainen, 2013).

Image segmentation within eCognition was based on elevation surface models. The 4-Band NAIP imagery was used to calculate image brightness values and NDVI values were calculated and both were used as inputs to identify vegetated and non-vegetated areas. The image was classified to identify vegetation vertical structure types representative of the modified Hink and Ohmart system developed by NMED (Muldavin, 2014). LiDAR profiles were used to identify understory vegetation to determine if forested area were Types 1 or Type 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 resulting classification was exported from eCognition as a Raster image and acreages were calculated.

Appendix IV – 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.

Appendix V - 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)

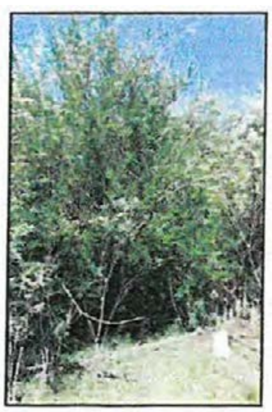
Type 1 - High Structure Forest with a well-developed understory.

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.

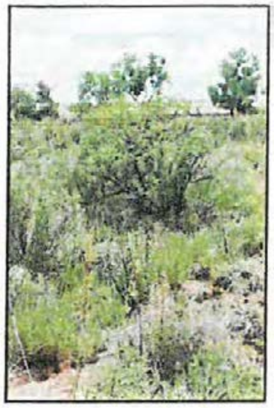
Tall mature to intermediate-aged trees (>5 m [>15 feet]) with canopy covering >25% of the area of the community (polygon) and understory layer (1-5 m [3-15 feet]) covering <25% of the area of the community (polygon). Majority of foliage is over 5 m (15 feet) above the ground. (This type incorporates 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.

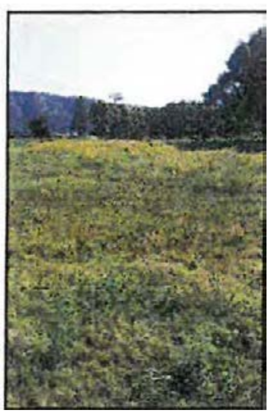


Type 6S-Short Shrub Stands.

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.