Lava SWCD Grants Projects 15-15 and 15-20

Pre-treatment Monitoring Report

2015

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conserving natural resources *for our future*

Lava & McKinley SWCDs

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 assessments performed on two non-native phreatophyte removal projects submitted by the Lava SWCD to the Greater Rio Grande Watershed Alliance. 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 2.0, 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 wetland assessment for use within the NMRAM (see Appendix IV). First, vegetation communities were mapped out by patch (polygon) according to the modified 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 eCognition Software

These projects were also analyzed by our GIS specialist, in large part because the size of project 15-15 reduced confidence in the standard low-intensity monitoring methods when applied to the project as a whole. Because LiDAR was not available for these projects site, the goal of the GIS analysis was to estimate vegetation cover in two different classes: trees and urban vegetation (e.g. lawns), and salt cedar, from existing aerial photography. Sagebrush and other understory vegetation was removed to simplify analysis.

Object based image classification systems, such as eCognition software, allow 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. In large areas where more detailed vegetation surveys are cost prohibited, eCognition provides a means to characterize a landscape using readily available aerial photography.

For the Grants and Mt Taylor areas, 2014 NAIP (National Agriculture Imagery Program) imagery was acquired. 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/).

NAIP was collected in 2014 with the near infrared (NIR) spectral band. The 4 band imagery (Red, Green, Blue, and NIR) at 1 meter cell size is available statewide. Having the NIR band allows for a greater analysis of vegetation and the calculation of the Normalized Difference Vegetation Index (NDVI). NDVI is a band ratio of the visible red and the near infrared spectral bands and is calculated using the following formula: (NIR – Red)/(NIR+Red). This makes vegetation monitoring and analysis feasible over large areas at no cost for image collection.

To identify dominate vegetation types, the image was first classified to identify salt cedar areas based on image object properties of Hue, Saturation, and Intensity and NDVI values of the image objects. The resulting classification was further stratified to identify individual trees found close to urban areas. The classification was based on finding the right threshold values for each feature. To determine specific threshold values, information about each image object could be displayed and tested to determine if those values were appropriate for the given land cover feature. The resulting classification was converted to an ArcGIS shapefile and acreage totals could be estimated.

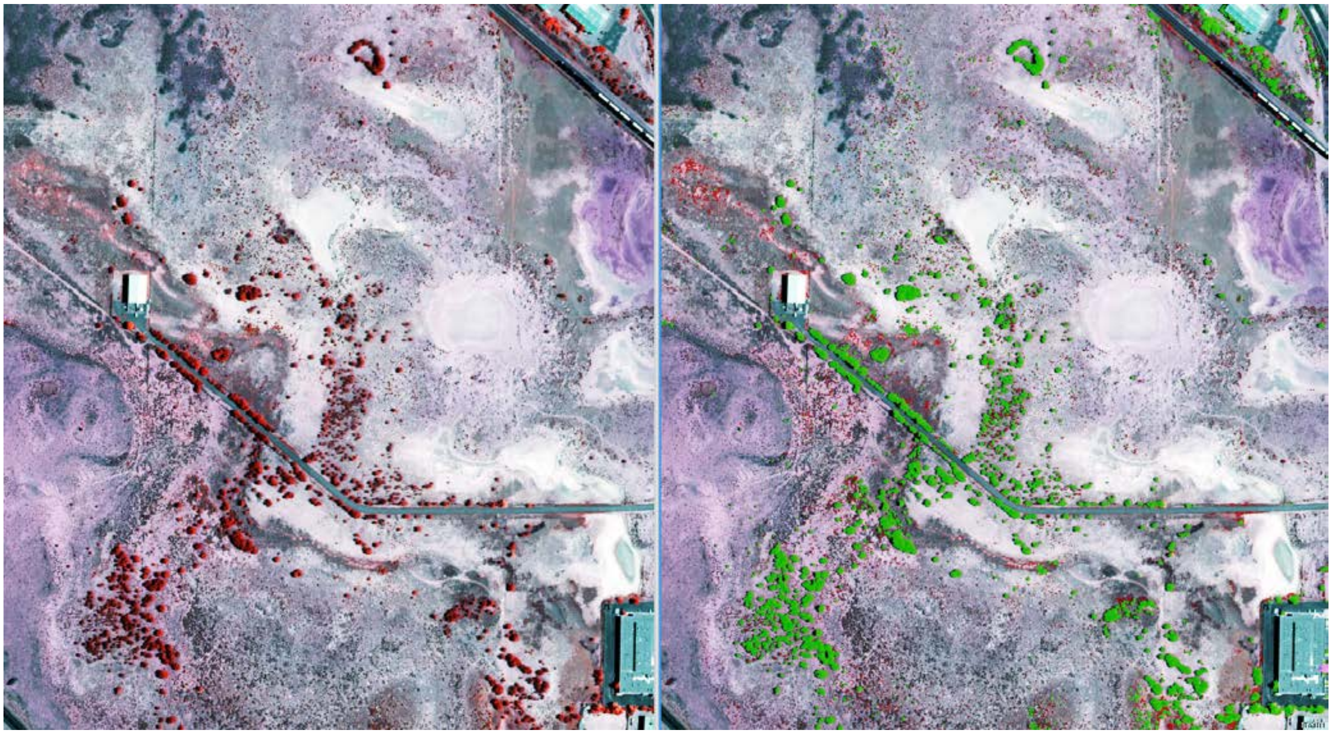

Figure 1. Example of eCognition classification for the Grants area. Left is the input 2014 NAIP False color composite. Right image is the eCognition classification, Salt Cedar dominated areas are in green.

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:

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

Other persons contacted:

- Fred Rossbach, Field Coordinator, Greater Rio Grande Watershed Alliance

Grants Projects

Projects 15-15 and 15-20 are located in and to the south of the city of Grants, New Mexico.

Grants receives an average of 10.4 inches of rain annually. Temperatures range from an average high of 88 degrees Fahrenheit in July, and an average low of 14 degrees Fahrenheit in January (City-stats, 2016). According to the NRCS Web Soil Survey, project area 15-15 is 44% Warm Springs loam, which is ecological site type R036XB009NM Salt Meadow, 30% Lava flows, 17% Viuda-Penistaja-Rock outcrop complex (ecological sites R036XB007NM Malpais and R035XA112NM Loamy), and 8% Venadito clay loam, ecological site type R035XA119NM Clayey Bottomland.

Project area 15-20 is 100% Venadito clay loam and R035XA119NM Clayey Bottomland.

The Salt Meadow ecological site typically supports a grassland state dominated by alkali sacaton and inland saltgrass; fourwing saltbush is the dominant shrub. In a deteriorated state, the site supports a plant community dominated by inland saltgrass, seepweed, iodinebush, salt cedar and bare ground. Other common grasses could include salsedge, foxtail barley, mat muhly, western wheatgrass, nuttall alkaligrass and alkali cordgrass. (Sylvester, 2002)

The Clayey Bottomland ecological site typically supports a grassland state dominated by western wheatgrass, blue grama, galleta, and alkali sacaton. It can also be found in a shrub-dominated state where dominant vegetation is rabbitbrush, fourwing saltbush, galleta and other grasses, as well as a bare state with sparse annual vegetation. (USDA NRCS, 2005)

The Malpais ecological site typically supports a grassland state dominated by blue grama and sideoats grama. Other common vegetation includes western wheatgrass, little bluestem, spike muhly, black grama, galleta, New Mexico feathergrass, alkali sacaton, winterfat, fourwing saltbush, broom snakeweed, and scattered piñon and juniper. In a detoriated state the grass community may become sod-bound, dominated by blue grama sod, threeawns, wolfstail and snakeweed. (USDA NRCS, n.d.)

The Loamy ecological site typically supports a grassland state dominated by blue grama, western wheatgrass, galleta, ring muhly, dropseeds, and/or threeawns. It can also be found in a piñon-juniper invaded state (dominated by piñon, juniper, and blue grama), a grass/succulent-mix state (dominated by blue grama, cholla and prickly pear), a shrub-dominated state (dominated by rabbitbrush or horsebrush and blue grama), as well as a bare state with sparse grass. (USDA NRCS, 2002)

Project 15-15, Southeast Grants

Monitoring was conducted at this site on September 16, 2015 as part of a restoration project targeting non-native phreatophytes scheduled for 2015-2016. The project is located within Cibola County, NM, on the southeast side of the city of Grants (see Figure 2 below). It is an upland site, bordered by urban development, the Atchison-Topeka railroad, and US I-40. The project was sponsored by the Lava SWCD. Planned treatment includes removal of nonnative phreatophytes. Restoration goals are to remove predominantly salt cedar, with some Russian olive and Siberian elm in order to create a more natural state, reduce fire hazard, promote native species, and increase awareness of bosque restoration efforts.

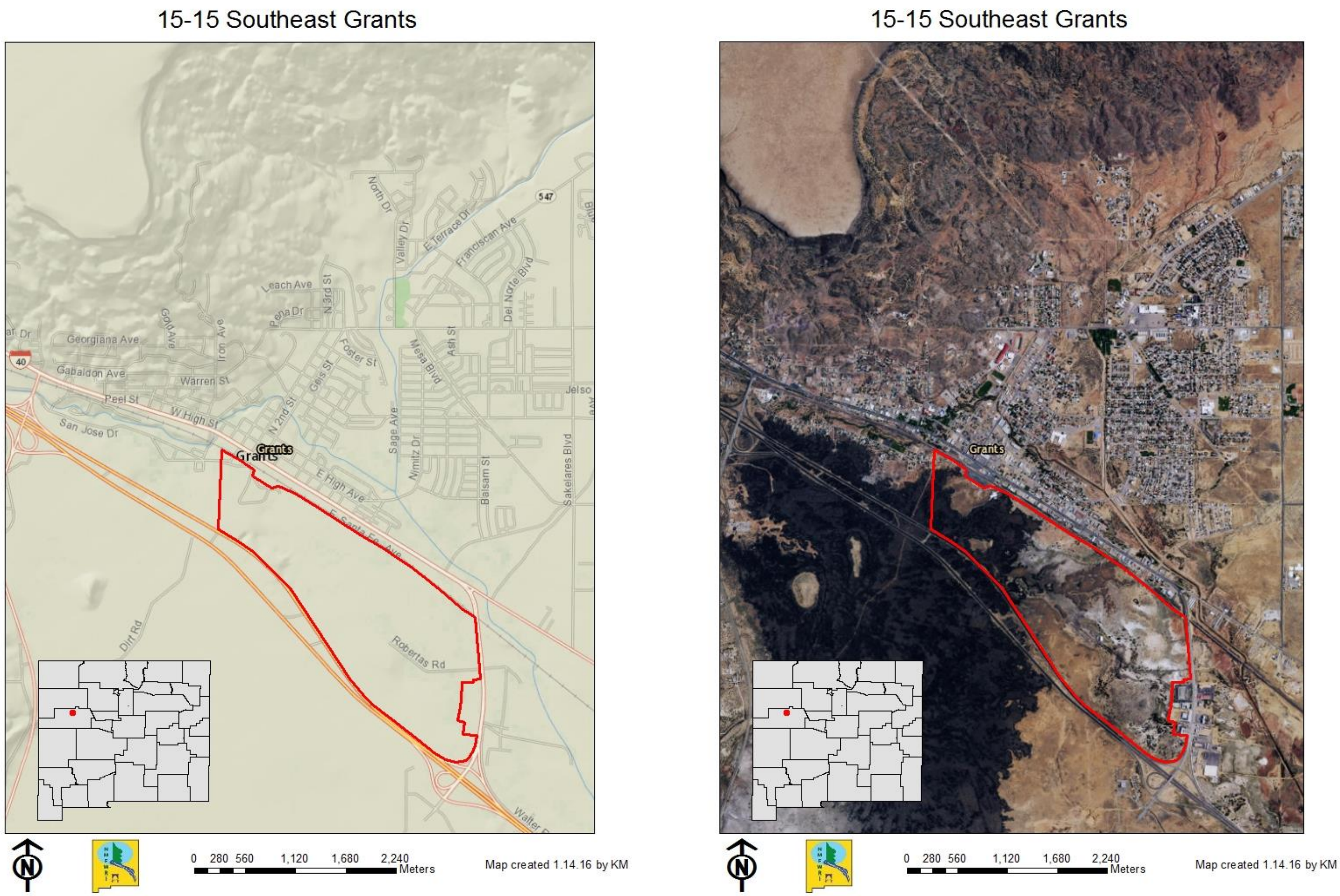

Figure 2. 15-15 Southeast Grants relative to the city of Grants.

Project 15-15 covers a large area along the railroad and US I-40 which is largely undeveloped. There are salt flats/alkali sink/playas on the NE side, and saltgrass scattered across the southern half of the site. There is no evidence of water movement across most of the site. Salt cedar is common, particularly in the eastern half of the site. One main road (Robert Rd) leads to a building near the center of the project, and several smaller two-tracks crisscross the project allowing access to billboards on the south side. Color balance has been altered in Figure 3 for better visibility of the sketched-in roads.

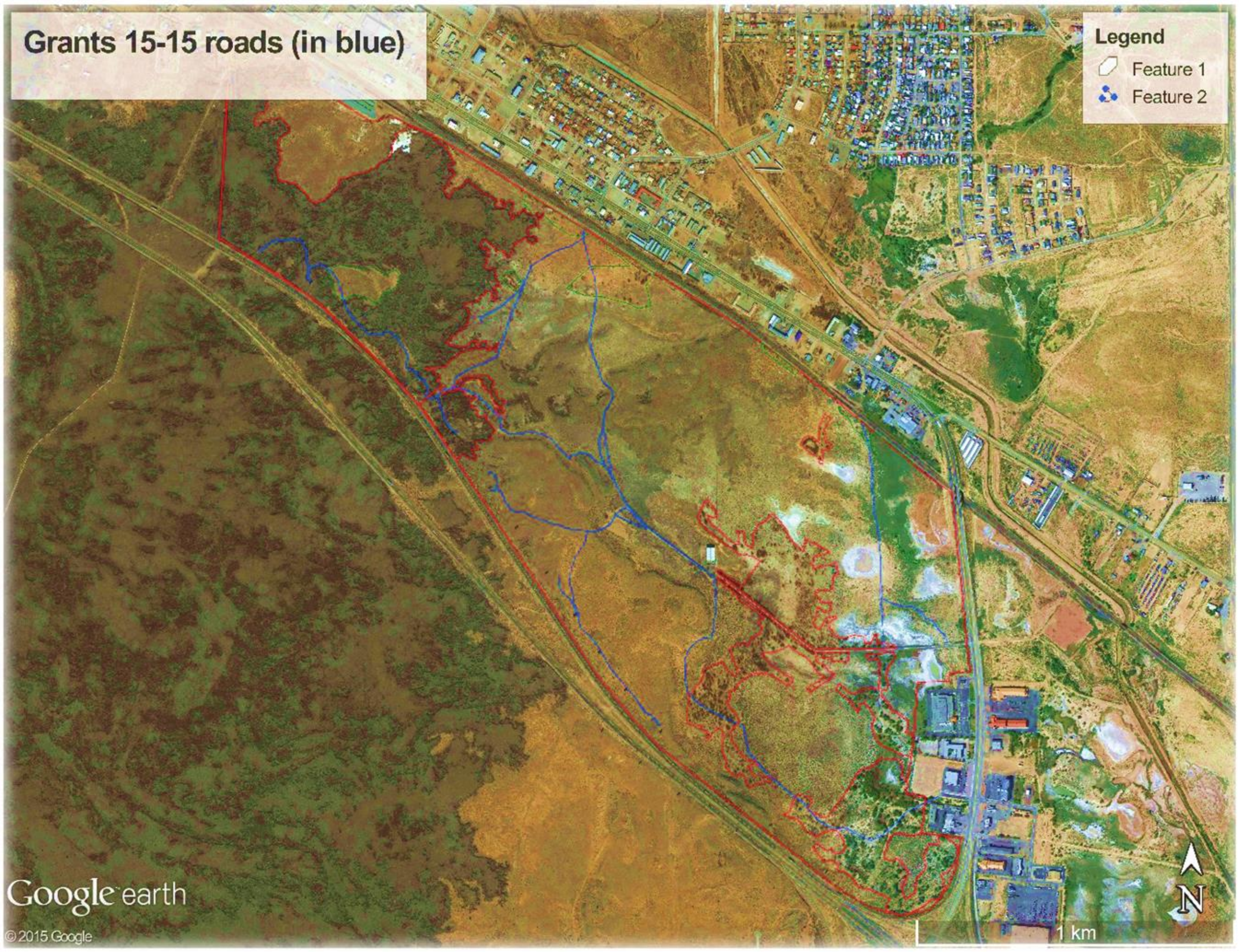

Figure 3. Sketch of two-track roads visible on aerial imagery within the 15-15 project area.

Metric (15-15 September 16, 2015)	**Score**
Relative Native Plant Community Composition	2
Vegetation Horizontal Patch Structure	4
Vegetation Vertical Structure	2
Native Riparian Tree Regeneration	1
Exotic Invasive Plant Species Cover	1
Project Biotic Score (based on above ratings)	2.1
Project Biotic Rating	C/Fair
Soil Surface Condition	3
Surface Fuels	0.8

Low scores for this project came from the high percentage of invasive plants and the absence of young native riparian trees. The amount of surface fuels is due largely to the presence of grasses, including saltgrass. The project scored best in the horizontal structural metric, indicating the presence of multiple occurrences of different vegetation communities across the landscape. This is reflected in the vegetation polygon maps in Figures 4 and 5, which show 11 recorded plant community patches, and structure types 5, 6H and 7. Note that due to the size of this site, which has an external boundary enclosing nearly 676 acres, a focus area of 293 acres was selected for traditional low-intensity monitoring assessment. This focus area scored a 2.1 out of 4 overall, which is a “C” or “Fair” biotic rating.

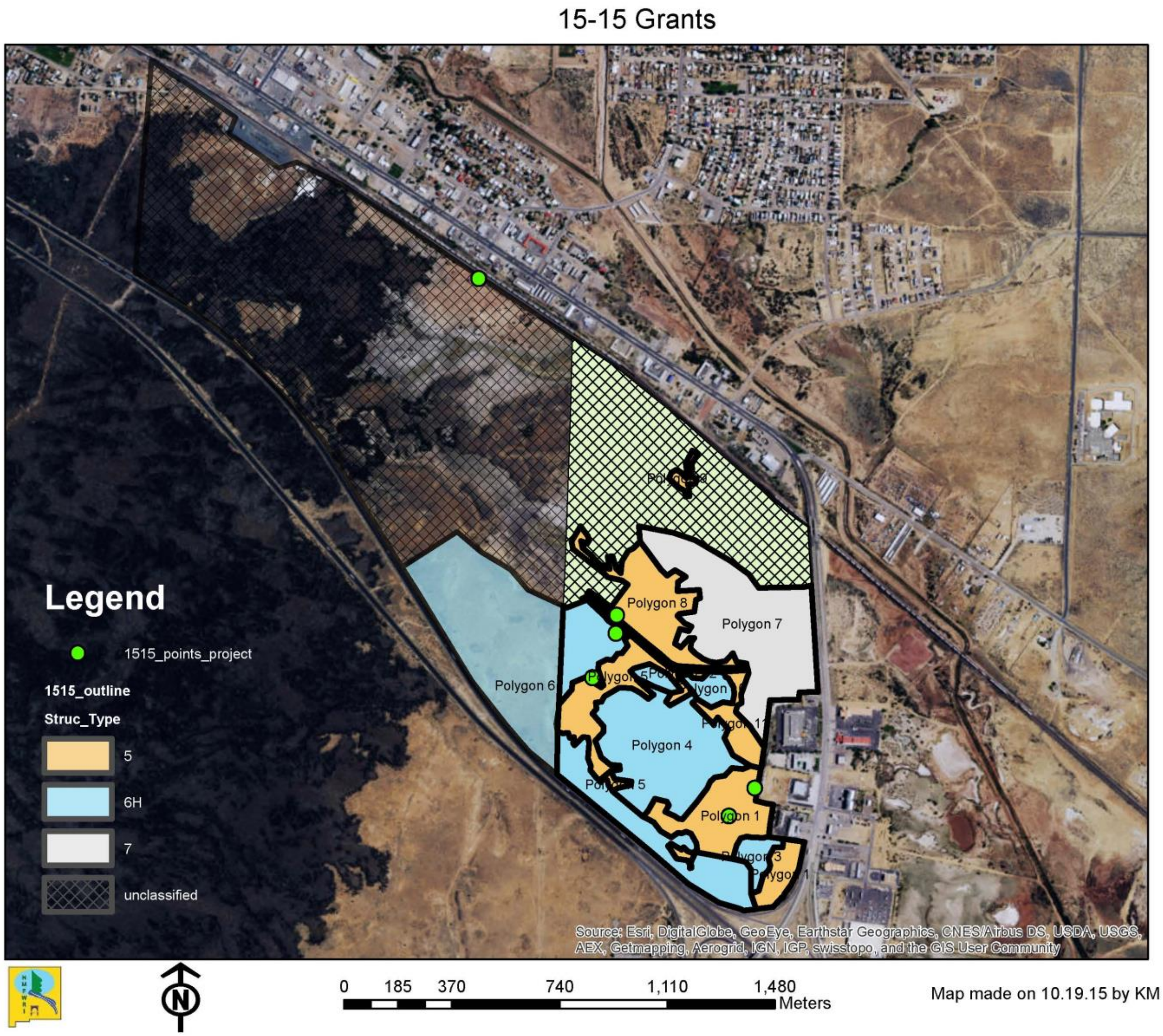

Figure 4. 15-15 Southeast Grants vegetation polygons and photopoints.

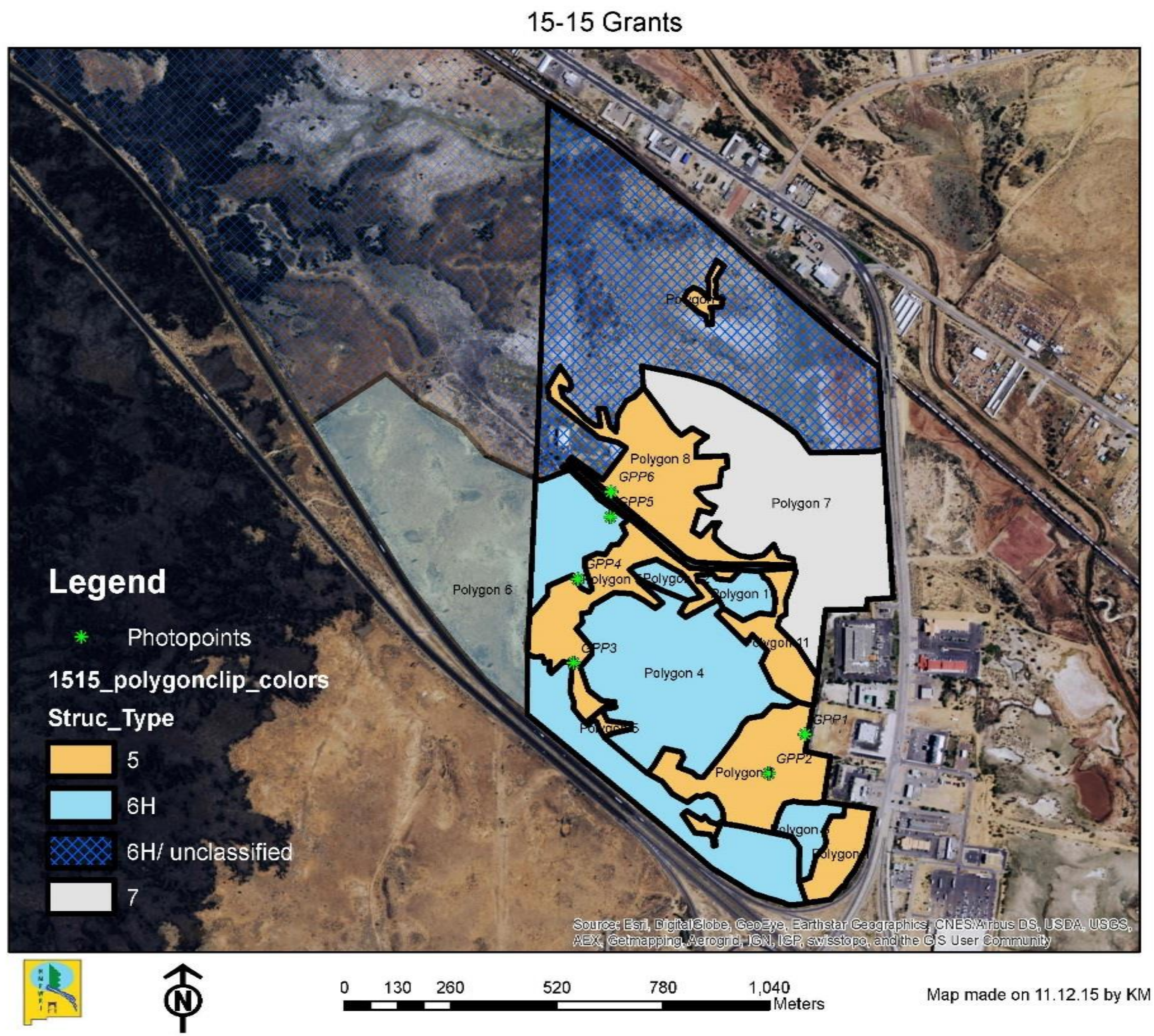

Figure 5. 15-15 Grants focus area polygons and photopoints.

The following figures (Figure 6 and Figure 7) show the results of the NAIP analysis using eCognition. 122 acres of lava flows (left side of the maps) were removed from the analysis because no vegetation treatment is planned to take place there. Of the remaining 554 acres, 15.9 acres were classed as salt cedar. Other trees (which include Siberian elms as well as native trees) and urban vegetation (which is not likely present in this project) comprised 0.45 acres. Our hope is that this information can supplement on-the-ground observations as well as provide more accurate information for determining treatment methods and expenses.

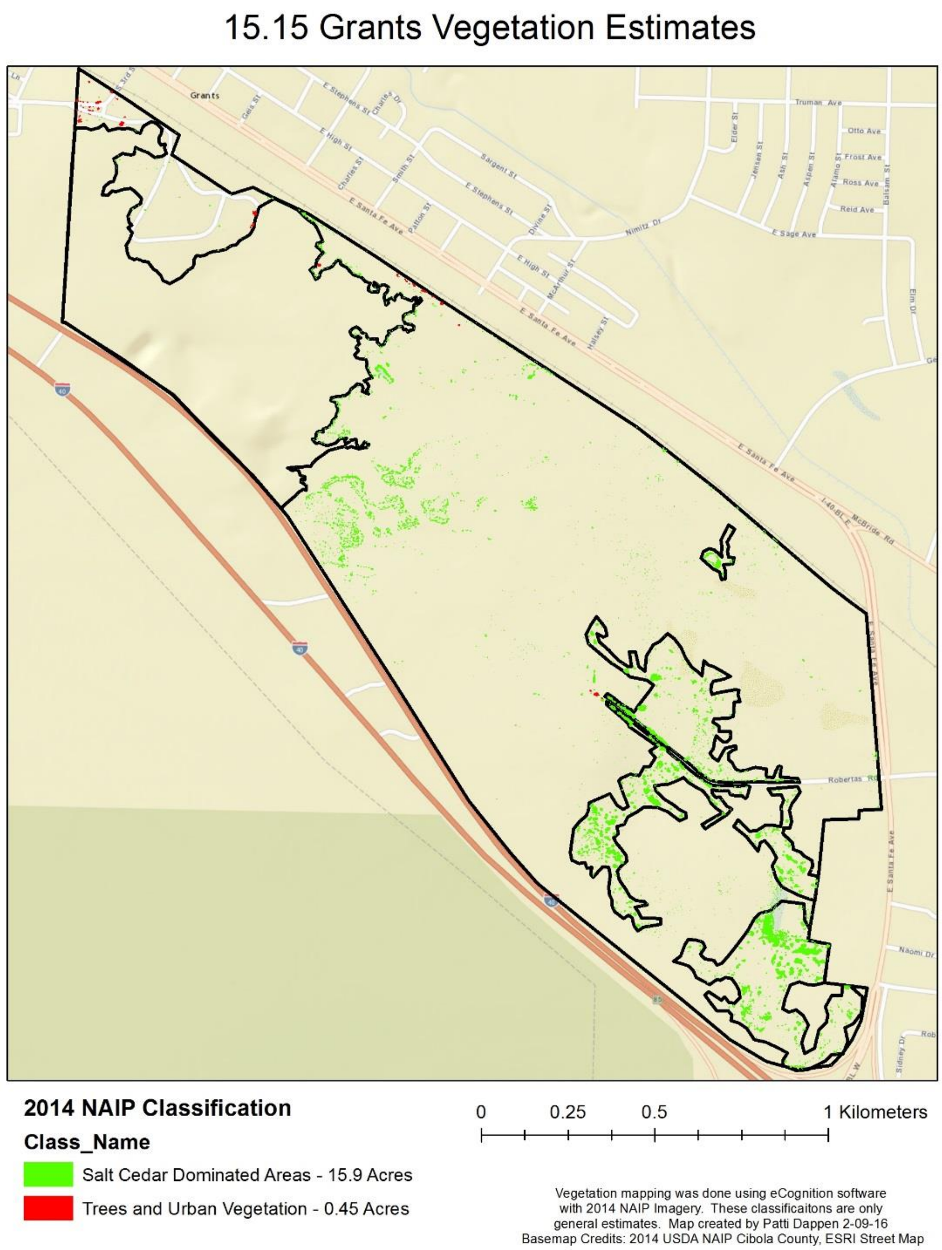

Figure 6. Salt cedar estimates for 15-15 Southeast Grants.

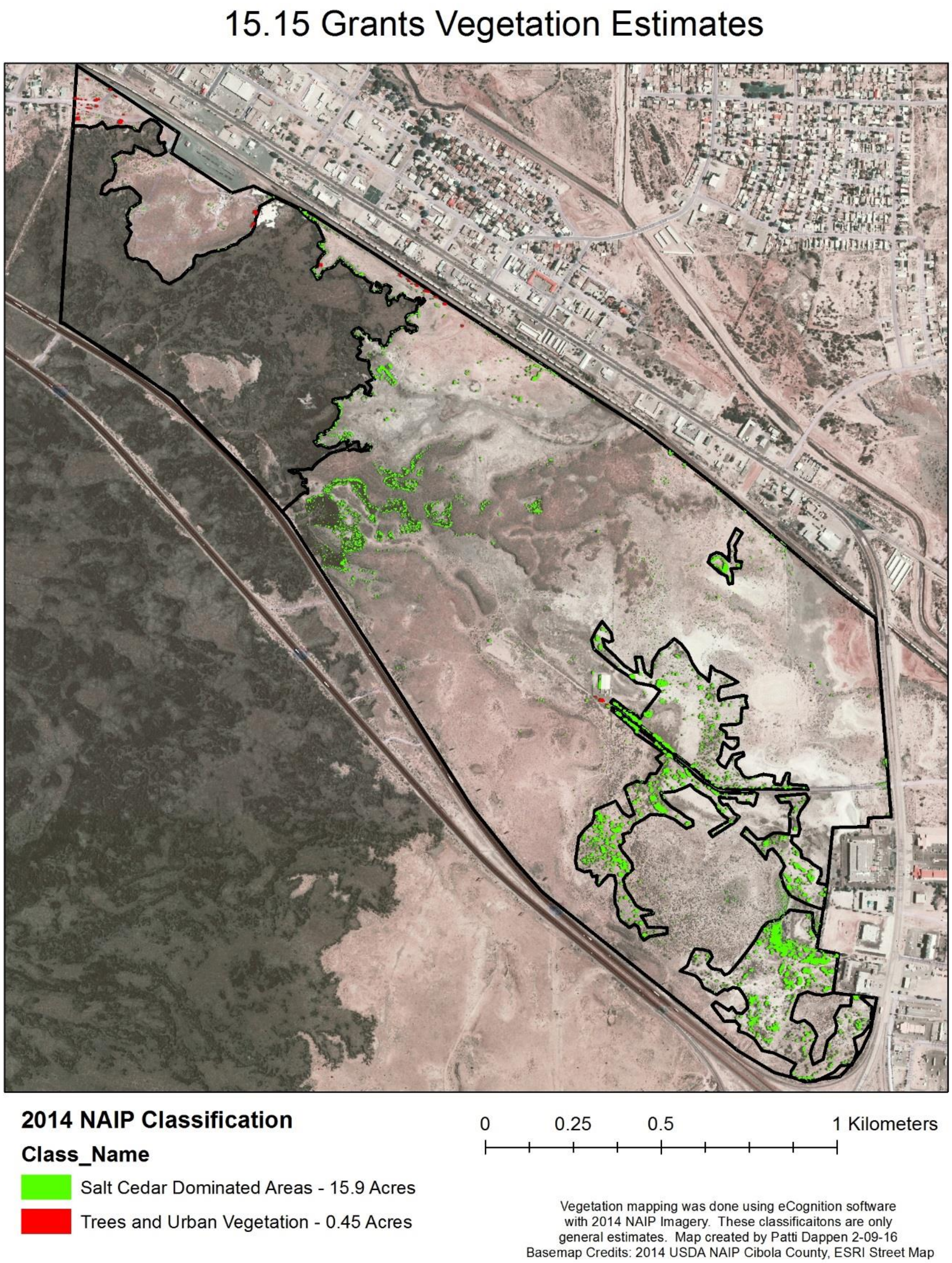

Figure 7. Salt cedar estimates for 15-15 Southeast Grants.

Project 15-20, Grants Phase 3/ Mount Taylor

Monitoring was conducted at this 32 –acre project site on September 16, 2015 as part of a restoration project targeting non-native phreatophytes scheduled for 2015-2016. The project is located on a number of private parcels in the town of Grants in Cibola County (see Figure 8). The project was sponsored by the Lava SWCD. Planned treatment includes removal of varying density salt cedar as well as Russian olive and Siberian elm. Restoration goals are to reduce fire hazard, promote native vegetation and raise awareness of bosque restoration projects in the local area.

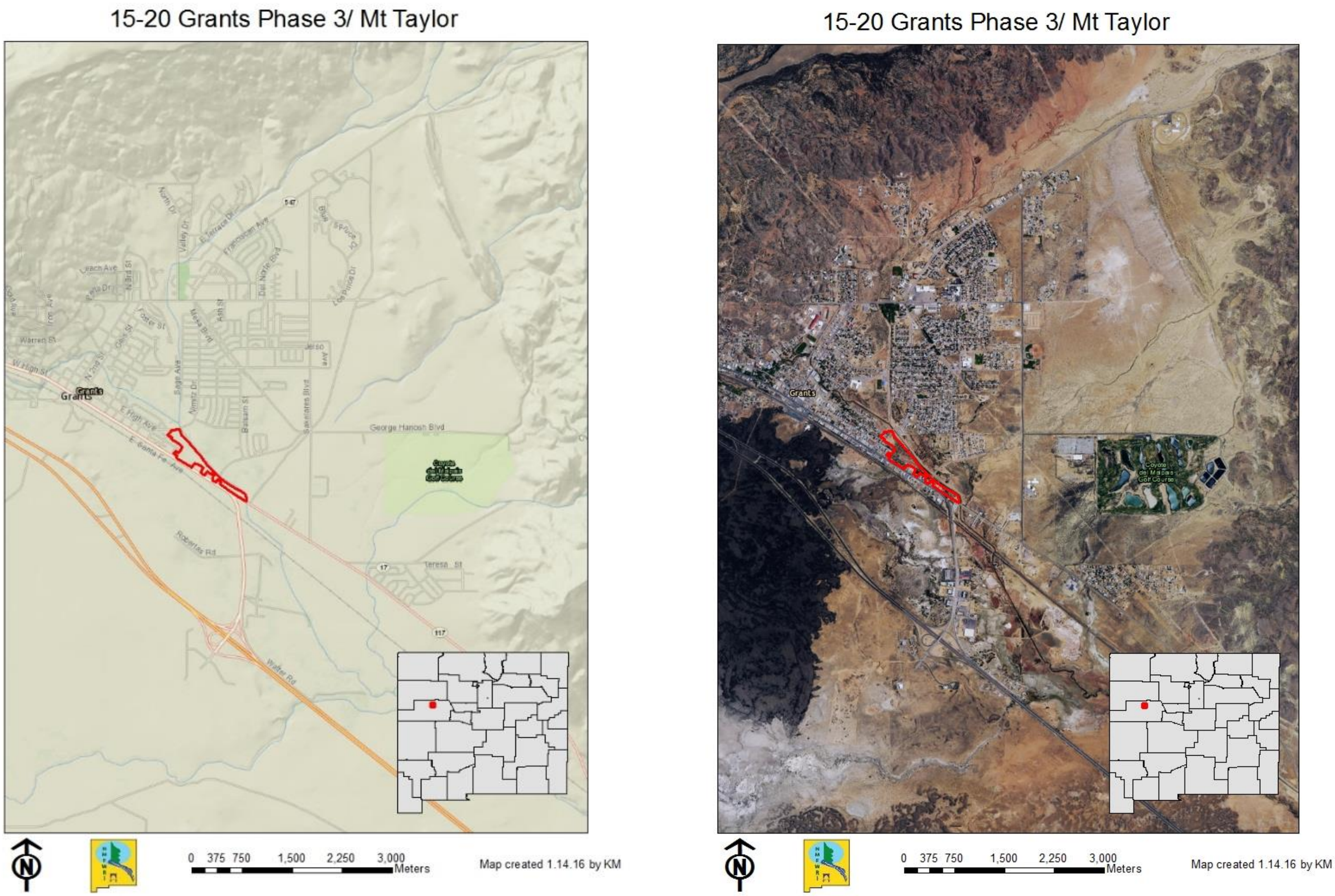

Figure 8. Project 15-20 Mount Taylor relative to the town of Grants.

Project 15-20 is comprised of a number of private properties in the city of Grants. The project can be accessed either through these private properties or from levees on the north side. The closest levee road has a hole along the edge which could get larger if not addressed in maintenance. There is a road through the middle of the project which is not driveable but which makes for easy walking. Exotic species observed during the September 2015 site visit included salt cedar of various age classes, Russian thistle and kochia. Native species included fourwing saltbush, *Suaeda nigra* (Mojave seablite), chamisa (rubber rabbitbrush), *Senecio wootonii* (Wooton's ragwort), alkali sacaton, Helianthus, greasewood and *Xanthium strumarium (*cocklebur).

Metric (15-20 September 16, 2015)	**Score**
Relative Native Plant Community Composition	1
Vegetation Horizontal Patch Structure	4
Vegetation Vertical Structure	2
Native Riparian Tree Regeneration	1
Exotic Invasive Plant Species Cover	1
Project Biotic Score (based on above ratings)	1.8
Project Biotic Rating	C/Fair
Soil Surface Condition	1
Surface Fuels	0.52

Low scores for this project came from the high percentage of invasive plants and the absence of young native riparian trees. The project scored best in the horizontal structural metric, indicating the presence of multiple occurrences of different vegetation communities across the landscape. This is reflected in the vegetation polygon map, below, which shows 12 different community patch types and structure types 5, 6H, 6S and 7. This site scored a 1.8 out of 4 overall, which is a “C” or “Fair” biotic rating.

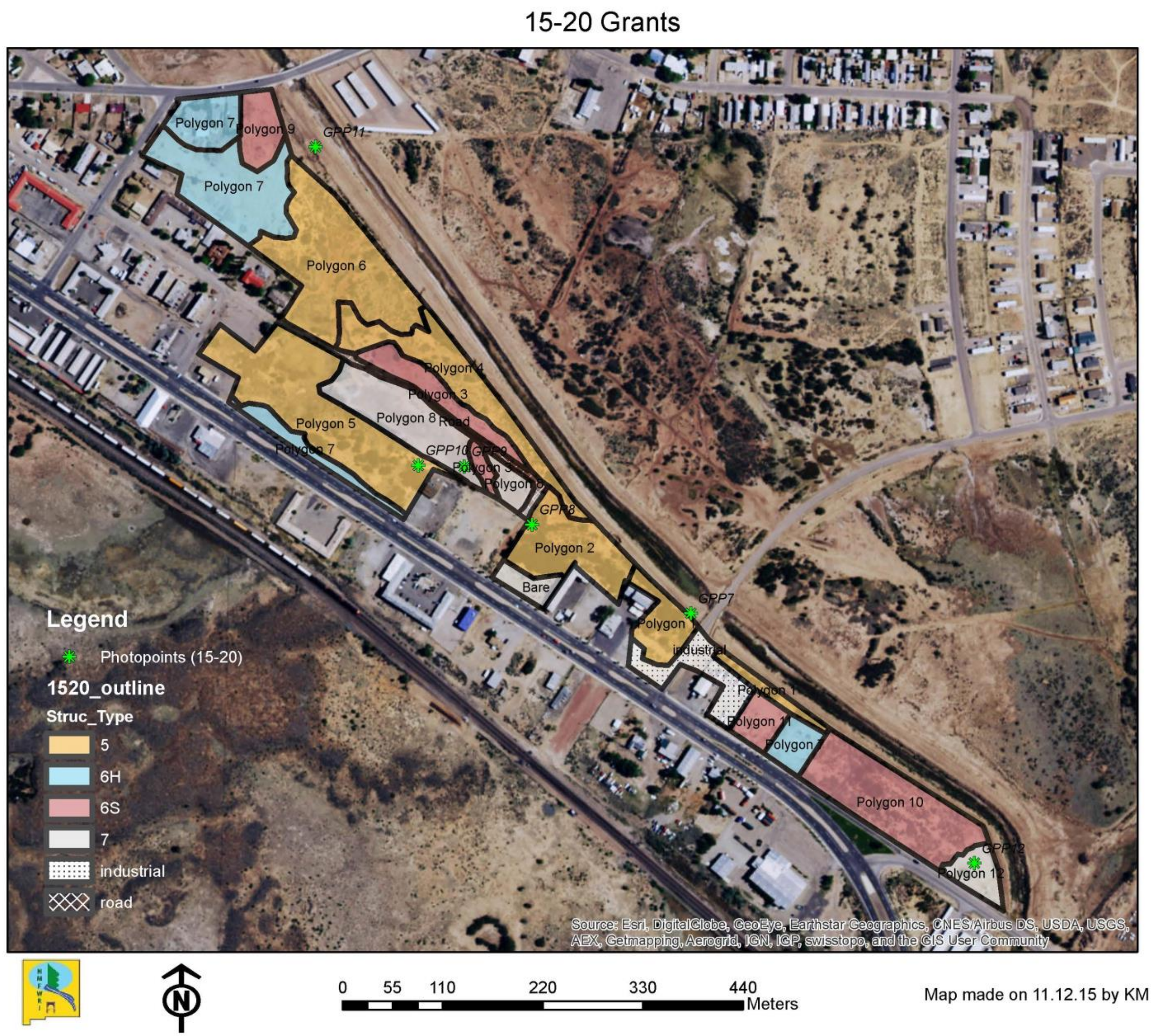

Figure 9. 15-20 Mt Taylor polygons and photopoints.

The following figures (Figure 10 and Figure 11) show the results of the NAIP analysis using eCognition. The entire outline of the project encloses 31.8 acres. Of this, 2.8 acres was classified as salt cedar, and 0.5 acres as trees and urban vegetation. This second classification includes Siberian elms as well as native trees and lawns. For this particular project this information is less critical than for project 15-15, we hope it will be useful supplementary information.

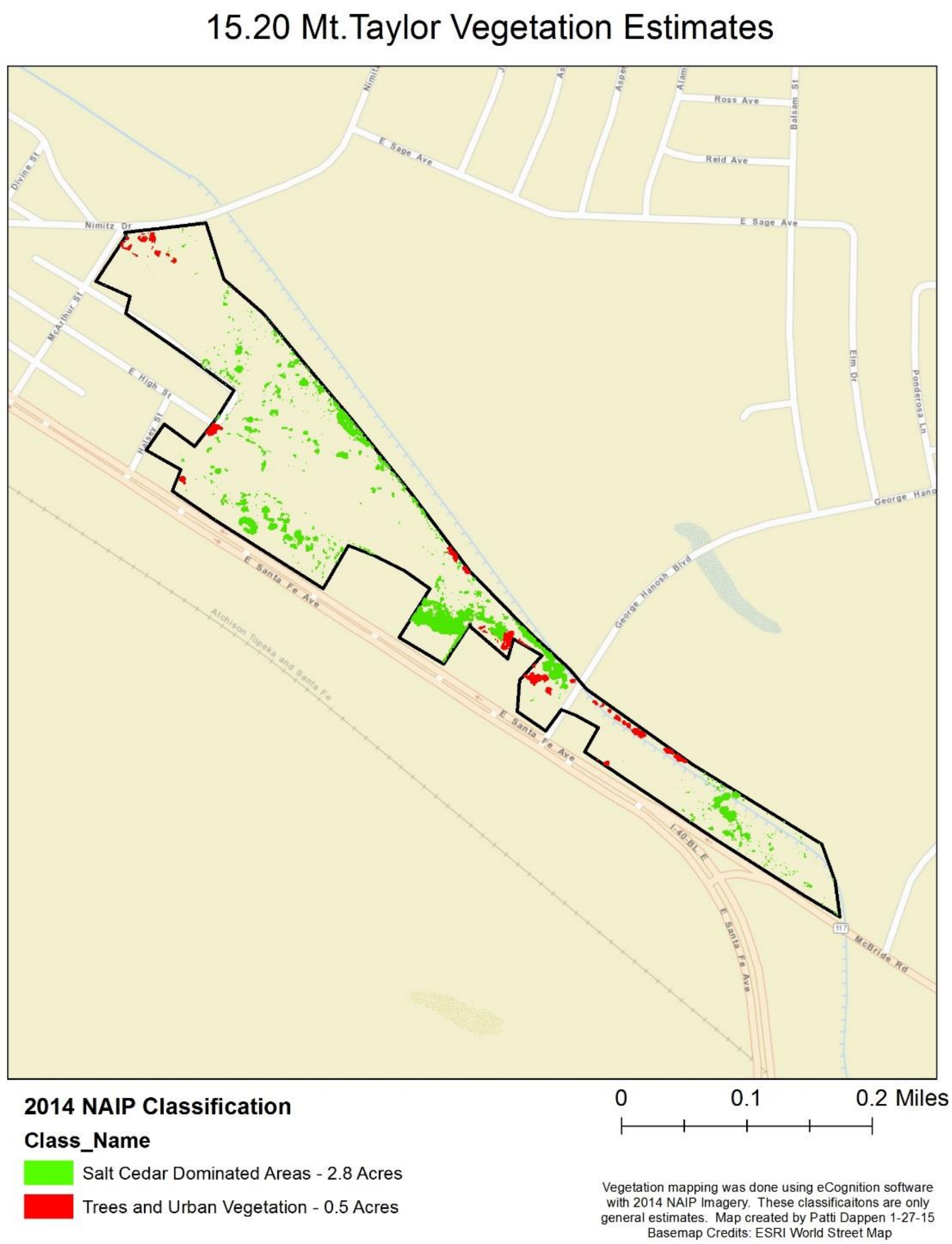

Figure 10. Salt cedar estimates for 15-20 Mt Taylor.

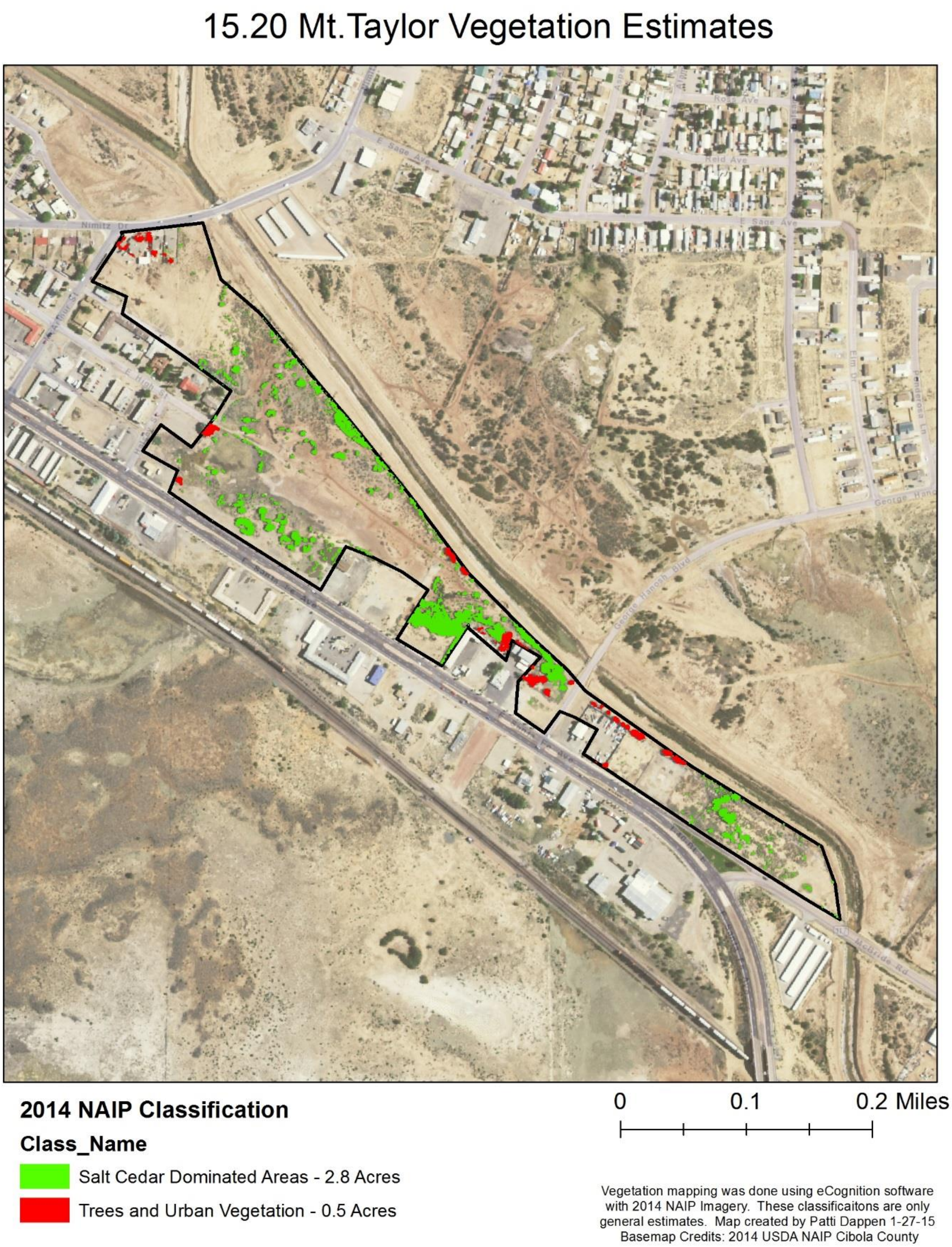

Figure 11. Salt cedar estimates for 15-20 Mt Taylor.

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: Photopoint Table

Project Name	Point number in NMFWRI GPX files	Point name on NMFWRI maps	Direction facing (azimuth)	Description	Coordinates
15-15pre	Pp1	GPP1	26		35.128866909, -107.829818716
15-15pre	Pp2	GPP2	293		35.128536914, -107.831047922
15-15pre	Pp3	GPP3	340		35.130732721, -107.836041106
15-15pre	Pp4	GPP4	approx 92 to 102		35.133930501, -107.835656209
15-15pre	Pp5	GPP5	322		35.13446602, -107.837377433
15-15pre	Pp6	GPP6	68		35.134519665, -107.835455295
15-15pre	Pp13	GPP7	200		35.144166666, -107.839444444
15-20pre	Pp7	GPP8	300	polygon 1	35.142081985, -107.830888918
15-20pre	Pp8	GPP9	190		35.143145481, -107.832229771
15-20pre	Pp9	GPP10	280	type 7 & road	35.143479751, -107.833268959
15-20pre	Pp10	GPP11	270	polygon 5	35.143471537, -107.834219635
15-20pre	Pp11	GPP12	285		35.14514205, -107.834082507
15-20pre	Pp12	GPP13	342	polygon 12	35.13954889, -107.827324346

Appendix II: Photo pages, by site

15-15 Photos

GPP1, view of salt cedar in polygon 1, near Walgreens. Taken facing 26 degrees NE.

GPP2, view of saltgrass and salt cedar in Polygon 1 and Polygon 4. Taken facing 293 degrees NW.

GPP3, view of polygon 5. Taken facing 340 degrees.

GPP4, view of Polygon 5 and 6.
Taken facing 92 degrees SE.

GPP5, view of polygon 6.
Taken facing 322 degrees.

GPP6, view of polygon 8.
Taken facing 62 degrees.

GPP13, view of NE end of project. Taken facing 200 degrees SW.

15-20 Photos

GPP7, view of salt cedar and kochia in Polygon 1. Taken facing 300 degrees NW.

GPP8, view of salt cedar, greasewood and two-track through project area. Taken facing 190 degrees SW.

GPP9, view two-track, salt flat, and sparsely vegetated area (Polygon 8). Taken facing 280 degrees NW.

GPP10, view of salt cedar and Polygon 5. Taken facing 270 degrees W.

GPP11, salt cedar and erosion along levee road.

GPP12, view of polygon 12. Taken facing 342 degrees NW.

Appendix III: All current monitoring options

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)

Vegetation Vertical Structure Type Definitions for NMRAM

Multiple-Story Communities (Woodlands/Forests)

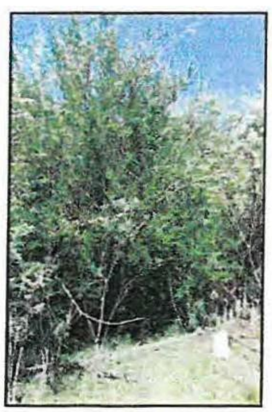
Type 1- High Structure Forest with a well-developed understory.

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.

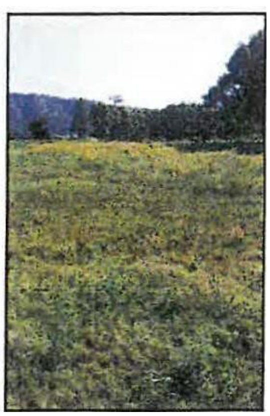
Young tree and shrub layer only (1.5-5 m [4.5-15 feet]) covering >25% of the area of the community (polygon). Stands dominated by tall shrubs and young trees, may include herbaceous vegetation underneath the woody vegetation. Photograph on San Francisco River by Y. Chauvin, 201
2.

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.