Galisteo Watershed: Wetlands Map for the Santa Fe Growth Management Strategy

Final Report

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Introduction

The Galisteo Growth Management Area (GGMA) is one of four areas defined by Santa Fe County for developing growth strategies. The GGMA is principally defined by the Galisteo watershed, is physiographically situated on the upland plateau south of Santa Fe and covers approximately 120,713 ha. The Galisteo Creek cuts through this upland region with its headwaters in the southern portion of the Sangre de Cristo Mountains and drains west into the Rio Grande (Figure 1). Any landuse planning strategy must account for wetlands associated with springs and streams such as the Galisteo and its tributaries Accordingly, the purpose of this project was to produce a suite of map layers in Geographical Information System (GIS) to support the determination of significant wetland and riparian areas within the GGMA as part of Santa Fe County's growth planning process.

Methods

Photo Interpretation and GIS Development

We used photo interpretive techniques in a GIS combined with field data acquired in the fall of 2008 and spring of 2009 to develop GIS layers indicating significant wetland and riparian areas within the GGMA. In addition to the wetland/riparian vegetation layer, we augmented existing GIS layers from Santa Fe County (SFCO) and the U.S. Geological Survey (USGS) representing physical features of the landscape and manmade structures. Color-infrared and natural-color aerial photography acquired in August of 2005 were used in the photo interpretive process (New Mexico GDACC 2007). An area covering approximately 1,052 ha (2599 ac) in the far northeast corner of the study area is not covered by the color-infrared photography and was therefore excluded from the map. Digital orthophoto quarter quads (DOQQs) derived from the aerial photography were used in the mapping. These had a one-meter spatial resolution and were produced to meet National Map Accuracy Standards (NMAS) requirements for 1:12,000-scale products. However, the quality of the imagery allowed for visual interpretations at a

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[1] Throughout this document the term wetlands is defined as both jurisdictional wetlands and vegetated riparian zones.

[2] Work submitted in fulfillment of Agreement No. 28-0150-GM/JS between the University of New Mexico and Santa Fe County. Suggested citation: Milford, E., T. Neville, and E. Muldavin. 2009. Galisteo Watershed: Wetlands Map for the Santa Fe Growth Management Strategy. Natural Heritage New Mexico Publ. No. 09-GTR-336. Natural Heritage New Mexico, University of New Mexico, Albuquerque, NM. 12 p.

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higher resolution scale of 1:3,000. Color infrared was particularly useful in separating wetland from upland areas, even when these areas were dry.

We used the USGS National Hydrography Dataset (NHD) Flowline layer as a guide for finding potential wetland and riparian areas. The dataset comprises approximately 2,175 linear kilometers of perennial and ephemeral reaches within the study area (Figure 1). Each segment was surveyed in the GIS and annotated. The USGS Geographic Names Information System (GNIS) was also used as a guide to indicate where known reservoirs, dams, and springs were located within the study area. As a result, this layer was augmented with over 200 additional point features during the desktop survey, principally to better represent impediments such as earthen dams and tanks within the drainages that affect the natural hydrology.

The SFCO GGMA Structures GIS layer was also augmented, with 67 new locations. Most of these new structures were small trailers and buildings. In addition to augmenting existing GIS layers, NHNM created and populated a new GIS layer for larger structures and other areas of disturbance within the drainages. This new feature class is the GGMA PolyFeatures layer and contains 127 labeled polygons. These augmented and new layers were created to be used in spatial analyses to determine potential impacts to riparian/wetland areas. These layers can now be used in a GIS-based assessment of wetland condition, which can aid the planning process in both identifying existing wetlands of high quality for conservation, and in targeting wetland areas in need of restoration.

Field Collection

We conducted three field trips in 2008 (October 24, November 7, and November 14) and one trip in 2009 (June 3) to identify dominant wetland types and improve the accuracy of the photo interpretation process (Figure 1). Prior to field reconnaissance, we selected the most promising photo-interpreted polygons and generated maps from the GIS for field use. Since the majority of lands within the watershed were privately owned, most field data was collected at or near roads. Privately owned lands were only visited if direct permission had been obtained from the landowner or manager. If new riparian/wetland areas were seen in the field that had not yet been photo-interpreted, we recorded these data on field data sheets, marked approximate locations on maps, and collected GPS position data. We recorded dominant species and relative percent of vegetation comprised of exotic species. We collected a total of 36 field plots for the study area.

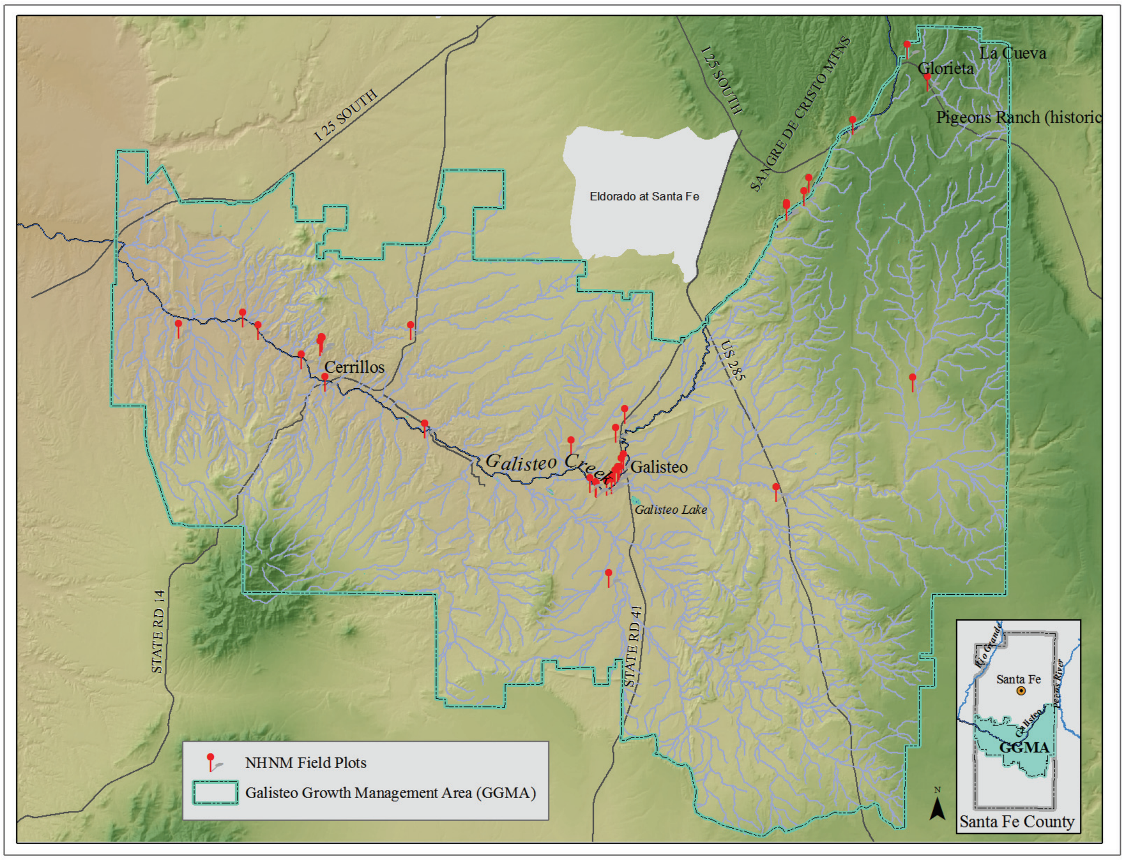

Figure 1. The Galisteo Growth Management Area and location of field plots.

Results

Photo Interpretation and GIS Development

Photo interpretation to determine species composition was based on differences in texture and color of the images and context, based on knowledge of individual reaches from field visits. Trees, shrubs and herbaceous vegetation can generally be distinguished from one another based on texture. Color, used in concert with texture, allows for the differentiation of the dominant woody species from one another. Salt cedar (*Tamarix ramosissima*) is generally distinguishable from coyote willow (*Salix exigua*), cottonwood (*Populus deltoides* ssp. *wislizeni*) and Russian olive (*Elaeagnus angustifolia*) based on color in the near infrared, while Russian olive can best be distinguished from cottonwood using natural color. However, photo interpretation is a somewhat qualitative process as the range of color on the photos differs within and between DOQQs. This occurs because of date and time of day differences in the acquisition of the photo and/or physiognomic differences related to maturity, or seasonality for the plants. For example, a young, dense stand of Russian olive can appear much the same as a young, dense stand of cottonwood; field data are particularly useful in these cases. At times, the young, moderately dense stands of salt cedar can also be confounding and appear similar to coyote willow stands. These apparent similarities may be due to varied reflectance attributed to stand age and substrate saturation. More often, these stands are differentiated on infrared color, salt cedar being a darker red. Vegetation in towns and residences adjacent to the riparian areas were not delineated. However, within the Glorieta area at the northeast corner of the study area, much of the development was within the current floodplain and therefore included in the interpretation.

A total of 651 polygons comprising approximately 858 ha were generated, representing potentially significant riparian and wetland areas within the study area. Small, isolated impoundments due to earthen dams or tanks were not considered significant riparian or wetland areas. Polygons were attributed with broad to specific categories based on taxonomy and native versus exotics. The higher physiognomic category, labeled "Class," contains seven subsets, and they are: Closed Woodland, Open Woodland, Sparse Woodland with Shrubs, Sparse Woodland with Grasses, Shrubland, Herbaceous Wetland, and Herbaceous. These are principally distinguished by percent canopy cover of trees relative to total vegetative cover (Table 1). Shrublands comprise the greatest amount of area delineated (416 ha); while, not surprisingly, Herbaceous Wetland had the least (12 ha). Much of the Shrubland class is dominated by salt cedar, with lesser amounts of coyote willow and minor amounts of rubber rabbitbrush (*Ericameria nauseosa*). Herbaceous Wetlands often occur near impoundments or, in rare cases, as seeps within the Cerrillos Hills Historic Park outside of the town of Cerrillos.

Table 1. Classification based on percent cover of trees.

%Cover Trees	Class	Ha
>60	Closed Woodland	101
25-60	Open Woodland	111
10-25	Sparse Woodland with Shrubs	92
10-25	Sparse Woodland with Grasses	40
<10	Shrubland	416
<10	Herbaceous Wetland	12
<10	Herbaceous	56

Each polygon contains numerous species. However, we limited attributing the GIS layer to the three most dominant species we could interpret and placed them into categories: Species1, Species2, and Species3, with dominance in descending order. The choices were limited to the following species/vegetation group subsets: Cottonwood, Russian olive, Salt cedar, Salt cedar Treated, Coyote willow, Herbaceous, Herbaceous Wetland, Juniper, Rubber rabbitbrush, and Other. The subset Other was typically a species not in our subset list either because it was an upland species or because it rarely occurred as a dominant. Siberian elm (*Ulmus pumila*), often found near or within drainages of towns, such as Cerrillos, is an example of one species grouped in the 'Other' category.

For each polygon we attributed a percent 'Exoticness' which combines cover of all exotic species into percent of exoticness relative to total vegetative cover. Values range from 0-100%. Examples of 100% cover can be found near the Galisteo Dam where mechanical removal is currently taking place. Since the aerial photography was acquired in 2005, any removal or active management occurring within the study area after August 2005 was not captured, but after field visits we delineated areas of treatment.

Map Units

Vegetated wetlands and riparian areas for the GGMA are delineated by dominant species and relative exotic species composition. The outcome is a GIS layer attributed with a higher-order physiognomic category, dominant-species composition, percent exotics, and a map-unit classification for each polygon. The map, containing over 650 polygons, is not limited to native-dominated wetlands, but comprises the full range of native to exotic.

The map legend is based on dominant species and percent of exotic encroachment (Table 2). We developed a scale of exoticness (EScale) based partially on restoration potential. The three scales are: 0-25, 26-65, and 66-100. The 0-25% scale is considered 'Native' with 26-66% considered 'Mixed', and greater than 66% 'Exotic'. These were: cottonwood, the most common native riparian tree; Russian olive, the most common exotic tree; coyote willow, the most common native shrub; and salt cedar, the most common exotic shrub. Other riparian trees and shrubs, both native and exotic, occur within the GGMA, but are not commonly stand dominants. Herbaceous stands are difficult to differentiate to species using digital aerial photography and were thus grouped into two broad, general subsets of either Herbaceous Wetland or Herbaceous. The subset Herbaceous Wetland included areas composed primarily of emergent or obligate wetland species with perennial to seasonal flooding, while Herbaceous consisted of all other herbaceous types. Polygons that were dominated by upland or arroyo riparian species were assigned to the "Other" map unit and were mostly dominated by juniper (*Juniperus* sp.), rubber rabbitbrush, or Siberian elm.

Table 2. Map legend.

Species 1	Exotic Scale (EScale)	Legend Name
Cottonwood	0-25	Cottonwood Native
Cottonwood	26-65	Cottonwood Mixed
Russian olive	26-65	Russian Olive Mixed
Russian olive	66-100	Russian Olive Exotic
Salt cedar	26-65	Salt Cedar Mixed
Salt cedar	66-100	Salt Cedar Exotic
Salt cedar treated	26-100	Salt Cedar Treated
Coyote willow	0-25	Coyote Willow Native
Coyote willow	26-65	Coyote Willow Mixed
Herbaceous Wetland	0-25	Herbaceous Wetland Native
Herbaceous Wetland	26-65	Herbaceous Wetland Mixed
Herbaceous	0-25	Herbaceous Native
Herbaceous	26-65	Herbaceous Mixed
Herbaceous	66-100	Herbaceous Exotic
Other*	various	Other
**Combined dominates of: Other or Juniper or Rubber rabbitbrush*		

Wetland/Riparian Vegetation Distribution

Exotics dominate the 858 ha of mapped riparian and wetland areas within the GGMA. Exotic-dominated stands comprise approximately 57% of the total vegetative cover with mixed and native at 29% and 13%, respectively. Considering the overall distribution of native-to-exotic (Figure 2), exotics comprise 493 ha. Salt cedar-dominated stands are the most common exotic type, comprising 81% of the total exotic-dominated area, followed by Russian olive-dominated stands at 19%. Less than 1% of the exotic-dominant area is categorized as Herbaceous Exotic.

Mixed-dominance stands comprised 251 ha, or nearly one-third of the mapped wetland area. Mixed-native dominated stands make up 59% of the total mixed-dominance area, with Cottonwood-dominated stands being the most common native-dominated mixed-stand type at 28% of the total mixed-dominance area, followed by Coyote willow (10%), Herbaceous (10%), Other (9%) and Herbaceous Wetland(2%). Mixed exotic stands were dominated by either Russian olive or Salt cedar, with 21% and 20% of the total mixed-dominance area, respectively.

Native-dominated stands (114 ha) comprised approximately one-eighth of the total mapped wetland area. Among native-dominated stands, cottonwood was the most common dominant, comprising 50% of the total native area. Less commonly dominant were Herbaceous (35%), Coyote willow (8%), and Herbaceous Wetland (7%).

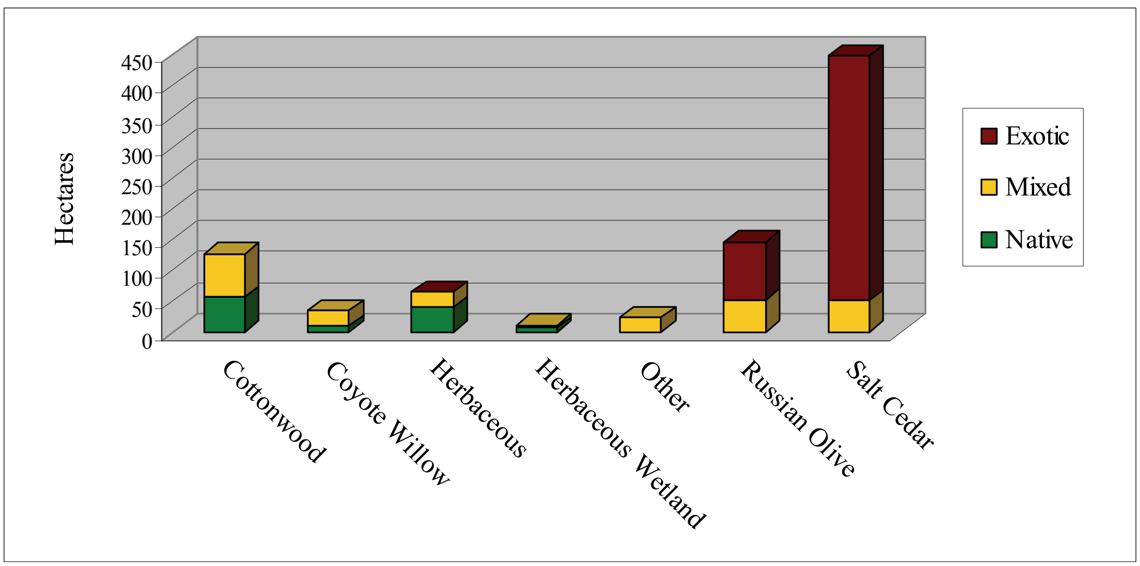

Figure 2. Distribution of dominant species categories and native-to-exotic characterization.

Overall, the encroachment of salt cedar is pervasive within the GGMA (Figure 3). Only in the northeastern portion of the study area, as Galisteo Creek flows southwest from Glorieta prior to its westward flow at Galisteo, are natives more abundant than exotics. Additionally, within Galisteo Creek, adjacent to the towns of Cerrillos and Galisteo, lie some of the best native woodlands. An example of the map at higher spatial resolution (Figure 4) shows an area of considerable ground control and access to the riparian areas at Galisteo. The Cottonwood Mixed stands within this reach contain coyote willow, scattered tree willow and Russian olive with a diversity of herbaceous vegetation.

As a first level of analysis, to identify the high-quality wetland areas within the GGMA, we created a map of the native-dominated stands (Figure 5). Because native-dominated stands only comprised about one-eighth of the total riparian/wetland area mapped, we also included native-dominated mixed stands due to their potential for restoration. Three major areas stand out as having potential high-quality riparian/wetland areas. The first is in the lower Sangre de Cristos and includes the areas along Glorieta Creek and the headwaters of Galisteo Creek. The second is a series of sites along lower Galisteo Creek, divided into three sub reaches: (a) around the town of Galisteo, extending both to the north and west from Galisteo; (b) along Galisteo Creek between Chorro Arroyo and Arroyo de la Vaca; and (c) along Galisteo Creek around the town of Cerrillos. The third major area of potential high-quality wetlands is along San Cristobal Arroyo to the east of Cañada Estacada. Because this area is on private land, it was mapped based on imagery, with only one field point taken from a bridge on State Road 285. Therefore, additional field visits are needed for validation and inclusion into a group of potential high-quality wetland sites.

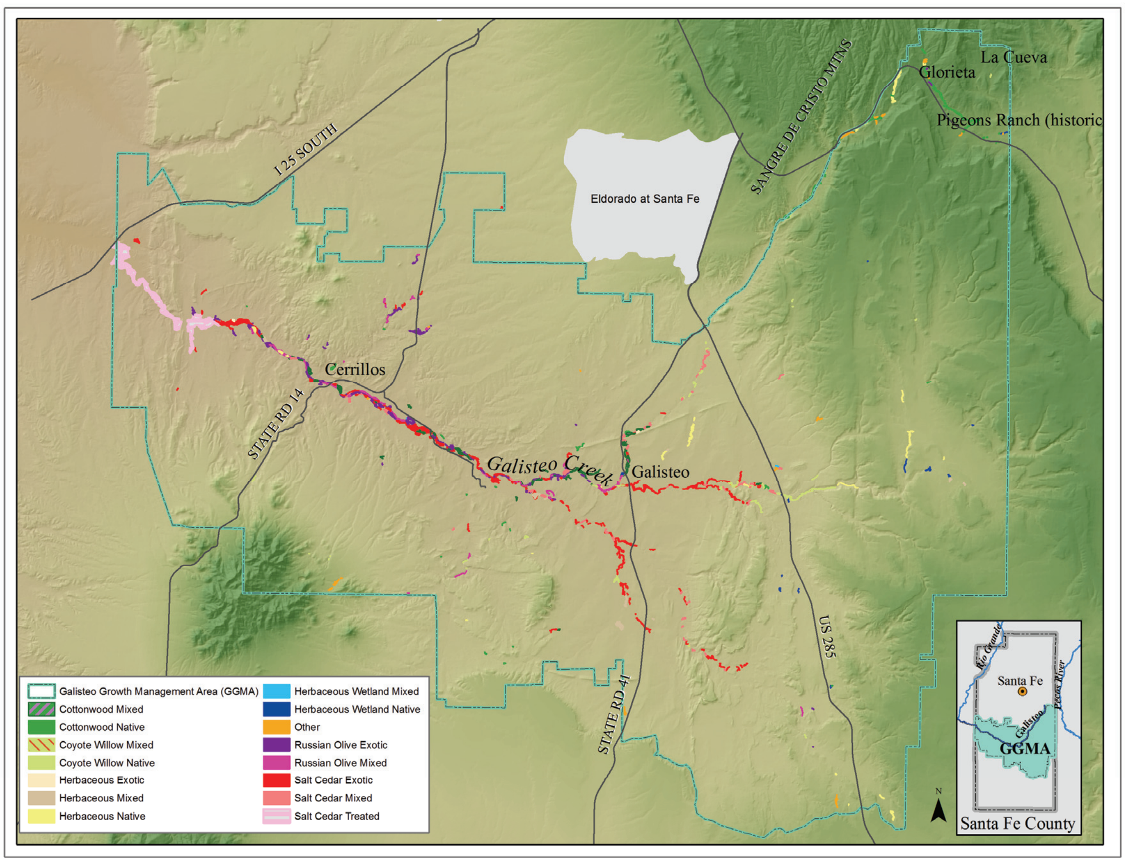

Figure 3. Final Riparian/Wetland vegetation map for the GGMA.

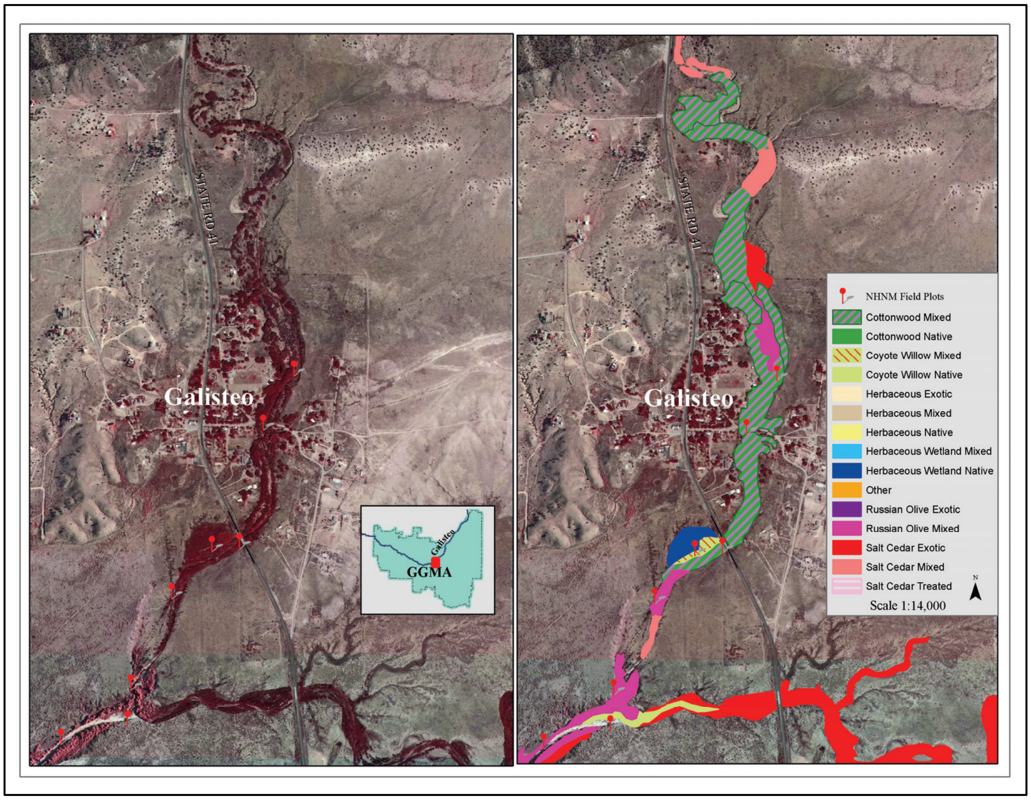

Figure 4. Color infrared orthophotography (left) and an overlay of the wetland/riparian map units (right).

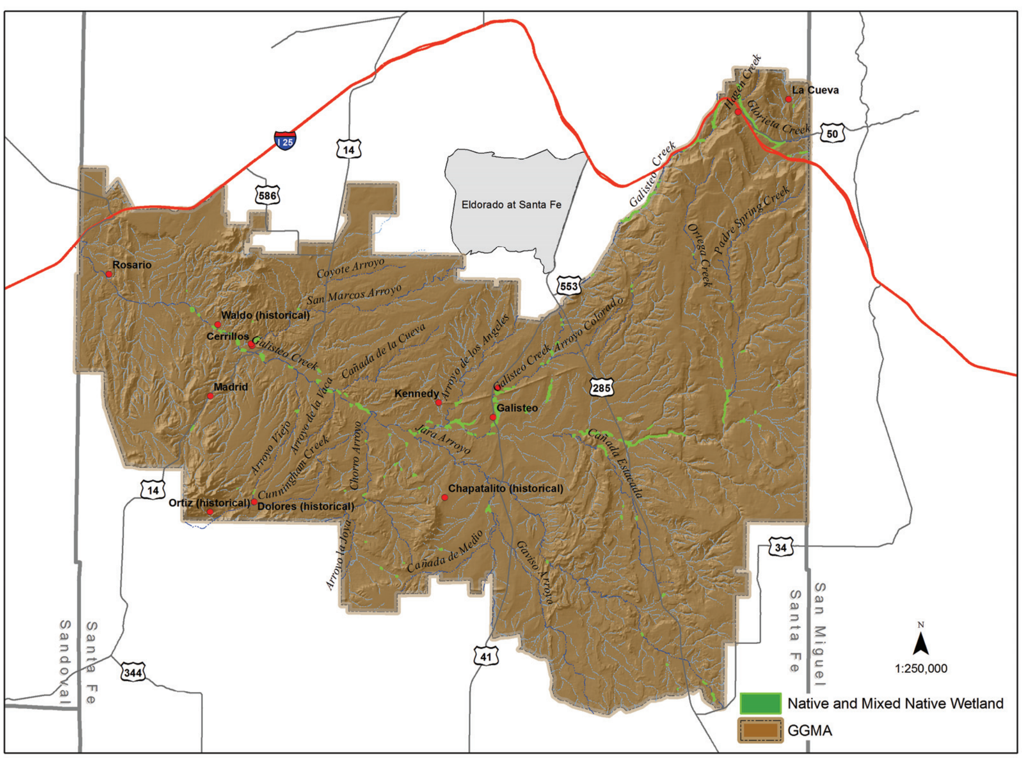

Figure 5. Map of native and mixed-native-dominated riparian/wetland stands.

Discussion

Stands designated as native dominated should receive the highest conservation priority, particularly considering their minor contribution to the overall wetland/riparian area within the GGMA. Due to large areas of encroachment by exotics, stands that are mixed but native dominated may also be good conservation targets. Ultimately, addressing the question of where the highest-quality wetland and riparian sites exist within the GGMA should include further GIS analysis to assess stands at a landscape level. This analysis may include an assessment of contiguous wetland area, dominance, and sustainability based on known threats derived from the layers of physical features and manmade structures developed under this contract. Additional data that may be available on wildlife use, threats such as planned development, and cultural or recreational value could be used to identify wetland quality and conservation priority.

Mixed stands may provide areas for potential restoration when taken in the context of the surrounding landscape and plant-species dominance. Mixed stands with a relatively intact hydrologic system and/or relatively substantial nearby communities of native-dominated vegetation would be priority restoration sites. Further analysis of the map will be required to identify the mixed sites most suitable for restoration.

Stands that are exotic dominated would most likely be lowest on the conservation and restoration priority list. However, in some cases, exotic-dominated sites might have high restoration potential based on hydrology, surrounding wetland vegetation communities for connectivity, and a lack of major stressors. Both mixed- and exotic-dominated riparian/wetland sites may also be providing significant habitat for wildlife, and are still part of the rare wetland resources within the GGMA that should be given consideration during county planning.

Based on the maps created for this project, it is clear that there are limited wetland/riparian areas within the Galisteo Growth Management area, most of which are concentrated around Galisteo Creek. However, the wetland and riparian areas of the GGMA currently have significant upland natural areas and largely intact hydrology. This provides the county with a window of opportunity to carefully plan growth to manage and preserve the unique biological and cultural resource that these riparian/wetlands provide.

Acknowledgements

Our thanks to Steve and Amy Tremper, Managers of the Cerro Pelon Ranch, for providing access to portions of the ranch for mapping purposes. Additionally, Jan-Willem Jansens of Earth Works Institute provided valuable feedback on the draft map.

References

New Mexico Geospatial Data Acquisition Coordination Committee (GDACC). 2007. Color infra-red and natural color orthoimagery acquired in 2005 over New Mexico.

APPENDIX

Deliverables

The map and associated legend provides the first step toward understanding the existing diversity and exotic encroachment issues within the GGMA. Other GIS products developed and augmented as part of this project can be utilized to further our understanding of the status of the surface hydrological system within the basin. With this final deliverable, we provide a CD that contains the report and GIS feature class layers in a geodatabase (geodb folder, Version ArcGIS 9.3) along with associated files including the legend and metadata. A list of items on the CD:

1. Report: *GalisteoWetlandsFinalMapReport.pdf*. Final report in Adobe Acrobat format.
2. Point feature class: *WetlandFieldPlotsFinal.* This layer contains plot locations from field visits attributed with notes and percent cover of dominant species. Note: Plots on private land are not included in the deliverable.
3. Polygon feature class: *GGMAWetlandFinal.* This is the final wetland/riparian area delineation for the study area. The principal legend is based on the attribute 'LegSpExotic', however, other attributes can be used to further analyze the composition of the map unit and amount of encroachment by exotics.
4. Point feature class: *GGMA_GNISSelect*. This is the USGS Geographic Names Information System (GNIS) layer derived from the on-line dataset in 2007. NHNM added over 200 point features to this layer representing earthen dams, dams, springs, and tanks observed during the photo interpretive process.
5. Polygon feature class: *GGMA_Structures*. Derived from the SFCO Structure point layer, NHNM added 67 locations that mostly include small structures, trailers, and buildings. These were categorized by type of structure and a buffer attribute assigned to them according to their estimated size.
6. Polygon feature class: *GGMA_PolyFeatures*. NHNM digitized 127 polygons representing diverse disturbances within and upland of drainages. These polygons include agricultural fields, fields, mining areas, sewage ponds, borrow pits, large buildings and ranch facilities, and other diverse disturbances that may impact the function of the hydrology of the basin.
7. Layer Files: *GGMA_WetlandFinalJune2009solid.lyr* and *GGMA_WetlandFinalJune2009outline.lyr*. These can be used to apply symbology seen in the report (…solid.lyr) or an additional symbology layer providing just an outline of the map units. Symbology/legend is based on the attribute LegSPExotic.
8. Metadata: .xml and .html format.
9. Photos: .jpg format labeled with PlotID to match GIS feature class FieldPlots. There may be more than one photo per PlotID which is followed by the cardinal, inter-cardinal direction, or description of an observation. Photos are organized in separate folders by collection date. Note: Photos taken on private land are not included in the deliverable.