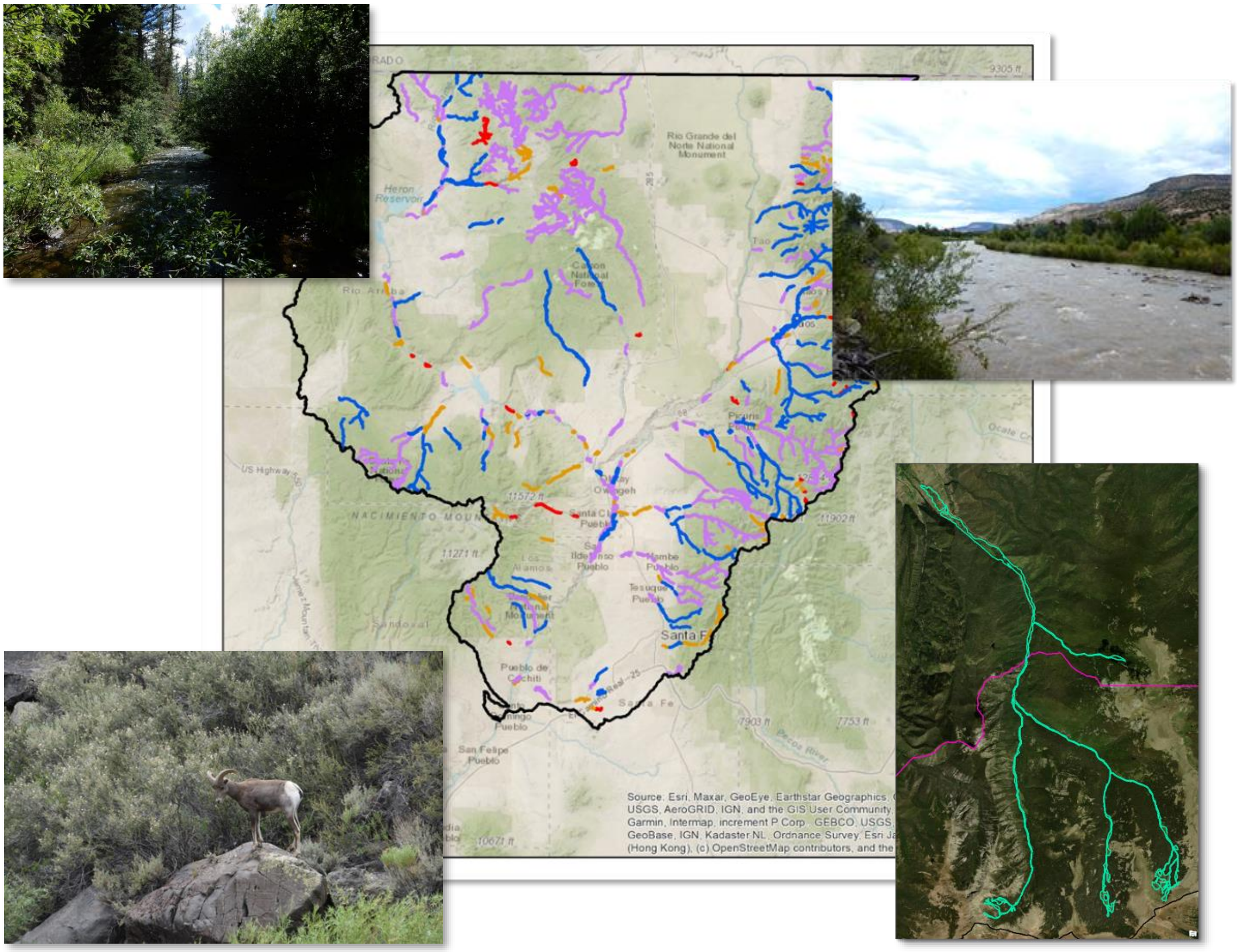
Upper Rio Grande Riparian Ecological Assessment

Riparian Conservation Opportunity Areas Portfolio



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Upper Rio Grande Riparian Ecological Assessment

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Natural Heritage New Mexico
University of New Mexico

Project Summary

October 15, 2022

Introduction

Natural Heritage New Mexico (NHNM) at the University of New Mexico, working with the National Wildlife Federation (NWF), conducted an ecological assessment to support the NWF Ribbons of Life Upper Rio Grande Riparian Connectivity Initiative. The primary goal of the initiative was a needs assessment to support conservation planning and actions to protect and restore riparian systems in the Upper Rio Grande (URG) basin in northern New Mexico and southern Colorado with a focus on promoting habitat connectivity and wildlife corridors (Figure 1). Along with social and economic components, integral to the initiative was an understanding of the underlying ecological template for meeting these goals. That is, an ecological assessment that identifies key strongholds and pinch points in connectivity in the region's riparian network and creates an operational portfolio of priority areas that could provide the greatest opportunities for conservation and restoration and help build resilience into riparian ecosystems of the Upper Rio Grande.

To meet these objectives, we took a novel, place-based GIS modeling approach using the fine-scale New Mexico Riparian Habitat Map (NMRipMap) as the foundation. This map gave us detailed wall-to-wall information within the riparian corridor on vegetation composition and structure in the URG (Figure 2). With this base, we looked to identify large blocks of remaining natural riparian habitat that could act as the anchors for conservation and expanding connectivity through the restoration of adjacent habitats that had reasonable potential for rehabilitation. In addition, we wanted to identify narrow constrictions of habitat within these

[1] Esteban Muldavin is Director and Senior Ecologist; Elizabeth Milford is the Senior Riparian Ecologist, and Corrie Reasner is the GIS analyst and spatial modeler; John Leonard, former GIS analyst with NHNM.

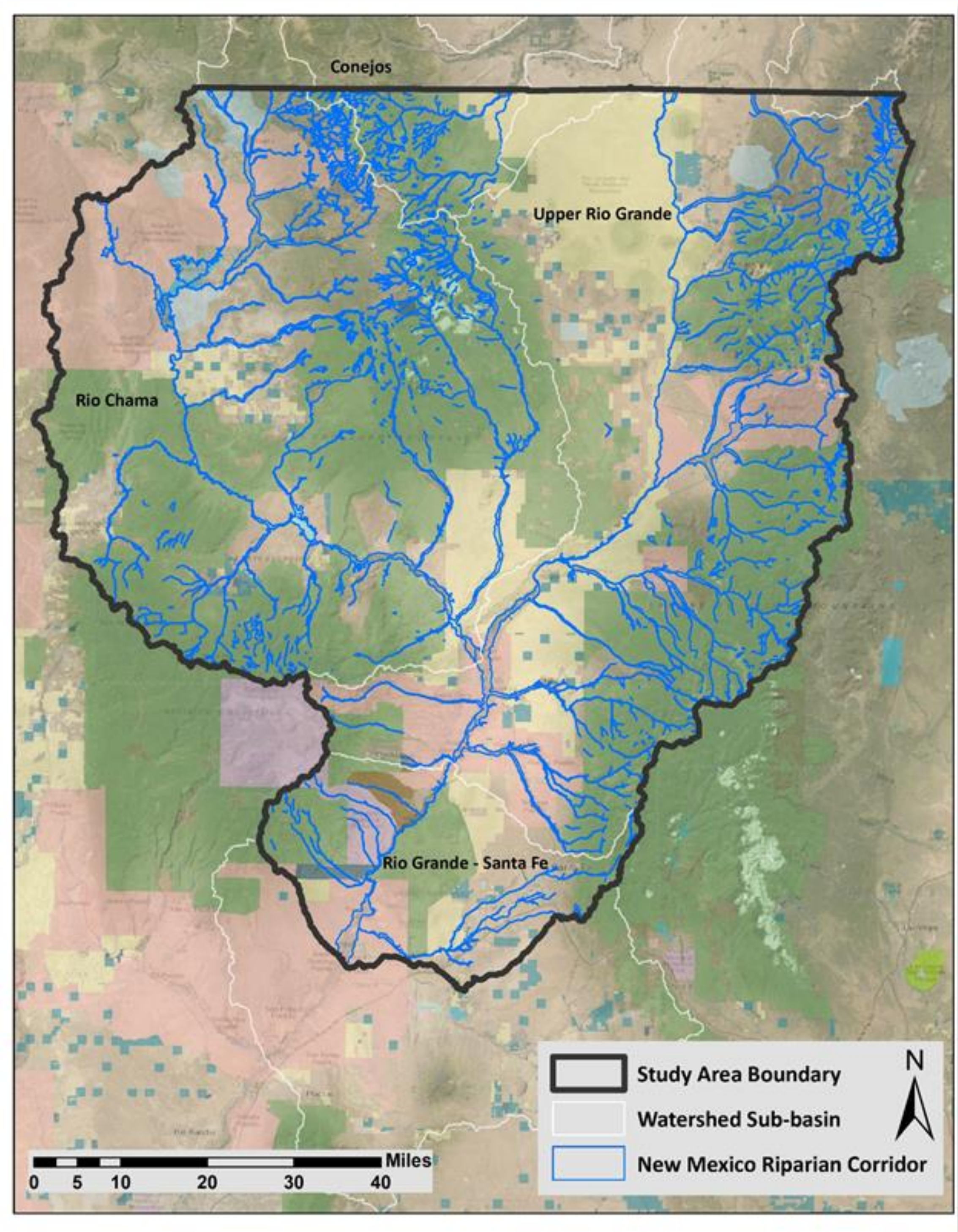

Figure 1. Upper Rio Grande Riparian Ecological Assessment project area, which besides the Chama, Upper Rio Grande (including the Conejos) sub-basin, also includes the Santa Fe River along with tributaries out of the eastern flank of the Jemez Mountains. The analysis was limited to the riparian corridor through the basin, which crosses a wide variety of jurisdictions (green = USFS, yellow = BLM, and orange are tribal lands plus private lands (no color)).

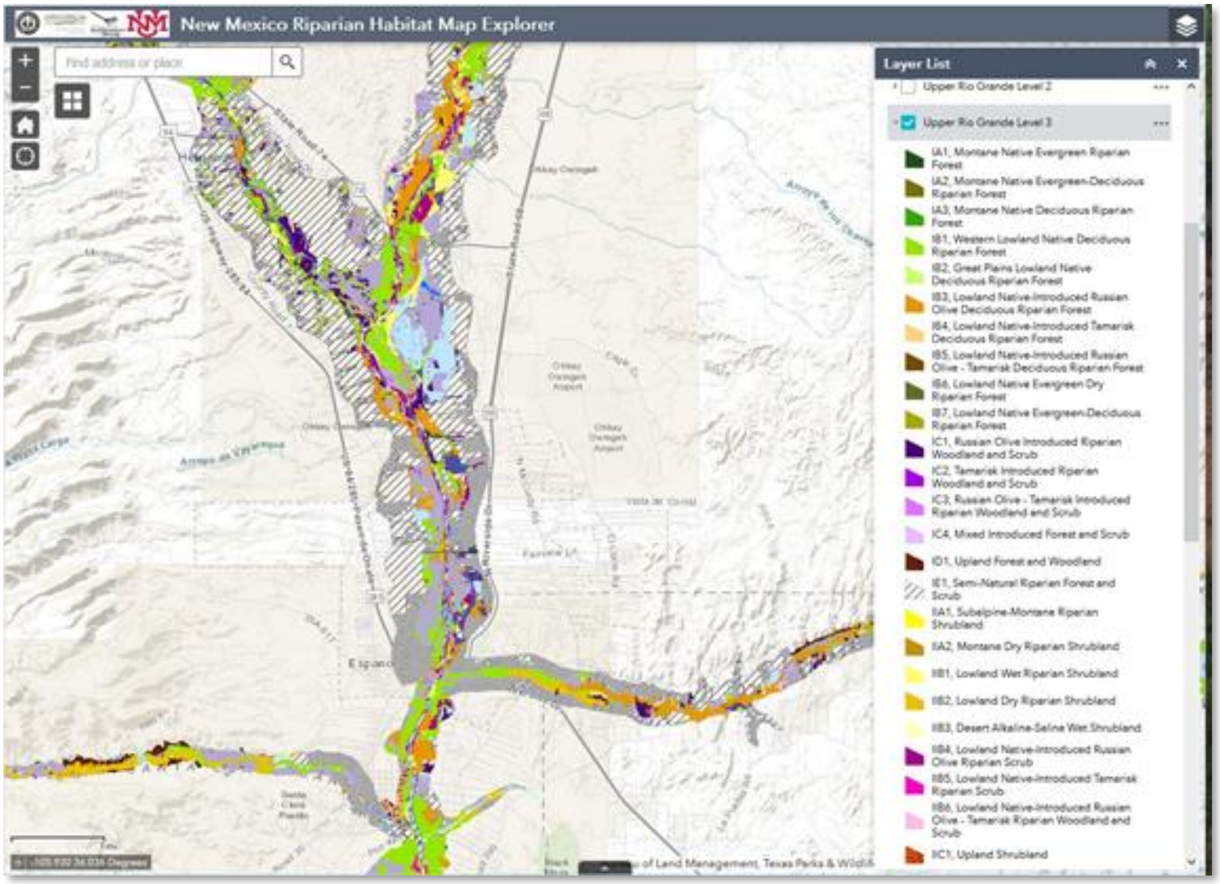

Figure 2. The high detail of Level 3 of the NM RipMap served as the base map for the assessment. This is an example from the confluence of the Chama and Rio Grande north of Espanola.

areas that may be of particular importance for protection in maintaining connectivity (pinch points). To provide operational conservation and restoration targets, we grouped these Large Riparian Natural Areas (LNRAs), Potential Restoration Areas (PRAs), and associated Pinch Points and adjacent smaller areas of natural vegetation into Riparian Conservation Opportunity Areas (RCOAs). To help strategize the use of RCOAs we rated them on their biodiversity values and provided information on their context (e.g., ownership, current protection, vegetation composition, etc.). Further, to support conservation planning and actions, we aggregated the RCOAs into an Upper Rio Grande RCOA Portfolio and have made it available through a web-based map viewer on our website (URG RCOA Portfolio). The RCOA Portfolio can also provide a platform to track success in protection and restoration, and ultimately how much resilience has been built into this critically at-risk ecosystem of the Upper Rio Grande in the face of ongoing environmental change.

The Place

The project area for the ecological assessment was the portion of the Rio Grande basin within New Mexico from the confluence of the Santa Fe River and the Rio Grande just below Cochiti Reservoir northward to the Colorado-New Mexico state border (see Figure 1). This is commonly referred to as the "Upper Rio Grande" (URG) in New Mexico. It includes the Chama River watershed to the west with tributaries draining out of the central Tusas Mountains (Rio Tusas, El Rito, Ojo Caliente, Rio Brazos among others) and those originating on the north flank of the Jemez Mountains (e.g., Rio Puerco). To the east is the Upper Rio Grande watershed itself with tributaries that that drain directly to the Rio Grande from the Sangre de Cristo Mountains on the eastern side of the basin (Rio Truchas, Rio Pueblo de Taos, Rio Hondo, etc.). It also includes the San Antonio River that drains north out of the Tusas Mountains to the Conejos River in Colorado and meets the Rio Grande near the state border. In addition, we included to the south the Rio Santa Fe and the White Rock Canyon portion of Rio Grande with creeks that flow out of the eastern flank of Jemez Mountains (e.g., Frijoles and Santa Clara creeks).

Across this landscape, elevations range from as low as 5,200 ft along the low-lying, semi-arid portions of the Rio Grande at the southern end of the study area to as high as 12,000 ft in the alpine and sub-alpine realms of the Sangre de Cristo Mountains. The creeks and rivers originate in diverse geologic contexts that include mountains and plateaus formed of crystalline granite, sedimentary sandstone and limestone, volcanic pumice, or lava flows. The streams run from high mountain grassy valleys down through confined canyons flanked by conifer forests, to open river valleys with relatively broad floodplains that support ribbons of cottonwood riparian forests in a matrix of agriculture and urban development. In addition, at lower elevations the Rio Grande and Rio Chama are constrained within canyon walls for long stretches where the breadth of the riparian zone is limited, i.e., the Rio Grande Gorge and the Rio Chama Canyon.

Ownership is a mix of private, public, and tribal jurisdictions (see Figure 1). Federal and state entities own the majority of the landscape, with the US Forest Service (USFS) managing much of the higher elevation forest lands and the Bureau of Land Management (BLM) the lower-elevation rangelands, with state lands scattered and intermixed. There are still significant tracts of private land, particularly along the river corridors with their long history of agricultural use and development. Tribal ownership among the eight northern pueblos and Jicarilla Apache is also significant, each with their own singular approach to managing wildlands. Embedded in this ownership matrix are differing levels of protection for river ecosystems that include national monuments and wilderness areas, state wildlife refuges, special management areas specified in agency and tribal natural resources plans, and private conservation easements monitored by the land trust community.

With this ownership matrix, land-use patterns are complex, reflecting the long history of human settlement in the region. There are urban centers such as Española and Taos that bring with them entrenched patterns of use that present significant challenges to building and maintaining riparian habitat connectivity. Similarly, the rural mountain valleys where agriculture is the predominant land use present a different set of challenges for conserving and building habitat continuity. Finally, the mid-to-high elevation wildlands that are largely intact and un-fragmented provide inherent strongholds for wildlife habitat connectivity yet have their own set of management issues (logging, grazing, ski resorts, etc.).

Intertwined in this complex landscape are diverse riparian vegetation communities of native cottonwood and conifer forests, willow shrublands, and herbaceous wetlands that make up the core riparian natural areas that anchor riparian ecosystem of the URG (Figure 3). Intermixed are stands of introduced species (Russian olive and tamarisk) that can dominate large swaths of the riversides and that are the focus of most restoration efforts in the basin. Taken together, these riparian communities become the focus here for building additional connectivity through protection and restoration within the dynamic framework of human land use[2]

Figure 3. The vegetation communities of the project area are diverse. clockwise from the upper left: Montane Native Evergreen-Deciduous Riparian Forest along Rio Santa Barbara; Montane Native Deciduous Riparian Forest along Cabresto Creek; Subalpine-Montane Riparian Shrubland along Polvadera Creek; Montane Wet Meadow in Valle Vidal in north-central New Mexico, and Lowland Native-Introduced Russian Olive Deciduous Riparian Forest along the Rio Grande south of Pilar.

[2]For detailed maps and descriptions of these vegetation communities see NMRipMap.

Methods

GIS framework and spatial catalog

The overall spatial analysis and visualization was conducted with ArcGIS 10.8.1. We compiled an extensive library of existing spatial data sources for the URG. These included land ownership with parcel maps where available, land status from the USGS Protected Areas Database (PAD-US), LANDFIRE landcover maps, the National Hydrology Dataset (NHD), National Agriculture Imagery Program (NAIP) aerial photo imagery (2016, 2018, and 2020), and standard data layers of elevation and terrain available through ArcGIS. In addition, we accessed the New Mexico Riparian Map (NMRipMap) layers and the New Mexico Crucial Habitat Assessment Tool (CHAT) layers housed at NHNM.

Creating the portfolio of Riparian Conservation Opportunity Areas

Existing riparian wetland vegetation communities within a riverine corridor provided the template for understanding habitat connectivity. Connected riparian corridors act as fundamental habitat for many wildlife species (riparian obligate birds, beavers, amphibians, small mammals, etc.) and support wildlife movement between upland habitats. This connected and extensive riparian habitat suggests a high degree of ecological integrity that enhances biodiversity sustainability. We used our NMRipMap as a base for understanding the distribution of these communities. It provided fine-scale delineation of riparian communities at the stand level (one-third of an acre or more)—the level commonly most relevant to wildlife species (see Figure 2). Further, habitats were mapped wall-to-wall within a riparian corridor that encompasses all perennial streams along with intermittent segments that link up perennial reaches. Within the corridor, other land-cover elements such as agriculture, roads, and urban development are also mapped. This allowed us to understand the degree of fragmentation of habitat and loss due development impacts within the framework of the corridor as a whole.

With this base map, Riparian Conservation Opportunity Areas or RCOAs were built as operational targets for conservation and restoration to enhance habitat connectivity. They were constructed by combining the following three key components: Large Riparian Natural Areas (LRNAs), Potential Restoration Areas (PRAs) and Adjacent Natural Areas (Figure 4). Large Riparian Natural Areas are large blocks of quality habitat that are likely to support more species than smaller, fragmented areas. We identified these areas by merging adjacent vegetation polygons from the NM RipMap that are considered high-quality riparian habitat (native riparian forests, shrublands, and herbaceous wetlands). Once these polygons were merged, we selected those blocks that were greater than 12.36 acres (5 ha) as LNRAs, a minimum area that is a common target for conservation and restoration (see Appendix A for vegetation types for high-quality habitat).

The next step was to build PRAs based on lower quality NMRipMap types that were adjacent to one or more LRNAs that, if restored, would have a substantial impact on restoring native riparian vegetation connectivity (Figure 4b). These potential restoration areas were classified into three different types based on restoration potential. Type 1 consists of vegetation currently dominated

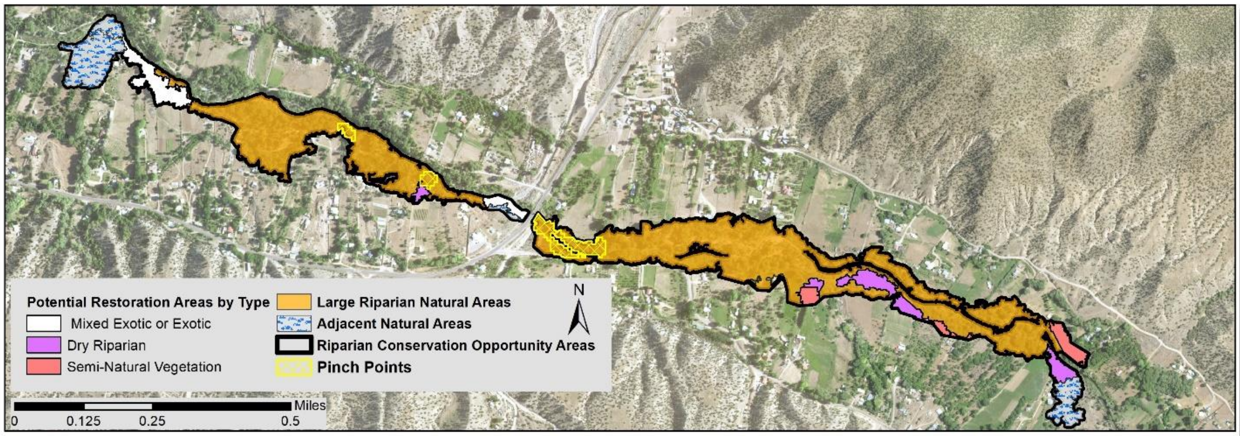

Figure 4. An example of the components that go into building Riparian Conservation Opportunity Ares along the Embudo River and the town of Dixon. These include delineation of Large Natural Riparian Areas (LNRAs), Potential Restoration Areas (PRAs), smaller Adjacent Natural Areas that share a border with PRAs, and Pinch Points in connectivity within the LNRAs.

by non-native or mixed native-exotic riparian vegetation (e.g., Russian olive and tamarisk, among others). These sites are most commonly the focus of restoration efforts in the basin through chemical or mechanical removal of the invaders. Type 2 areas were those stands classified as drier vegetation that may have historically been higher quality, wetter vegetation but are now commonly found on higher and drier terraces in the flood plain. As a result, restoration can be more complex in terms of improving hydrological connectivity to support the wetter riparian communities. Type 3 areas were composed of semi-natural relict and non-native woodlands and shrublands outside of core natural riparian zones. While typically highly modified, they can play a role in increasing connectivity in the RCOAs, but they may be embedded in other land-cover types such as agriculture that present a challenge for cost-efficient restoration.

Adjacent Riparian Areas are smaller vegetation stands along the boundaries of PRAs that consisted of high-quality riparian habitat types that did not meet the LRNA size requirement of 12.35 acers (Figure 4c). But when LNRAs and PRAs are brought together, these smaller natural areas now play a role in connectivity within the RCOA as a whole. Combining these three components creates an RCOA.

An added component of RCOAs was the identification of “pinch points” within the LNRAs where riparian vegetation narrows, creating a greater risk for breaking habitat connectivity and therefore creating a conservation target of special concern. To detect pinch points across the project area, we employed the program Omniscape (Landau et al. 2021) where habitat connectivity is modeled using algorithms based on the flow of electricity through circuits. Briefly, thinking of how electricity flows through a circuit, it will move along lines of least resistance, which in this case would be, by definition, the best natural riparian habitat. In contrast, urban development and agriculture would represent areas of high resistance forcing most “electrons” to flow through the natural areas’ “circuit.” When these natural areas narrow, the current flow of electrons increases, creating hotspots that represent our “pinch points” in riparian connectivity (Figure 5 provides an example of a flow map through the Taos area).

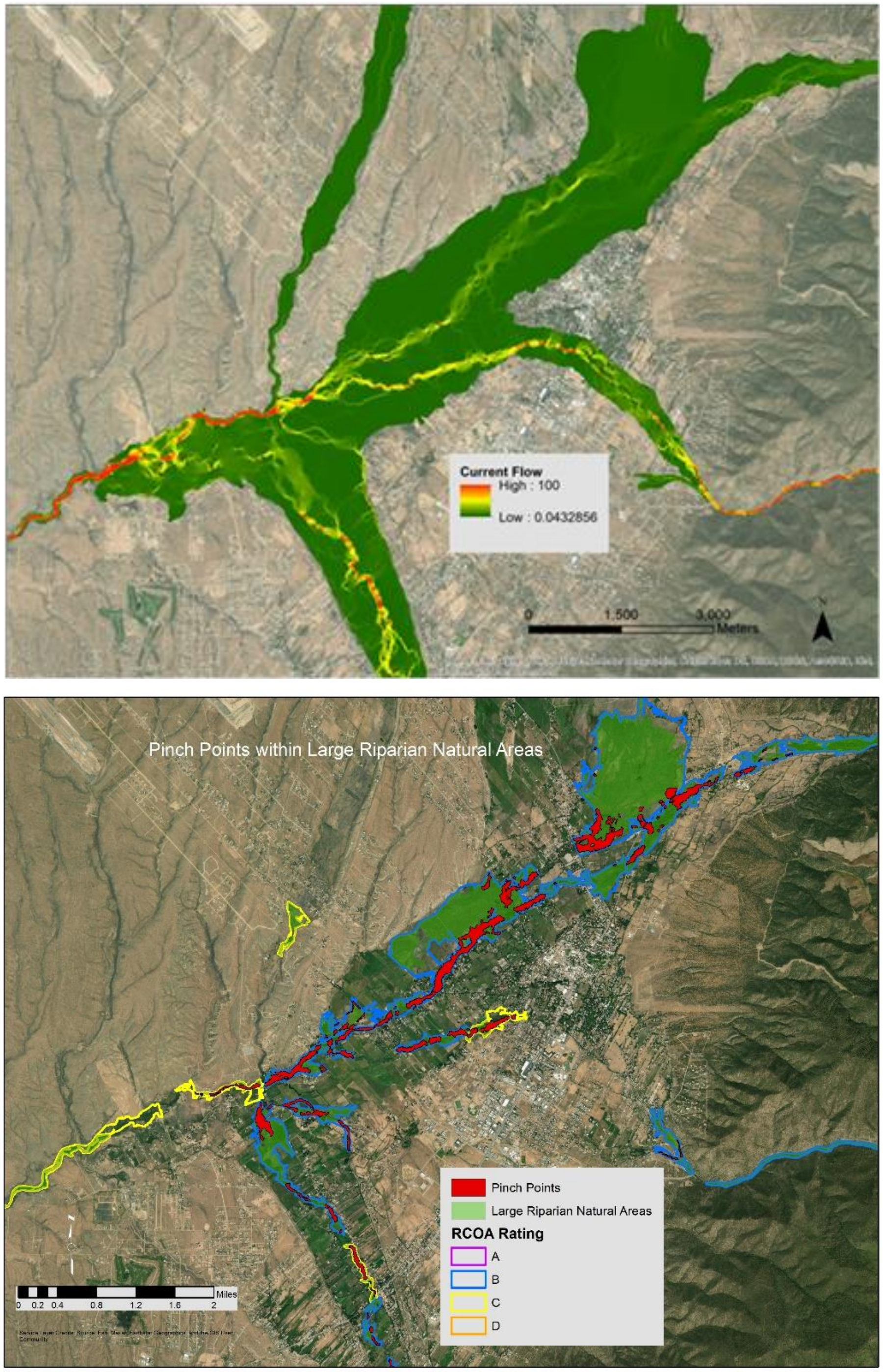

Figure 5. An example of an Omniscape flow map through Taos, NM (top) and "Pinch Points" that occur within Large Riparian Natural Areas (LNRSs) (bottom).

To identify the sites with the highest connectivity risk as targets, we set a threshold at the 98th percentile of "current flow" within the Omniscape current map and converted all areas above this threshold into polygons. By definition, pinch points occurred only in high-quality habitat of LNRAs, and accordingly each pinch point polygon was linked to its respective LNRAs in the GIS.

RCOA, LRNA, PRA and Adjacent Natural Area attributes

We attributed the RCOAs with a large suite of variables that specify information about their size, NMRipMap vegetation composition, habitat value, diversity, ownership, and total areas of LRNAs, PRAs and Adjacent Natural Areas that make up each RCOA. The NMRipMap vegetation composition attributes are for the quality riparian vegetation types that make up the LRNAs; the vegetation types that make up the PRAs were excluded from this calculation. For the habitat value attributes, the percentage amount of the highest quality riparian vegetation types by stratum (forest, shrubland, and herbaceous) were calculated.

To address the biodiversity values of RCOAs, we applied the Shannon diversity index (Shannon and Weaver 1963) to quantify patch-diversity of high-quality vegetation types. In this case, the number of high-quality vegetation types in a given RCOA was a proxy for diversity richness, and the relative areas among types was a proxy for evenness of the index. Overall, higher index values indicate higher patch diversity. Additionally, we intersected the RCOAs with the New Mexico Crucial Habitat Assessment Tool (NM CHAT) Species of Concern layer as a measure of the importance of the RCOA for sensitive species (plant and animal). An RCOA was attributed with the highest rated SOC value intersected. Finally, we intersected the RCOAs with the BLM National Surface Management Agency Areas Polygon Map and attributed the RCOAs with surface ownership by percent.

For LRNAs, we have a separate layer with their size, vegetation composition, high-value habitat percentages and Shannon Index (Shannon and Weaver 1963) and the linking IDs to their respective RCOA. Similarly, we attributed the layer of PRAs with their dominant restoration type – 1) Mixed-exotic or exotic, 2) Dry riparian, and 3) Semi-natural vegetation – and their NMRipMap vegetation type. In addition, we calculated a relative benefit index that quantifies the benefit of restoring the target PRA. Specifically, this is the area added from the LRNA (or LRNAs) divided by the PRA polygon. The full attribute list and definitions is provided on at the website and as part of the geodatabase metadata.

RCOA Ratings

We rated the quality of RCOAs based on the amount of natural area, biodiversity value per the Shannon index, and restoration potential. RCOAs were rated from "A" highest quality down to "D." The variable used and the rating scales are given in Table 1.

Viewing the Portfolio

The entire RCOA portfolio can be viewed in a webmap application on the NHNM webpage for the project along with this report, the attribute table, and a downloadable geodatabase containing the spatial layers (https://nhnm-dev2.unm.edu/RCOAs or at https://nhnm.unm.edu/).

Table 1. Riparian Conservation Opportunity Area ratings table.

RCOA Scoring Field Names	Description		
RCOA_Rating	RCOA rating based on the RCOA_Rating Average_Score	**Rating**	**Average Score**
		A	>= 3.25 to 4
		B	>= 2.5 and < 3.25
		C	>= 1.75 and < 2.5
		D	1.0 to < 1.75
RCOA_Average_Score	Average of RCOA ratings of the following fields: • RCOA_Size_Score • RCOA_PRA_pct_Score • RCOA_VegTypeDiversity_Score • RCOA_HighValueHabitat_Score • RCOA_SOC_Score		
RCOA_Size_Score	RCOA rating based on the area of the RCOA in acres.	**Score**	**Acres**
		4	>= 200
		3	>= 100 and < 200
		2	>=25 and <100
		1	<25
RCOA_PRA_pct_Score	RCOA rating based on percent PRA	**Score**	**Percent**
		4	< = 10%
		3	<= 20% and > 10%
		2	<= 30% and > 20%
		1	> 30%
RCOA_HighValueHabitat_Score	Habitat Value Rating based on percent of High Value Habitat.	**Score**	**Percent**
		4	>= 75%
		3	>= 50 and < 75%
		2	>= 25 and < 50%
		1	<25%
RCOA_VegTypeDiversity_Score	RCOA rating based on the RCOA Vegetation Type Diversity Index Values	**Score**	**Diversity Index**
		4	>= 1.5
		3	>= 1 and < 1.5
		2	>= 0.5 and < 1
		1	< 0.5
RCOA_SOC_Score	Rating based on the highest value NM CHAT, Species of Concern (animals and plants) (SOC) hexagon that the RCOA intersects.	**Score**	**Highest SOC Value**
		4	1
		3	2
		2	3
		1	4 & 5
		0	6

Outcomes

The Riparian Conservation Opportunity Areas Portfolio

The core outcome of the ecological assessment was the Riparian Conservation Opportunity Areas Portfolio of 447 RCOAs across the project area (Figure 6). The majority of these were in the larger Rio Grande watershed (60%), with 33% in the Chama, and the remaining 7% in the smaller Santa Fe watershed (Figure 7). On an area basis, these RCOAs were found at nearly equal amounts on public (41%) and private lands (44%) with an additional 15% on tribal lands (Figure 8). On public lands, most RCOAs were found at higher elevations on USFS lands (on an area basis about 93%) or NPS and DOE (3%). However, there were some on BLM lands as well (3.5%). Ones on private and tribal lands tended to be at lower elevations in the broad river valleys and in desert canyons (but not always, e.g., Taos Pueblo).

The distribution of RCOAs based on ecological and biodiversity values varied. “A” sites with high amounts of high-quality and diverse natural area with limited restoration needs accounted for only 10% of the RCOAs. These sites were mostly found on USFS lands at higher elevations where they can extend from near the forest boundary up into the wilderness areas (Figure 9). However, they can also be found in lower-elevation valleys as continuous ribbons of riparian vegetation in an agricultural and developed matrix (Figure 10).

In contrast, the majority of the RCOAs had a “B” rating for biodiversity value and size (54%). These places generally had a higher proportion of potential restoration area and a commensurate smaller amount of high-quality natural area (they could also be smaller and less diverse than “A” sites). Overall, they tended to occur at mid to lower elevations in agricultural areas or even in urban settings (Figure 11). They also occurred in higher mountain settings or desert canyons, but here they tended to have limited diversity in vegetation communities or they were more constrained in size (Figure 12 and 13). When looking to conservation actions, the expectation is that these sites will require potentially more investment than “A” sites for restoration or acquisition for expansion to increase habitat connectivity.

Stepping down, RCOAs with a “C” rating again reflect further reduction in diversity or size, or both. For example, along the Chama River in near Abiquiu, “C” sites tend to be smaller and imbedded in a more fragmented landscape with clear breaks in connectivity (Figure 14). There is also a tendency for the ratio of restoration areas to natural areas to go up, further driving up conservation costs. Yet, these RCOAs represent about a third of the portfolio and can still be of significant conservation value depending on their context. Similarly, RCOA’s with a “D” rating are smaller still and likely less diverse, but may still be important for building habitat connectivity, particularly in reaches where they can act as links between other RCOAs. They only make up 3% of the portfolio but, by definition, still have a modicum of natural area and restoration potential, or they would have been excluded.

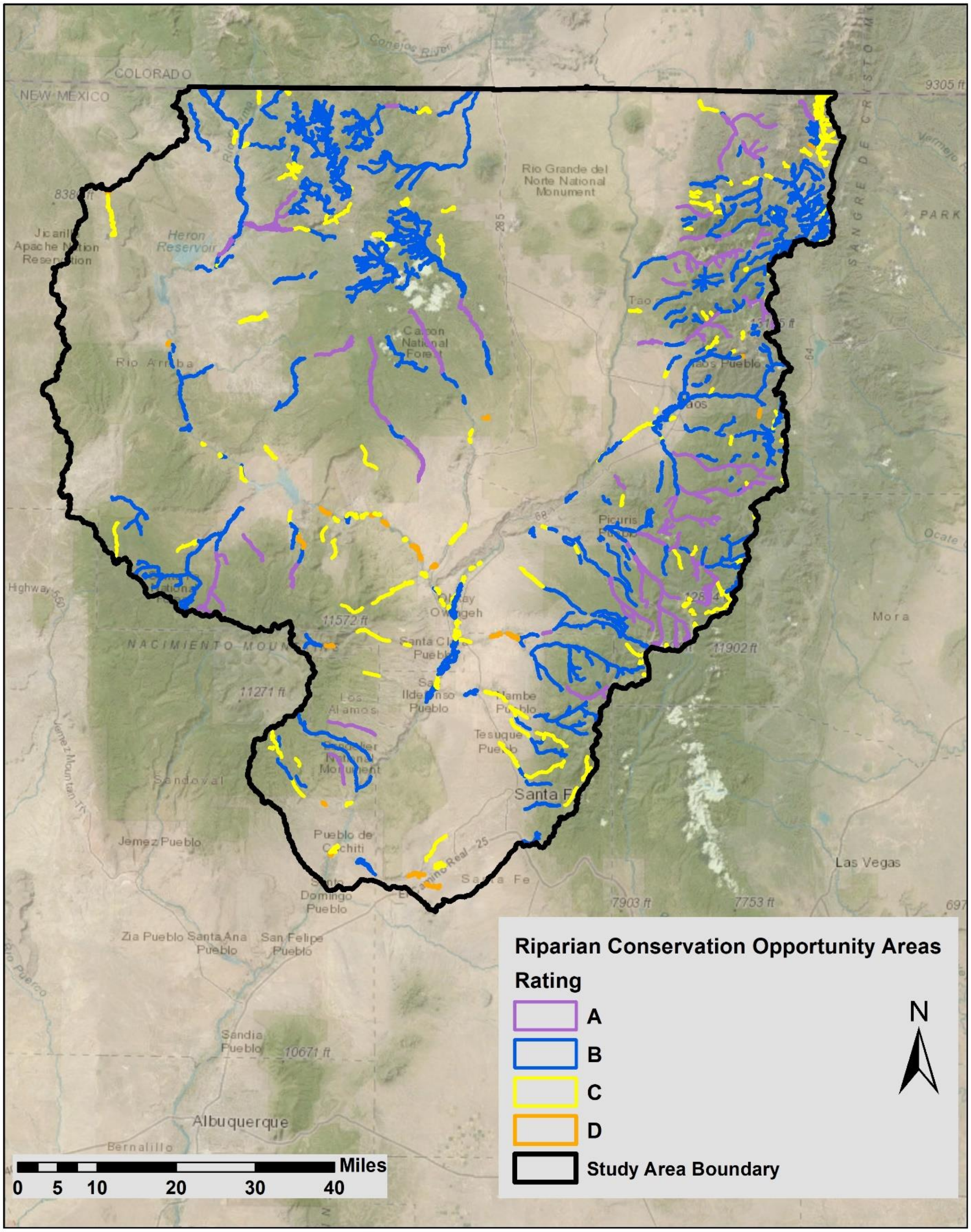

Figure 6. The distribution of the 447 Riparian Conservation Opportunity Areas by ecological ratings in for the Upper Rio Grande project area.

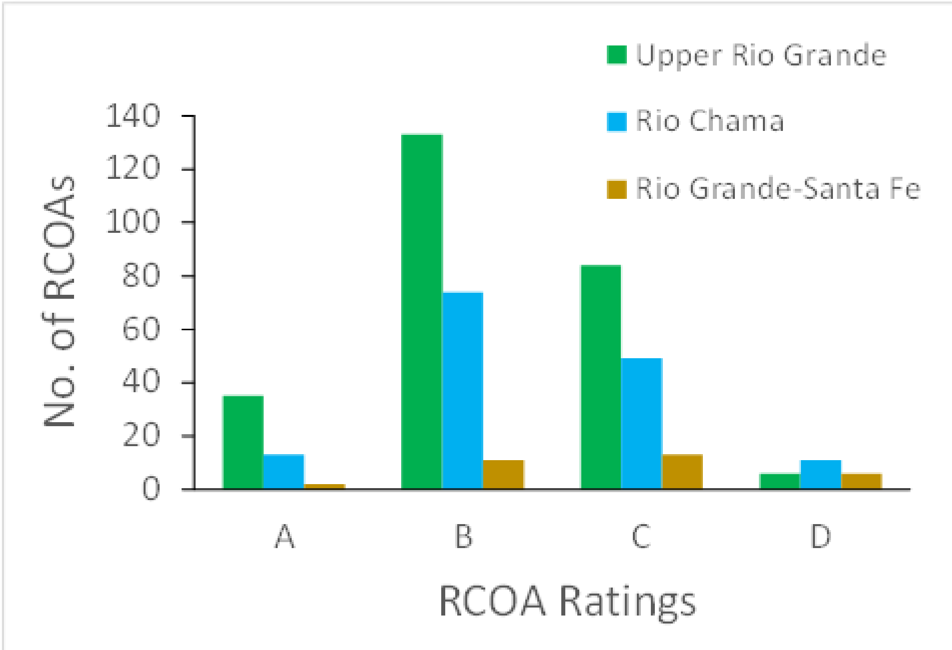

Figure 7. Distribution of Riparian Conservation Opportunity Areas by ratings class and basin

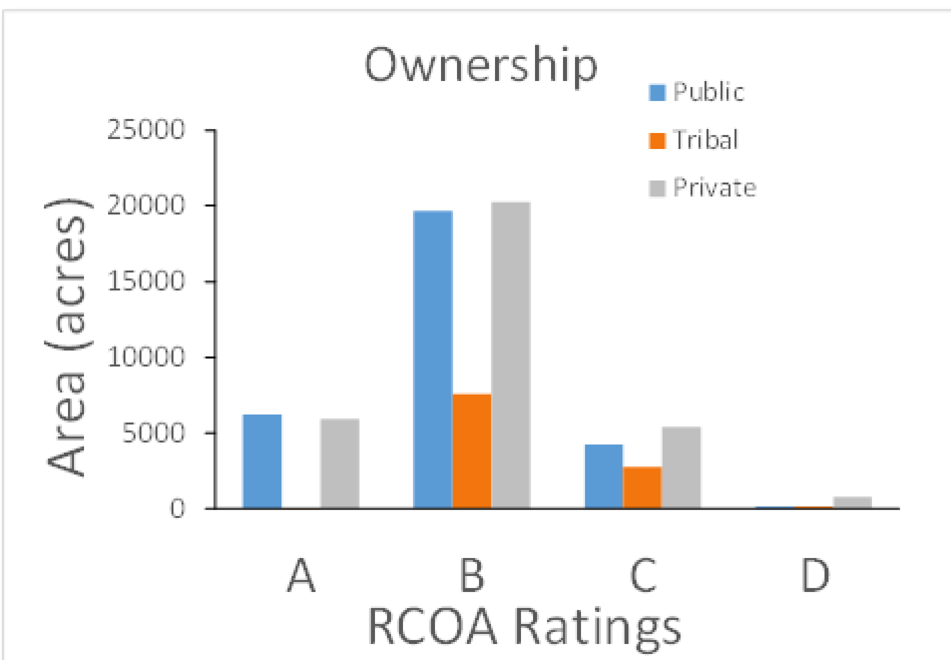

Figure 8. Distribution of Riparian Conservation Opportunity Areas (RCOAs) by major ownership catregories.

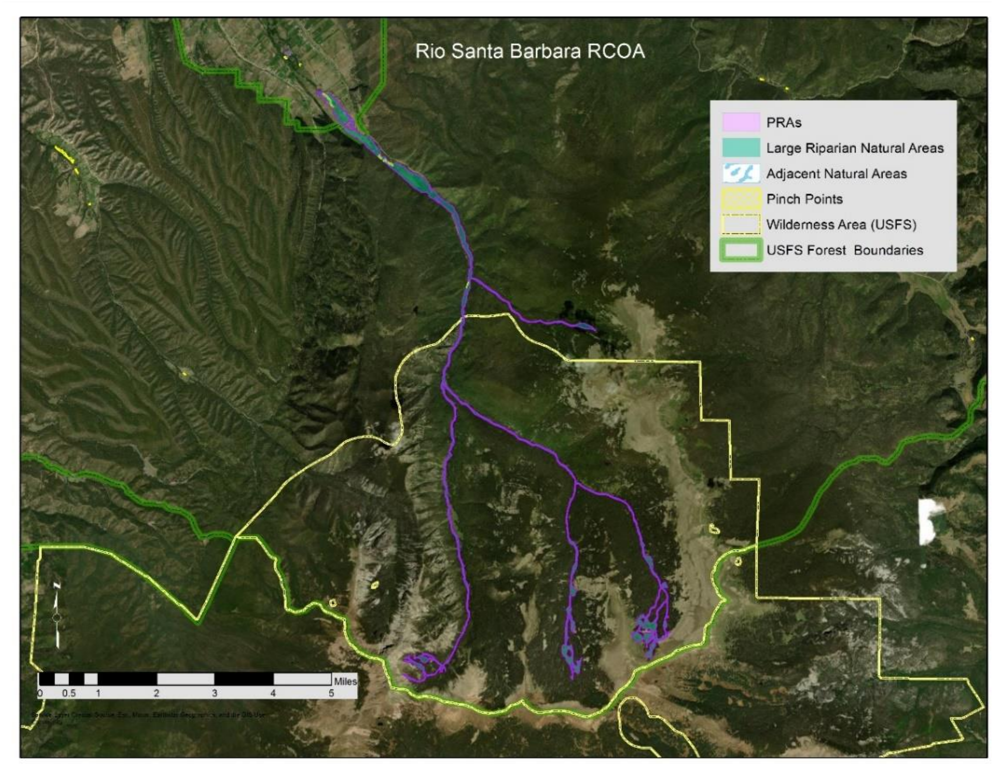

Figure 9. The Santa Barbara River is an example of an “A” RCOA located in mostly on undeveloped USFS lands and extends up into the Pecos Wilderness.

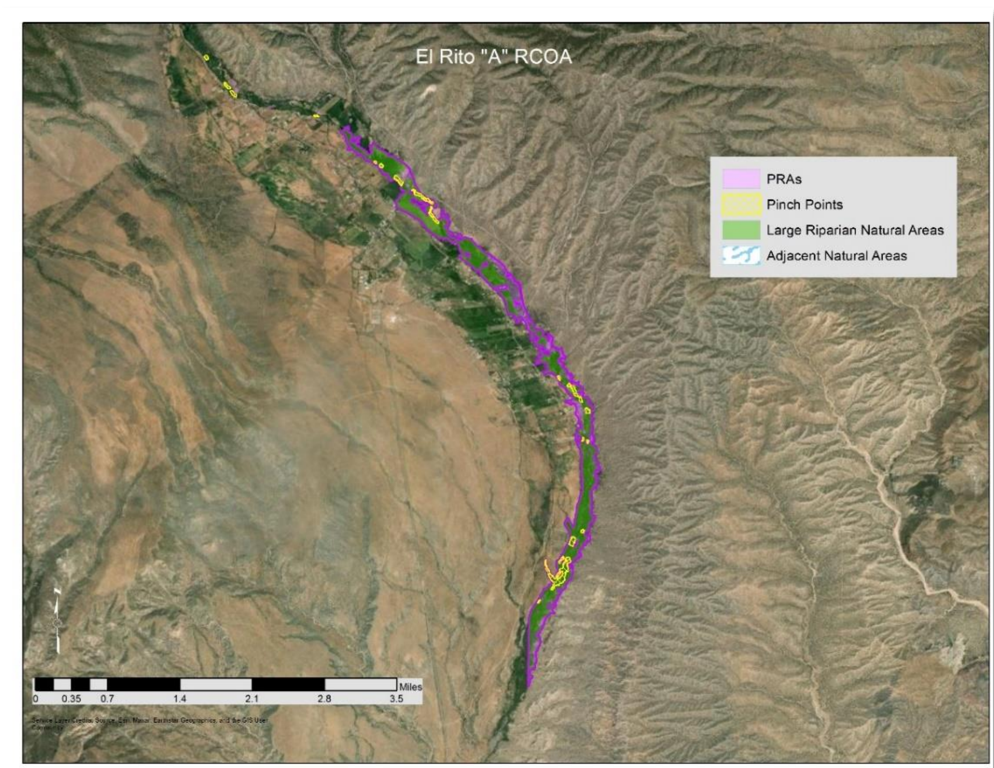

Figure 10. This is an example of an A-rated RCOA in a rural setting where the remaining riparian corridor of natural vegetation is mostly intact.

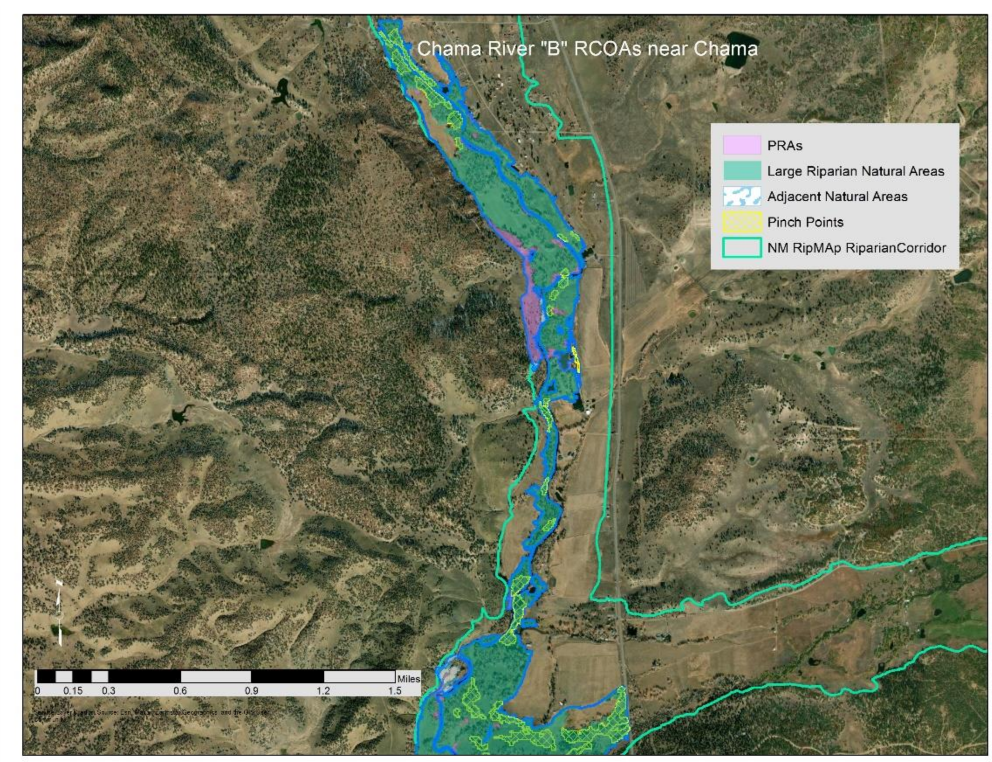

Figure 11. These B-rated RCOAs along the Rio Chama south of Chama are mostly intact connectivity wise along the channel but there are scattered patches of Potential Restoration Areas (PRAs) that reflect the lower rating.

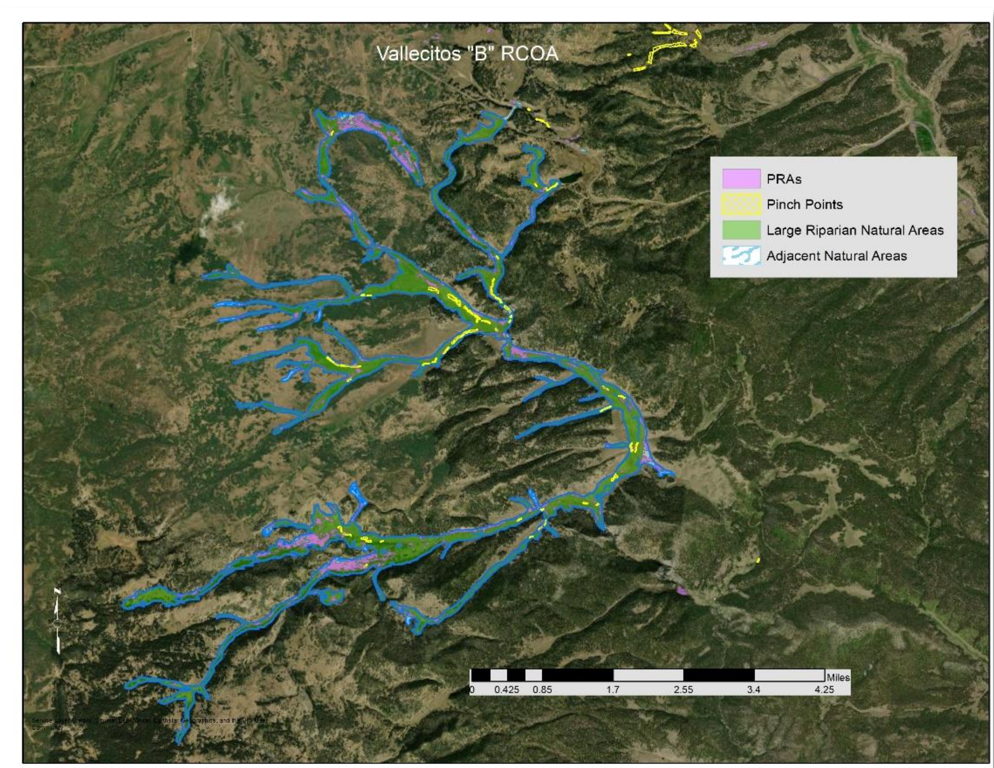

Figure 12. Some RCOAs at high elevations lack vegetation diversity and receive a lower rating such as this B-site at Vallecitos.

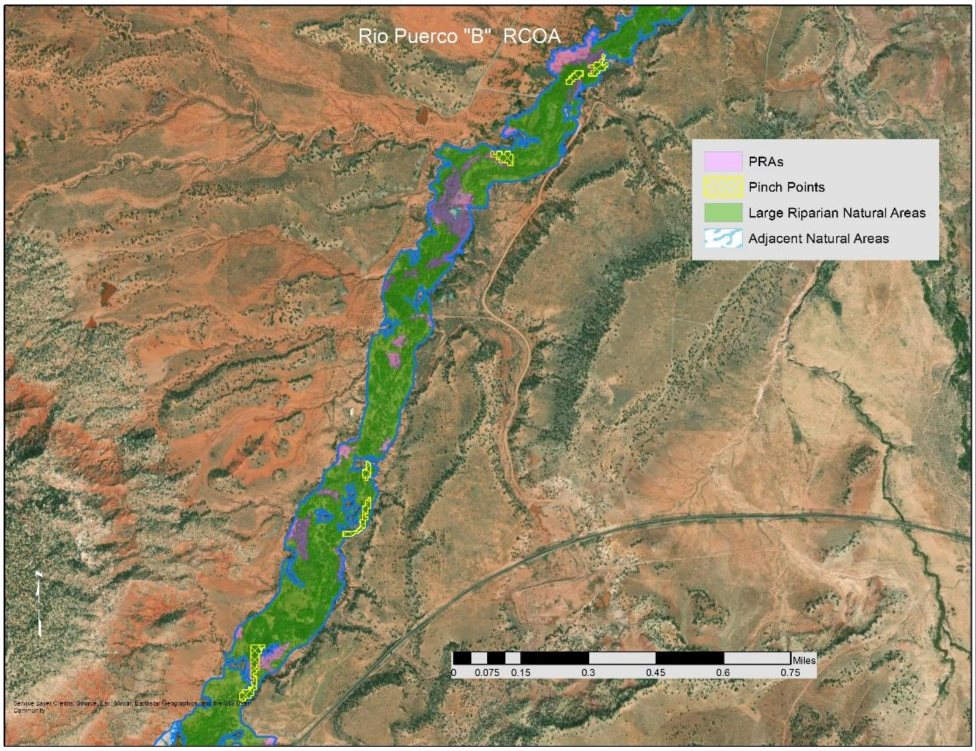

Figure 13. Lowland sites are constrained within canyon walls which can lower the diversity and hence the rating of an RCOA site such as this along the Rio Puerco above Abiquiu Reservoir.

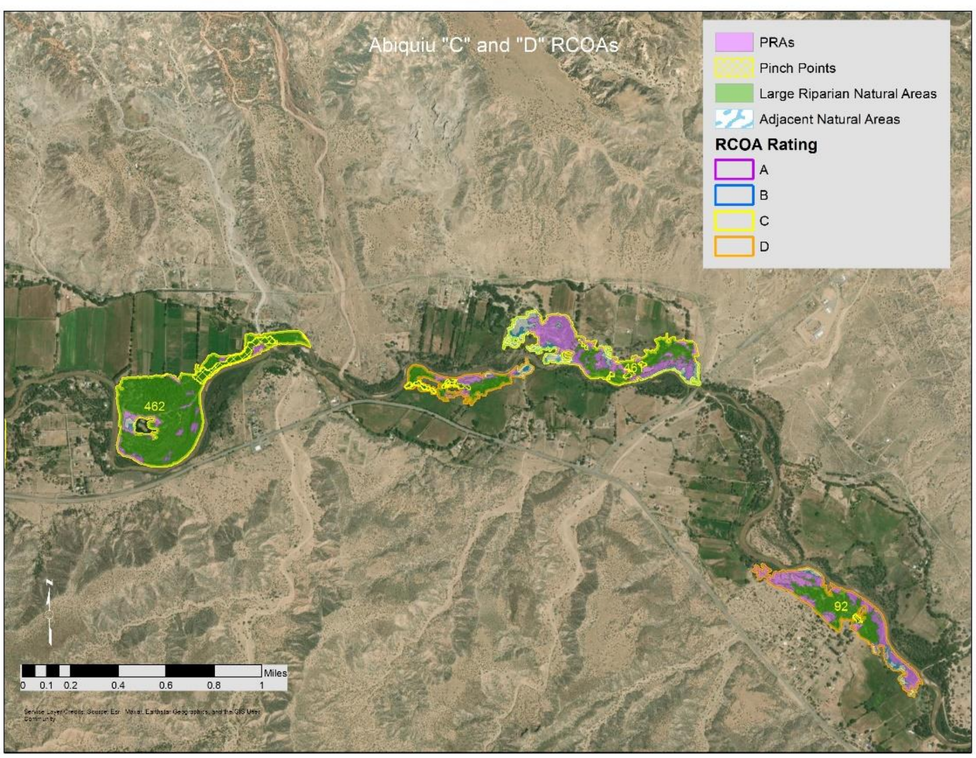

Figure 14. RCOAs with C and D rating are commonly smaller as a function of landscape fragmentation, have a great ratio of potential restoration area to natural area such as these along the Rio Chama near Abiquiu, NM.

There are some 1,209 “pinch points” within the RCOAs throughout the basin, but they are particularly important at lower elevations where natural areas have become constrained by development into relatively narrow bands of vegetation (at higher elevations some sites are just naturally narrow and bounded by natural upland vegetation). In this setting, they potentially represent some of the weakest links in maintaining habitat connectivity (see Figure 5). We suggest that in the process of conservation planning that special consideration is given to protecting and expanding these areas where possible.

Use of Portfolio

While the portfolio provides operational targets for conservation, it was largely developed using automated GIS spatial modeling with an initial quality-control check by inspection of the maps. Hence, it represents just the first iteration, or Version 1.0, that will require further evaluation and testing both analytically and in the field. For, example there are inevitably errors in the underlying data such as the vegetation map that may have affected an RCOA delineation, or known sites of high value on the ground missed entirely in the process. In addition, the vegetation map is based on 2016 imagery and changes since then may have occurred in a given location. Accordingly, users should recognize that site-level evaluations are needed as a precursor to any conservation or restoration action. Yet, this is a flexible dataset where tools can be developed that allow updates to the portfolio based on user input and tracking projects for sites through time.

With respect to the ratings, they too are first approximations and some elements that affect conservation and restoration actions are not readily analyzed in a GIS at the site level. For example, access and ownership are complex issues that can affect the opportunity element of conservation that are not reflected in the ratings. The quality of buffer around a site is not directly integrated into the ratings, i.e., if a site is surrounded by urbanized area versus upland natural land, that can affect conservation values. Lastly, the rating system does not account for dispersed land use impacts such as grazing. There are ways to address these issues in a GIS environment, but they were beyond the scope of this project.

The next challenge is to address the interstitial areas or “connectivity zones” between RCOAs that may be highly fragmented and have lower conservation values per the standards set here, but nonetheless cannot be ignored in the goal of maximizing habitat connectivity throughout the basin. This is particularly important in the zones that may have been willing participants in conservation where additional guidance would be useful. This can be addressed by finer scale GIS analysis and a different set of connectivity rules.

Overall, the RCOA portfolio presented represents the first comprehensive look at riparian conservation and restoration values in the Upper Rio Grande. It is a relatively straightforward, place-based perspective that conservation practitioners use in planning and implementation of projects for improving overall riparian health and habitat connectivity in the basin.

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Appendix A.

NM RipMap Vegetation Map Units for LRNAs and Adjacent Natural Areas
Forest and Woodlands
Western Lowland Native Deciduous Riparian Forest
Lowland Native Evergreen and Deciduous Riparian Forest
Montane Native Deciduous Riparian Forest
Montane Native Evergreen Riparian Forest
Montane Native Evergreen and Deciduous Riparian Forest
Shrublands
Lowland Wet Riparian Shrubland
Lowland Dry Riparian Shrubland
Montane Wet Riparian Shrubland
Montane Dry Riparian Shrubland
Herbaceous Vegetation
Western Lowland Marsh
Lowland Wet Meadow
Subalpine-Montane ***Wetland***
Montane Wet Meadow
NM RipMap Vegetation Map Units for PRAs
Type:
Mixed exotic or exotic
Lowland Native-Introduced Russian Olive Deciduous Riparian Forest
Lowland Native-Introduced Tamarisk Deciduous Riparian Forest
Lowland Native-Introduced Russian Olive-Tamarisk Deciduous Riparian Forest
Russian Olive Introduced Riparian Woodland and Scrub
Tamarisk Introduced Riparian Woodland and Scrub
Russian Olive-Tamarisk Introduced Riparian Woodland and Scrub
Mixed Introduced Forest and Scrub
Dry Riparian
Lowland Native Evergreen Riparian Dry Riparian Forest
Montane Dry Riparian Meadow and Grassland
Western Lowland Salt Meadow and Dry Grassland
Riparian Bare Ground/Rockland [non-channel]
Semi-Natural Vegetation
Semi-Natural Riparian Forest and Scrub