River Ranch Riparian Assessment

A Survey of Current Ecological Conditions
to
Support Resource Management Planning

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River Ranch Riparian Assessment

A Survey of Current Ecological Conditions to Support Resource Management Planning[1]

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Executive Summary

The New Mexico Department of Game and Fish (NMDGF) is developing a natural resources management plan for its newly acquired River Ranch property along the Mimbres River in Luna County, NM. The long-term goals for the River Ranch are to maintain and improve riparian habitat for all wildlife species as well as species of greatest conservation need (SGCN). To help meet these goals and support the planning process, this riparian assessment was conducted on River Ranch May 18 to 20, 2015 to provide baseline data on biotic and abiotic habitat conditions using the New Mexico Rapid Assessment Method for Lowland Riverine Wetlands (NMRAM). The NMRAM is a semi-quantitative and efficient approach to sampling and assessing the ecological status of riverine wetland and riparian areas. The NMRAM assessment uses a combination of mapping analysis and field surveys to measure 12 metrics that reflect landscape context, biotic, and abiotic attributes of the riparian ecosystem. These in turn are rolled-up into an overall ecological condition score by sampling area (SA) and averaged for the site as a whole.

River Ranch is located approximately 38 km (23 mi) north of Deming, NM on the north edge of Luna County, within the lower portion of the Mimbres River. The section of the Mimbres River on which the River Ranch is located is among the last wet portions of the river were it leaves the confines of the Mimbres Valley and enters the wide, closed desert basin to the south. At the River Ranch, the Mimbres has mostly perennial flow. However, surface flow can be intermittent, particularly in the summer months. The River Ranch has a diversity of riparian vegetation communities. These include relatively large and mature woodland stands dominated by Fremont's Cottonwood (*Populus fremontii*), Goodding's willow (*Salix gooddingii*), and velvet ash (*Fraxinus velutina*), shrublands along the river banks and some low terraces, and extensive swaths of big sacaton (*Sporobolus wrightii*) grasslands on the upper terraces. Associated with this diversity of vegetation communities is a wealth of fauna.

On the River Ranch, livestock grazing was the most recent land use, but the ranch also contains a few old fields. South of the upstream property boundary 0.6 km (0.4 mi) there is an earthen irrigation

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[1] Final report Project Work Order Number EEP-150302, New Mexico Department of Game and Fish to the University of New Mexico.

diversion dam that was diverting about 80% of the base flow when the site was visited in May 2015. The dam diverts water into an irrigation ditch that runs along the eastern side of the floodplain.

Based on the NMRAM assessment the River Ranch riparian wetlands overall are currently in excellent condition, with both the lower and upper SA rating excellent, and the middle SA rated good. The ranch average for both landscape context and biotic metrics was also excellent. The abiotic metrics were rated in the good category. However, the data from some individual metrics also point out areas where management is needed to maintain or improve the condition status of the ranch. Both in some of the biotic and abiotic metrics, there are indications of a decline in groundwater, and losses in hydrologic connectivity on the ranch. Most measurements showed that these declines were more severe below the irrigation diversion dam. In particular, the metric Vegetation Vertical Structure indicated a lack of riparian shrub layers across the lower portion of the ranch, indicating a reduced groundwater table, as well as possible removal by livestock in the past. Across the ranch scores for the metric Native Riparian Tree Regeneration were low, with very few young trees observed. This can indicate both a reduced groundwater table, a loss of hydrological connectivity to the floodplain, and/or removal of seedling and sapling trees by livestock. Finally the metric Hydrologic Connectivity, which was measured using two different methodologies, indicated a minor to moderate loss in connectivity from the expected, with the lowest connectivity scores coming from the middle SA, just below the irrigation dam.

The recommendations from this assessment are:

1. Maintain maximum possible base flows in the active river channel, particularly in the growing season, and in keeping with the property water rights. If possible this should include a redesign of the irrigation dam, and active flow in the irrigation ditch only when needed for downstream irrigation.
2. Livestock should be kept out of the active channel and adjacent riparian zone until the woody riparian vegetation has had a chance to reproduce and mature. Once vegetation has recovered, if grazing is considered, livestock use should be carefully monitored, and access to the active channel should be limited or excluded.
3. If recommendations 1 and 2 do not produce an improvement in riparian tree reproduction, it is suggested that the ranch management look into more active restoration, including earthwork.
4. Big sacaton stands around the large mature tree stands should be managed to create fire breaks to reduce fire risk to the forests.
5. Removal of the few saltcedar and Russian olive individuals on the ranch is recommended to prevent expansion of these species and future ecosystem disruption.

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Cover: View from western terrace towards Mimbres River near the center of the River Ranch property (Photo by E. Muldavin).

Introduction

The New Mexico Department of Game and Fish (NMDGF) is developing a natural resources management plan for its newly acquired River Ranch property along the Mimbres River in Luna County, NM. The long-term goals for the River Ranch are to maintain and improve riparian habitat for all wildlife species as well as species of greatest conservation need (SGCN). To help meet these goals and support the planning process, this riparian assessment was conducted on River Ranch May 18 to 20, 2015 to provide baseline data on biotic and abiotic habitat conditions using the New Mexico Rapid Assessment Method for Lowland Riverine Wetlands (NMRAM)[2].

The NMRAM is a semi-quantitative and efficient approach to sampling and assessing the ecological status of riverine wetland and riparian areas. For River Ranch, three sampling areas (SAs) were established for the assessment, distributed such that they captured the range of variation in riparian ecological conditions. The NMRAM assessment uses a combination of mapping analysis and field surveys to measure 12 metrics that reflect landscape context, biotic, and abiotic attributes of the riparian ecosystem. These in turn are rolled-up into an overall ecological condition score by SA and averaged for the site as a whole. Based on the information gathered in the NMRAM process—the individual metric scores and other observations made while on the site—we provide an assessment of current conditions with a discussion of the implications for maintaining and improving the riparian habitat of the ranch.

Figure 1. The Mimbres River near the northern boundary of the River Ranch.

[2] The most current version of the NMRAM Handbook and Field Guides can be downloaded from the New Mexico Environment Department, Surface Water Quality Bureau, Wetlands Program website at https://www.env.nm.gov/swqb/Wetlands/NMRAM/. The Lowland draft manual should be available from the site in the fall of 2015.

Methods

Study area

Location and hydrology

River Ranch is located approximately 38 km (23 mi) north of Deming, NM on the north edge of Luna County, within the lower portion of the Mimbres River (Figure 1). The section of the Mimbres River on which the River Ranch is located is among the last wet portions of the river where it leaves the confines of the Mimbres Valley and enters the wide, closed desert basin to the south. Approximately 5 km (3 mi) below the southern River Ranch boundary the Mimbres becomes a dry drainage that only carries surface flows during large precipitation events. The River Ranch incorporates 3.8 km (2.3 mi) of river reach flowing from north to south, with elevations that range from 1,543 m (5,060 ft) at the upper end to 1,518 m (4,980 ft) at the lower, resulting in a low stream gradient (approximately 0.6-0.7%).

The floodplain varies from approximately 130 to 500 m in width, but is 200 to 400 m in width on average. The narrower floodplain widths occur at the northern (upstream) end of the River Ranch, where the Mimbres passes through a natural confinement created by bedrock at the base of a hill on the west and a ridge to the east. At the River Ranch, the Mimbres has mostly perennial flow sustained by discharge from a drainage basin of 1,335 km^2 (515 mi^2). However, surface flow throughout the upper Mimbres valley can be intermittent, particularly in the summer months, due to climatic conditions and irrigation withdrawals (Cooper 2013).

There are no stream gages with consistent data on the Mimbres River below the River Ranch, but there is a gage at the town of Mimbres (Gage Station 08477110) 38 km (23 mi) upstream of the study site that is used here to understand the general flow regime of the river. Data for this gage is available for the years 1978 to 2014. In general, the data set was complete, but there was a 15-month gap between June 2013 and Oct 2014. Also, peak discharge data was only available for some years. Stream flow shows bi-modal peak flows, with one peak occurring between February and March, and the other occurring in August (Fig. 3). The system is driven by both winter snowmelt and later summer precipitation, with both capable of producing large- magnitude flows. The large peak flow from the fall of 2014 was just under 500 cfs at the Mimbres gage (Fig. 4). Similarly sized peak flow events occurred in 2012 and 2008. Within the period of record, there have been 12 peak-flow events that were more than 1000 cfs, and approximately five in the 500-1000 cfs range (Fig. 5), giving the 2014 flow a two-to-three-year return interval.

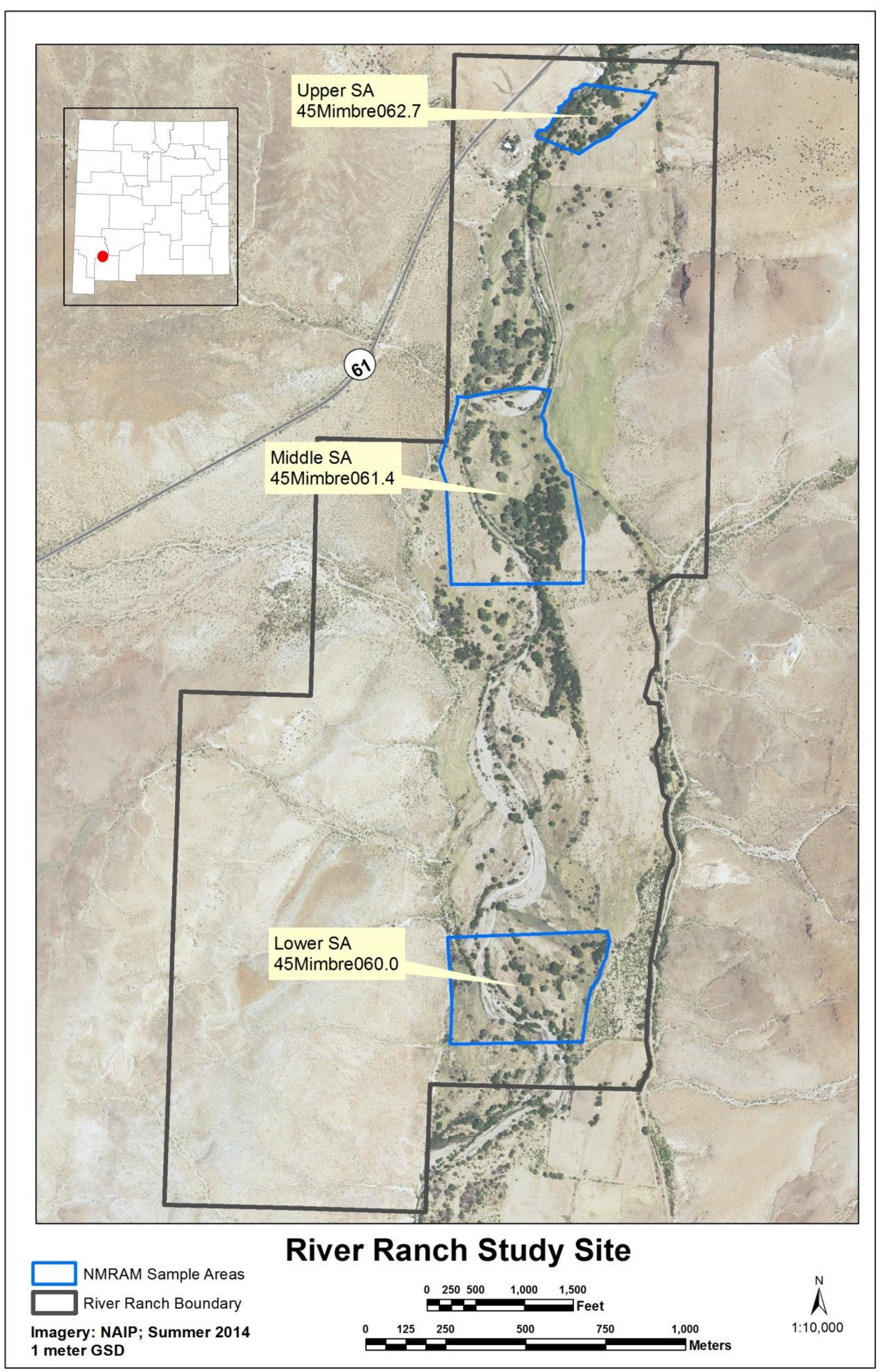

Figure 2. River Ranch study area showing three NMRAM Sampling Areas (SAs).

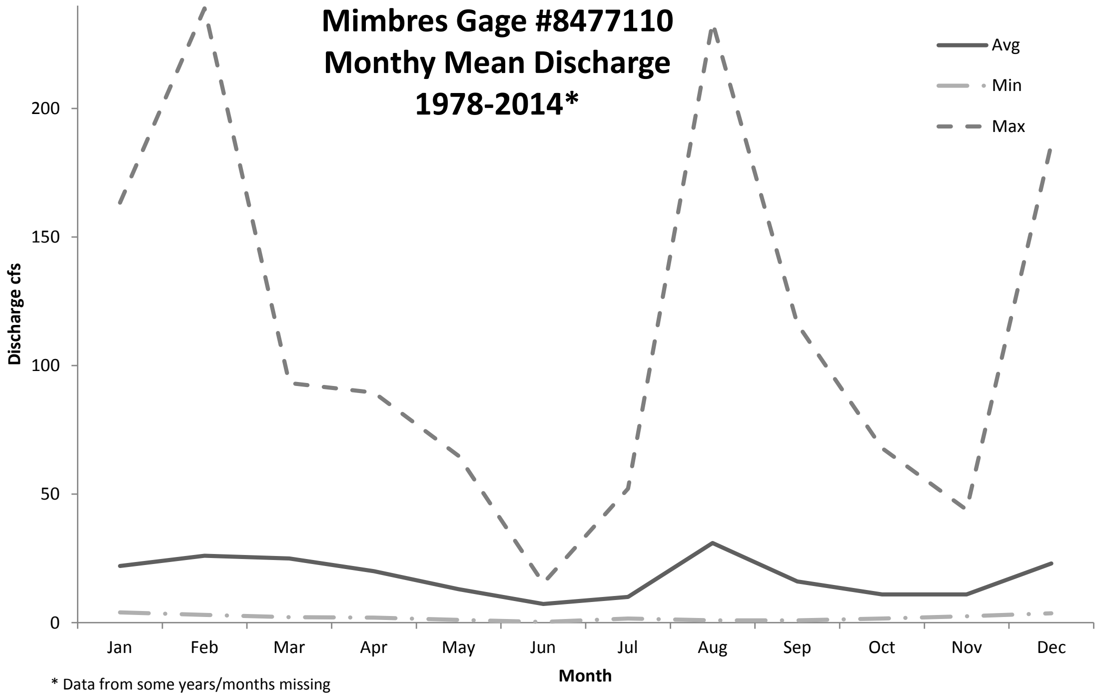

Figure 3. Average, maximum, and minimum monthly discharge on the Mimbres River at Mimbres NM (Gage Station 08477110). Gage period 1978 to 2014.

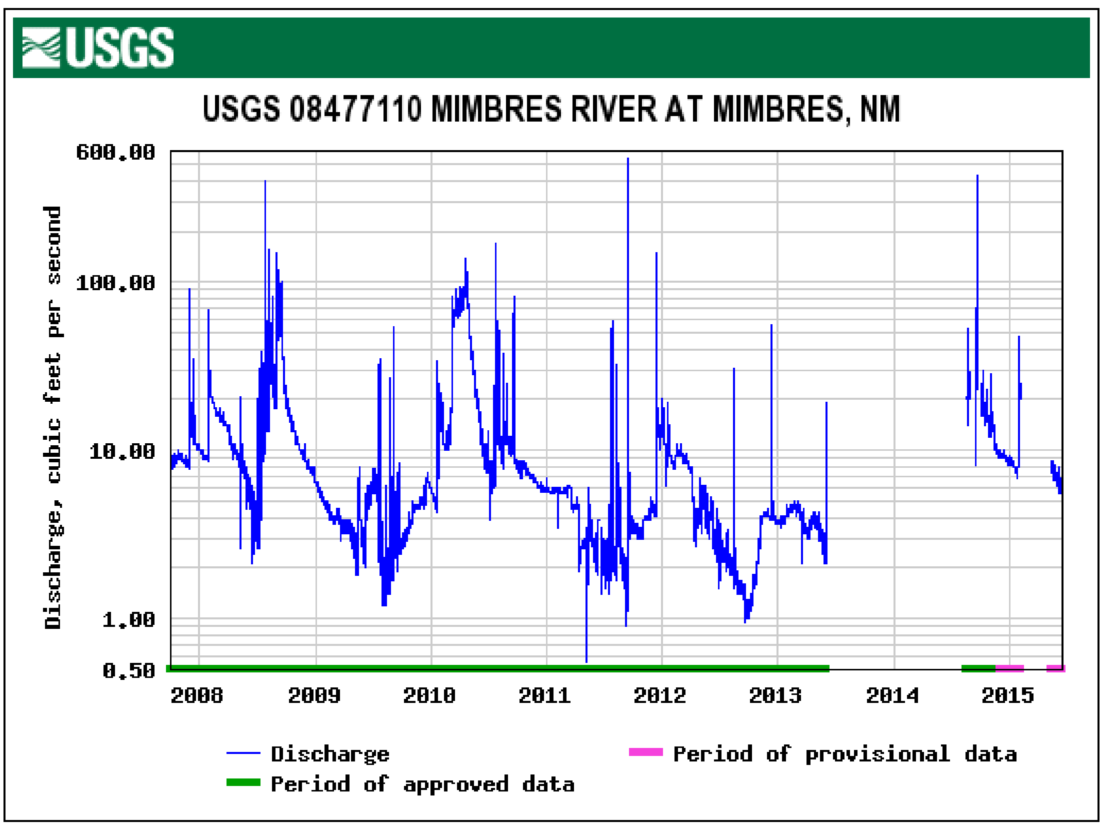

Figure 4. Daily discharge at Mimbres gage from Oct 2007 to May 2015

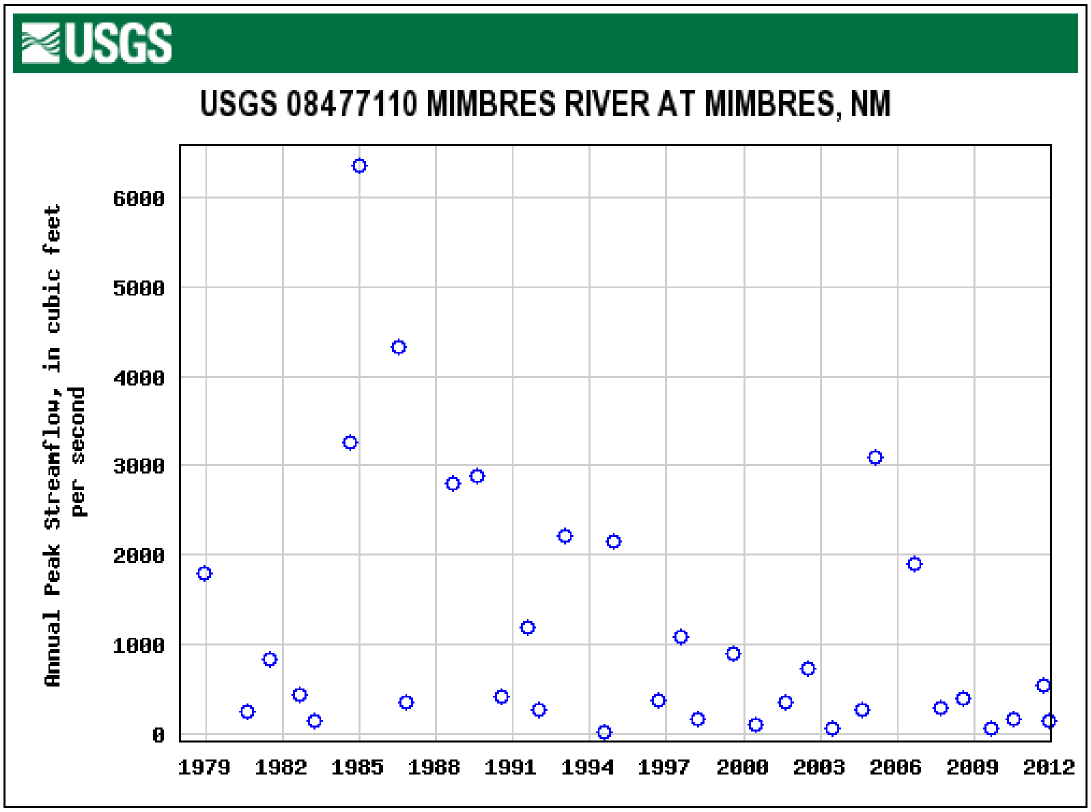

Figure 5. Annual peak flow in cfs for Mimbres gage from 1978 to 2012.

Figure 6. There are large expanses of big sacaton grasslands on the River Ranch.

Vegetation and Fauna

Figure 7. The Mimbres though the River Ranch supports a wide variety of riparian habitats.

The River Ranch has a diversity of riparian vegetation communities. There are relatively large and mature woodland stands dominated by Fremont's Cottonwood (*Populus fremontii*), Goodding's willow (*Salix gooddingii*), and velvet ash (*Fraxinus velutina*) (see Figures 7, 13-15). These communities are mostly associated with the higher river bars and terraces per map unit B of the provisional soils map[3] (Figure 9). These communities are considered globally imperiled with a NatureServe status rank of G2[4] (Faber-Langendoen et al. 2012). In addition, the site reportedly supports the state record for the largest velvet ash. Lining the river bank and occasionally on alluvial terraces are shrublands dominated by coyote willows (*Salix exigua*) and seepwillows (*Baccharis salicifolia*) along with strands of herbaceous wetlands along the channel (soils map units A and C). In addition to the woodlands and shrublands, there are extensive swaths of big sacaton (*Sporobolus wrightii*) grasslands on the upper terraces (Figure 6). The 10 plant associations identified in this survey are listed in Table 1 and ordered by the U.S. National Vegetation Classification hierarchy[5].

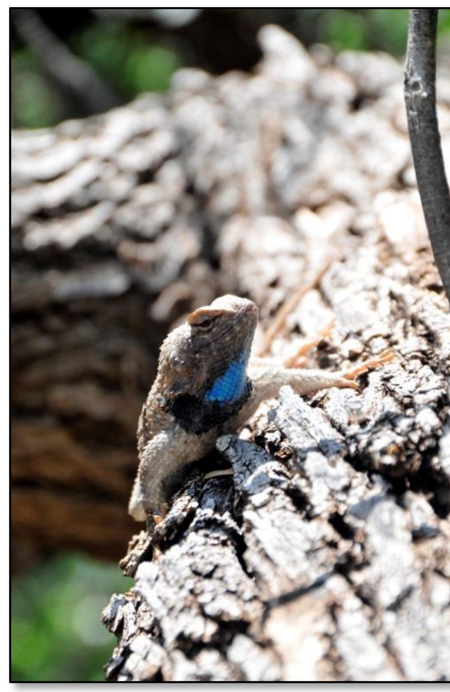

Figure 8. A Clarks spiny lizard in a Freemont cottonwood on the south end of Tigner grove.

Associated with this diversity of vegetation communities is a wealth of fauna (Figure 8). For the ranch, 174 species have been reported, including 108 birds, 28 mammals, 13 reptiles and amphibians, and 25 dragonflies and damselflies[6]. Among these, 22 are on the New Mexico Species of Greatest Conservation Need list (SGCN)[7]. Together with two Nature Conservancy preserves located at mid and upper sections of the Mimbres, the River Ranch anchors a unique conservation opportunity area of state-wide importance.

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[3] Personal Communication, Luis Garcia, Natural Resources Conservation Service, Las Cruces, NM.

[4] NatureServe Explorer: http://explorer.natureserve.org/servlet/NatureServe?sourceTemplate=tabular_report.wmt&loadTemplate=assoc_RptComprehensive.wmt&selectedReport=RptComprehensive.wmt&summaryView=tabular_report.wmt&elKey=687971&paging=home&save=true&startIndex=1&nextStartIndex=1&reset=false&offPageSelectedElKey=687971&offPageSelectedElType=communities&offPageYesNo=true&post_processes=&radiobutton=radiobutton&selectedIndexes=687971

[5] See http://usnvc.org/.

[6] Personal communication, River Ranch species list as of May 20, 2015. Mark Watson, New Mexico Department of Game and Fish.

[7] Draft State Wildlife Action Plan June 24, 2015, New Mexico Department of Game and Fish.

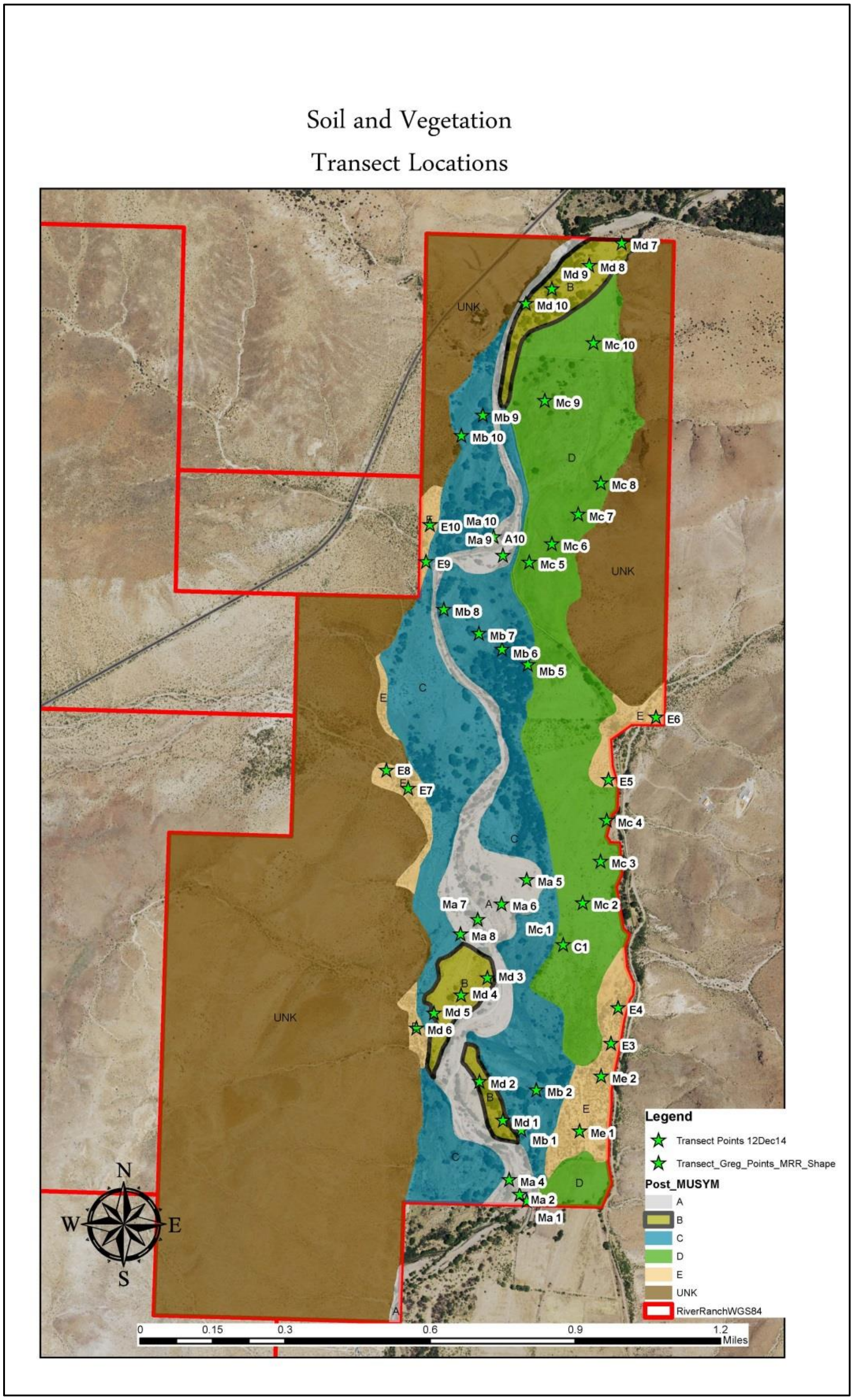

Figure 9. Provisional soils map for River Ranch developed by the Natural Resources Conservation Service, Las Cruces Office.

Table 1. River Ranch vegetation plant associations based on the 2015 reconnaissance survey as order by the U.S. National Vegetation Classification hierarchy (http://usnvc.org/).

National Vegetation Classification Hierarchy				NVC Code
1 Forest to Open Woodland				
1.B Temperate & Boreal Forest				
1.B.3 Temperate Flooded & Swamp Forest				
1.B.3.Nd Southwest North American Flooded & Swamp Forest				
M036	Warm Southwest Riparian Forest			
	G508	Sonoran-Chihuahuan Lowland Riparian Forest Group		
			Fraxinus velutina - Celtis laevigata var. reticulata / Sporobolus wrightii Woodland	NHNM000875
			Populus fremontii - Juglans major Forest	NHNM000874
			Populus fremontii - Salix gooddingii / Baccharis salicifolia Forest	**CEGL002683**
			Populus fremontii - Salix gooddingii Woodland	CEGL000944
			Populus fremontii / Sporobolus wrightii Woodland	NHNM000878
			Salix gooddingii/Baccharis salicifolia Woodland	NHNM000877
2 Shrubland & Grassland				
2.B Temperate & Boreal Grassland & Shrubland				
2.B.6 Temperate & Boreal Freshwater Marsh, Wet Meadow & Shrubland				
2.B.6.Nc Southwestern North American Warm Desert Freshwater Marsh				
M076	Warm Desert Freshwater Shrubland, Meadow & Marsh			
	G533	North American Warm Desert Riparian Low Bosque & Shrubland Group		
			Baccharis salicifolia / Gravel Bar Shrubland	CEGL005951
			Baccharis salicifolia/Sporobolus wrightii Shrubland	NHNM000876
3 Desert & Semi-Desert				
3.A Warm Desert & Semi-Desert Woodland, Scrub & Grassland				
3.A.2 Warm Desert & Semi-Desert Scrub & Grassland				
3.A.2.Na North American Warm Desert Scrub & Grassland				
M086	Chihuahuan Desert Scrub			
	G289	Chihuahuan Mesquite Upland Scrub Group		
			Prosopis glandulosa / Sporobolus wrightii Shrubland	NHNM000653
M087	Chihuahuan Semi-Desert Grassland			
	G489	Chihuahuan Semi-Desert Lowland Grassland Group		
			Sporobolus wrightii / Monotypic Herbaceous Vegetation	NHNM000270

Land use history

The Mimbres valley has a long history of human use going back to the prehistoric Mimbreño people. Within the last two centuries it has been significantly altered by human activities. The biggest changes to the watershed were initiated by landscape-altering grazing from large numbers of imported livestock and extensive logging for the booming mining industry of the late 19th and early 20th century. Although the forests recovered, the soils and watercourses have not. The Mimbres may have been more cienega-like in the past (NMDGF 2006). Agricultural surface-water diversion, groundwater withdrawal, inappropriate livestock management, channelization, and invasion of exotic plants and animals remain significant threats to the Mimbres River ecosystem as a whole (Cooper 2013).

On the River Ranch, livestock grazing was the most recent land use, but the ranch also contains a few old fields, and a very old tomato cannery. South of the upstream property boundary 0.6 km (0.4 mi) there is an earthen irrigation diversion dam approximately three feet higher than the river bottom on the west side, and six feet higher on the east side (Figure 2). The dam had been recently replaced, because the fall 2014 flood had removed the previous dam, and filled the ditch headgate with sediment.[8] This dam was diverting about 80% of the base flow when the site was visited in May 2015. The dam diverts water into an irrigation ditch that runs along the eastern side of the floodplain. In May 2015, the water was being returned to the river via overland flow just above the lower ranch boundary. The ditch continues south along the edge of the floodplain to actively cultivated fields below the property boundary.

Figure 10. Earthen irrigation dam in the river channel looking upstream and north.

Sampling design and analysis

The New Mexico Rapid Assessment Method for Riverine Wetlands (NMRAM) was used to assess the current condition of the Riparian Wetlands on the River Ranch. This assessment method examines landscape context, biotic and abiotic attributes of a wetland of interest, and is based on a combination of mapping and field observations. Currently there are two modules of the NMRAM for unconfined riverine systems. One is for smaller montane streams with gradients above one percent and at higher elevations and associated with montane riparian vegetation, and the other for larger lowland rivers with gradient less than one percent and dominated by desert riparian vegetation. The lower Mimbres, while a relatively small river, occurs in a lowland setting with the type of vegetation and stream gradient that is consistent with the requirements of the Lowland module. Hence, data was collected using the Lowland module (version 1.0). Yet, because it is a small river we also employed a few components of the Montane module that we thought might help in the assessment as supplemental information.

NMRAM data collection occurs in discrete Sampling Areas (SA) with defined boundaries. For the River Ranch, three SAs were created. These SAs were distributed more or less equally from north to south across the property to obtain a representative sample of conditions on the

[8] Personal communication, Mark Watson, NMDGF.

ranch and to capture the range in variation across the property (Fig 1). There are 12 metrics distributed across three attribute categories: landscape context, biotic, and abiotic (Table 1). Each metric is assessed and assigned a rating based on the data. The data and the scores themselves are entered onto the NMRAM datasheets. The datasheet contains a roll-up table which takes all the individual scores and calculates new scores by attribute categories and then an overall SA score based on the attribute scores. The SA scores for a site are then averaged to produce an overall project score. Finally, the NMRAM datasheets include a series of stressor checklists, which although not used in calculating the final SA score, are included as ancillary information on factors that may be affecting the conditions of the wetland. Copies of the complete NMRAM datasheets, with all of the data collected are provided as part of the Digital Addendum and summaries of the data and are reported below.

All data collected by the NMRAM is done on a rank scale of A to D (4 to 1), with A representing a wetland in Excellent condition, B a wetland in Good condition, C a wetland in Fair condition, and D a wetland in Poor condition. The implication is that wetlands in excellent condition are providing all of their expected functions and services, while wetlands in poor condition are providing few to none of their expected functions and services. Full descriptions of all the methods for collecting NMRAM data and metric descriptions and rationale can be obtained from the NMRAM field guides available on the New Mexico Environment Departments website (https://www.env.nm.gov/swqb/Wetlands/NMRAM/).

As part of the NMRAM biotic metric assessment process, a vegetation patch map was created for each SA. These were digitized in GIS and are provided as shapefiles in the Digital Addendum. Additionally, photographs of each vegetation patch were taken, as well as photographs of channel cross-sections, and other features. All photographs are provided in the digital addendum included with the report. The locations of some vegetation and abiotic features, as well as the channel cross-sections were recorded with a Garmin GPS with an accuracy of +/- 3 m (Digital Addendum). An electronic Data Addendum to this report contains all of the raw data in PDF files, along with the photo files and a PDF of this report.

Table 2. NMRAM Lowland Version 1.0 list of Metrics.

Attribute categories and metrics		*Score weights*	
		Attributes	*Metrics*
Landscape Context Metrics		**0.3**	
	1. Buffer Integrity Index		0.3
	2. Riparian Corridor Connectivity		0.3
	3. Relative Wetland Size		0.2
	4. Surrounding Land Use		0.2
Biotic Metrics		**0.35**	
	1. Relative Native Plant Community Composition		0.3
	2. Vegetation Horizontal Patch Structure		0.2
	3. Vegetation Vertical Structure		0.2
	4. Native Riparian Tree Regeneration		0.1
	5. Invasive Exotic Plant Species Cover		0.2
Abiotic Metrics		**0.35**	
	1. Hydrologic Connectivity		0.4
	2. Physical Patch Diversity		0.4
	3. Soil Surface Condition		0.2

Results

NMRAM Scores

The NMRAM rating scores by attribute category and metric for each sampling area and the overall site scores are provided in Table 3. Each of the metrics measures a different aspect of riparian condition. Below we will present a brief introduction to each of the metrics measured on the ranch, along with the conditions that lead to the scores of each.

Landscape context metrics are designed to measure the conditions surrounding an SA, and are primarily assessed using a GIS, with field confirmation. The Buffer Integrity Index, which is composed of two sub-metrics, Buffer Percent and Buffer Width, is a measure of the amount of natural and semi-natural vegetated buffer on the lateral sides of the SA. Vegetated buffers enhance wetland function and protect the wetland from anthropogenic environmental stressors. Overall buffers on the River Ranch were excellent, with only a slight reduction in width due to Highway 61 to the west, and the dirt County Road to the east.

Table 3. NMRAM scores for all metrics by attribute categories for each sampling area and the overall ranch average.

	Sampling Areas			
	Upper	**Mid**	**Lower**	
	62.7	**61.4**	**60.0**	**Ranch Avg.**
Landscape Context Attributes				
Buffer Integrity Index	3.5	4	3.5	**3.67**
Buffer Percent	4	4	4	**4**
Buffer Width	3	4	3	**3.33**
Riparain Corridor Connectivity	4	4	4	**4**
Relative Wetland Size	3	3	4	**3.33**
Surrounding Land Use	3	3	3	**3**
Biotic Metrics				
Relative Native Plant Community Composition	4	4	3	**3.67**
Vegetation Horizontal Patch Structure	4	3	4	**3.67**
Vegetation Vertical Structure	3	2	2	**2.33**
Native Riparain Tree Regeneration	2	1	2	**1.67**
Invasive Exotic Pland Species Cover	4	4	4	**4**
Abiotic Metrics				
Hydrologic Connectivity (Multi-channel)	3	2	3	**2.67**
Physical Patch Diversity	3	3	4	**3.33**
Soil Surface Condition	4	4	4	**4**
Additional Montane Abiotic Metrics (Not in score roll-up)				
Hydrologic Connectivity (Montane)	*2*	*1*	*3*	***2.00***
Channel Stability	*3*	*3*	*3*	***3***
Stream Bank Stability and Cover	*3*	*3*	*2*	***2.67***
Landscape Context Score	3.45	3.6	3.65	**3.57**
Biotic Score	3.6	3.1	3.1	**3.27**
Abiotic Score	3.2	2.8	3.6	**3.2**
SA Wetland Condition Score	**3.415**	**3.145**	**3.44**	**3.33**
SA Wetland Rank	**A**	**B**	**A**	**A**

Riparian Corridor Connectivity (RCC) measures the integrity of connectivity versus fragmentation of the riverine corridor upstream and downstream from the SA. Intact riparian corridors allow for unimpeded movement of wildlife, intact habitat, and propagation of plant communities. On the ranch riparian corridor connectivity was also excellent. The only break in riparian corridor connectivity that was measured was the earthen dam, but it was small enough to not lower the RCC rating.

Relative Wetland Size is an index of reduction of the current wetland size relative to its estimated historical extent, due to human-induced disturbances, particularly land-use conversions. Large reductions of area can alter hydrology and ecosystem processes, and may create ecological instability or reduce viability. Overall the ranch had good relative wetland size, and only missed an Excellent rating for this metric due to the presence of old fields at the edge of the floodplain on its east side.

Surrounding Land Use measures the amount and intensity of human land use in the buffer zone surrounding the SA. The intensity of human activity in the landscape has a proportionate impact on the ecological processes of the riparian ecosystem. The ranch was rated Good on surrounding land use. The rating table for surrounding land use is very strict for the Excellent category, so although the ranch is mostly surrounded by undeveloped range land, there were enough roads and fields in the buffer zone to move it to the Good category.

Biotic metrics measure key biological attributes within the wetland that reflect ecosystem integrity. Relative Native Plant Community Composition is an index of the abundance of native-dominated vegetation communities versus exotic-dominated vegetation communities. High native plant species diversity generally indicates overall high biotic diversity, stability of wetland biotic communities, increased wildlife habitat and species diversity. The ranch received an Excellent score on relative native-plant community composition. The lower SA scored a Good rather than Excellent on this metric, but that was due to exotic herbaceous species in the understory. Woody dominant species throughout the ranch are predominantly native. Of note, the introduced shrub bird-of-paradise (*Caesalpinia gilliesii*) was found in scattered patches on the high terraces, although not in large enough numbers to affect the metric rating.

Vegetation Horizontal Patch Structure is an assessment of general vegetation patch diversity and complexity of the patch pattern (interspersion) within and SA. Multiple horizontal plant patches across the SA indicate high biotic diversity and a history of dynamic fluvial processes. The ranch as a whole earned an Excellent rating on this metric, and generally a high number of different vegetation patches were recorded. However, the amount of area per patch was not very equally distributed in the middle SA, where there was a majority of one vegetation type, big sacaton grasslands.

Vegetation Vertical Structure is an assessment of the overall vertical structural complexity and richness of the vegetation canopy layers across the SA. Vertical vegetation structure is an integral part of habitat structure and is correlated with overall biodiversity. The ranch earned only a Fair rating on this metric, due to limited riparian shrub layers, both in the understory of mature forest patches and as independent stands. Of note, the upper SA did earn a rating of Good on this metric, as it had a greater percentage of forest with shrub understory than the other SAs.

Native Riparian Tree Regeneration assesses the abundance of riparian tree reproduction across the SA. Healthy functioning riverine wetlands should consist of a mosaic of woody vegetation stands that include stands of both mature and young regeneration trees. Absence of young trees may indicate ecological dysfunction. The ranch earned a Poor rating on this metric, due to a near absence of native riparian tree reproduction. The upper and lower SAs did earn Fair ratings on this metric, but still had very little active tree reproduction. The majority of reproduction that was seen on the ranch was root, or adventitious shoots (Figure 11)

Figure 11. Gooding's willow branch in the active channel with adventitious shoots (Lower SA).

Invasive Exotic Plant Species Cover is a measure of the total percent cover of a set of exotic plant species that are considered invasive based on the New Mexico list of noxious weeds[9]. Invasive non-native species can have a significant impact on community diversity and function. High levels of invasive exotic species within a riparian plant community are a direct threat to maintaining wetland function and biodiversity. The ranch earned an Excellent rating on this metric, as did all three SAs. Only a few isolated Russian olive and saltcedar individuals were observed across the ranch.

The abiotic metrics focus on hydrological conditions, physical ecological complexity and anthropogenic disturbances. Hydrologic Connectivity is an assessment of the ability of water to flow into or out of the wetland or to inundate adjacent areas. Surface hydrological connectivity between a river and riverine wetlands formed on its floodplain supports key ecological functions and plant and wildlife habitat diversity by promoting an exchange of water, sediment, nutrients and organic carbon (Collins et al. 2008). On the River Ranch we assessed Hydrologic Connectivity using the Lowland module narrative rating system for multi-channel systems, as the method most suited to the lower Mimbres. Using this method the ranch rated Good on

[9] List maintained by the New Mexico Department of Agriculture, last updated 2009. Available on the website http://www.nmda.nmsu.edu/apr/noxious-weed-information/

Hydrologic Connectivity as a whole. The majority of back and side channels showed evidence of flow from the fall 2014 flood event, which was estimated to be a two to five-year return event based on gage data (Figures 4 and 5). Of note, the middle SA showed less evidence of water flow through its side channels and thus rated only a Fair on Hydrologic Connectivity.

To get a more complete picture of the Hydrologic Connectivity on the ranch, we also measured the entrenchment ratio within the active channel using the protocols from the Montane module. While entrenchment ratio does not give a complete picture of flow patterns in a multi-channel system, it does speak to the ease or difficulty for water to move out of the main active channel. The entrenchment ratios, with their ratings from the Montane module, are provided in Table 4. As a whole the ranch scored a Fair rating on Hydrologic Connectivity as measured by this method, due to generally poor entrenchment ratios. However, there was a great deal of variability in entrenchment ratios between the SAs, and even within SAs. The lower SA had the least amount of entrenchment on average, but also had the widest variability on entrenchment ratios between cross-sections, with ratios spanning Excellent to Poor. The lower SA also had the highest number of active side and back channels, and showed evidence of a highly dynamic fluvial process. Between the middle and lower cross sections on the lower SA there was a fallen cottonwood in the channel that had recently caused the active channel to be abandoned (Figure 12). Below the fallen tree a head cut had formed a new active channel, while the former main channel was now a side channel (Figure 13). The channel below this head cut was the one with the worst measured entrenchment ratio on the SA.

Table 4. Entrenchment Ratios measured for cross-section and average for each SA. U=Upper cross-section, M=Middle cross-section, L=Lower cross section.

SA	Cross Section	Entrenchment Ratio	NMRAM Rating
Upper (062.7)	U	1.96	3 (B)
	M	1.45	1 (D)
	L	1.28	1 (D)
	SA Average	**1.56**	**2 (C)**
Middle (061.4)	U	1.08	1 (D)
	M	1.37	1 (D)
	L	1.32	1 (D)
	SA Average	**1.26**	**1 (D)**
Lower (060.0)	U	3.19	4 (A)
	M	1.73	2 (C)
	L	1.15	1 (D)
	SA Average	**2.02**	**3 (B)**
River Ranch Average		**1.61**	**2 (C)**

Physical Patch Diversity describes the physical structural richness of riverine wetlands and associated channels. Variety in physical features leads to a varied and complex habitat that fosters biological diversity. Overall the ranch had an Excellent rating for physical patch diversity, due to a high number of side and back channels, as well as other physical patch types spread across the floodplain. The lower SA was particularly diverse due dynamic multiple channels.

Figure 12. Fallen cottonwood blocking main channel on lower SA, beaver activity most likely occurred after the tree fell.

Soil Surface Condition is a measure of anthropogenic disturbance to the wetland and riparian soils that results in modification of soil characteristics. Disturbance to the soil can affect biological, physical and chemical processes and impede wetland function. The ranch overall, and all three SAs, scored an Excellent rating on soil surface condition, due to the very minimal level of development throughout the ranch.

Figure 13. Head cut at top of new channel, just below fallen cottonwood (Figure 12).

In addition to the Lowland module metrics, we also collected Channel Stability, and Stream Bank Stability and Cover metric data using the Montane module protocols. These metrics are not included in the Lowland module because they are not well suited to sand-bedded lowland rivers. Because of this the data collected with these metrics on the River Ranch can only be considered descriptive, and is included here to broaden our understanding. Channel Stability assesses the degree of channel aggradation or degradation based on the departure from characteristic pattern, profile, and dimension. Large, persistent changes to the flow or sediment regime caused by upstream land-use changes, alterations of the watershed, or climatic changes tend to destabilize the channel and cause it to change form (Collins et al. 2008). Overall the ranch as a whole rated a Good on this metric. There were slight indications of aggradation, particularly in the upper SA, but most of the indicators available to score the metric were only applicable to rock or cobble-bottom streams, so the score is based on three or less indicators per site.

Stream Bank Stability and Cover is a measure of stream bank soil/substrate stability and stream bank erosion potential that reflect overall stream bank stability, which generally indicates less anthropogenic disturbance. Stable stream banks should support more perennial vegetation and more stable and healthy wetland communities. The ranch overall scored in the Good category on this metric, with the lower SA scoring only fair. In general the banks throughout the ranch had a high degree of variability in the amount of stabilizing vegetation and indicators of erosion potential present, and the scores on this metric often varied greatly from one cross-section to another within an SA.

Based on the NMRAM assessment the River Ranch riparian wetlands overall are in Excellent condition, with both the lower and upper SA rating Excellent, while the middle SA was rated Good (Table 3). The ranch average for both landscape context and biotic metrics is also Excellent. The abiotic metrics rated in the Good category. However, the data from selected metrics indicate areas of Poor condition, and a potential for future overall conditions to decline without active management, and are discussed below.

There were 14 different vegetation patches types mapped as part of the Biotic Metric data collection process (Figs. 14 to 16). These patches represent nine recognized plant communities, and four vegetation groups in the U.S. National Vegetation Classification[10] (Table 1). Although detailed community composition data was not collected as part of the NMRAM process, there is a wealth of published data available on the majority of the vegetation communities observed on the River Ranch. The ranch's forest communities dominated by Fremont's cottonwood, velvet ash and Goodding's willow are all considered globally rare and highly threatened due to altered hydrologic regimes, flood control structures, and land conversion.

[10] Available on http://usnvc.org/

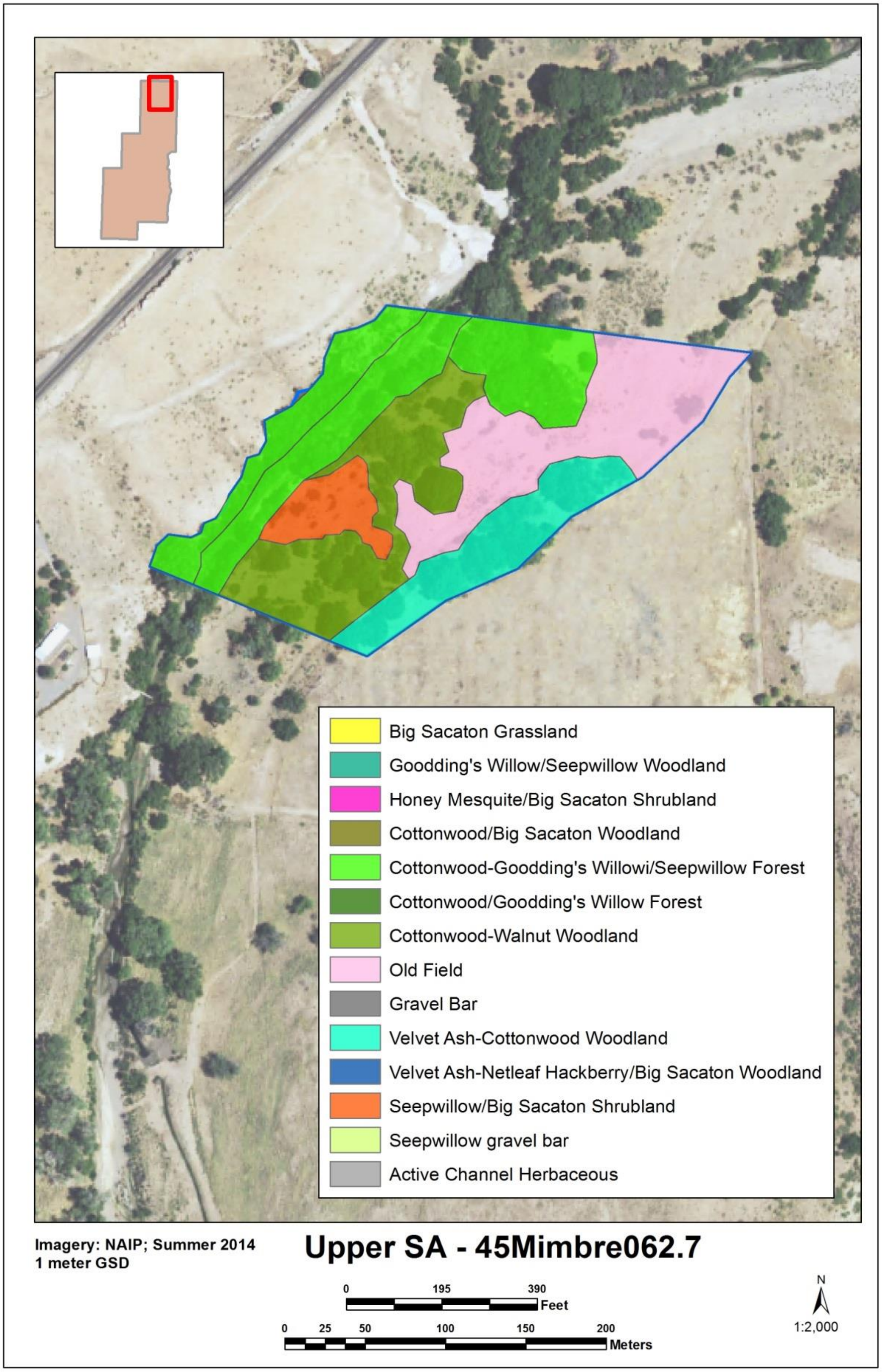

Figure 14. Vegetation Polygon Map for Upper SA - 45Mimbre062.7.

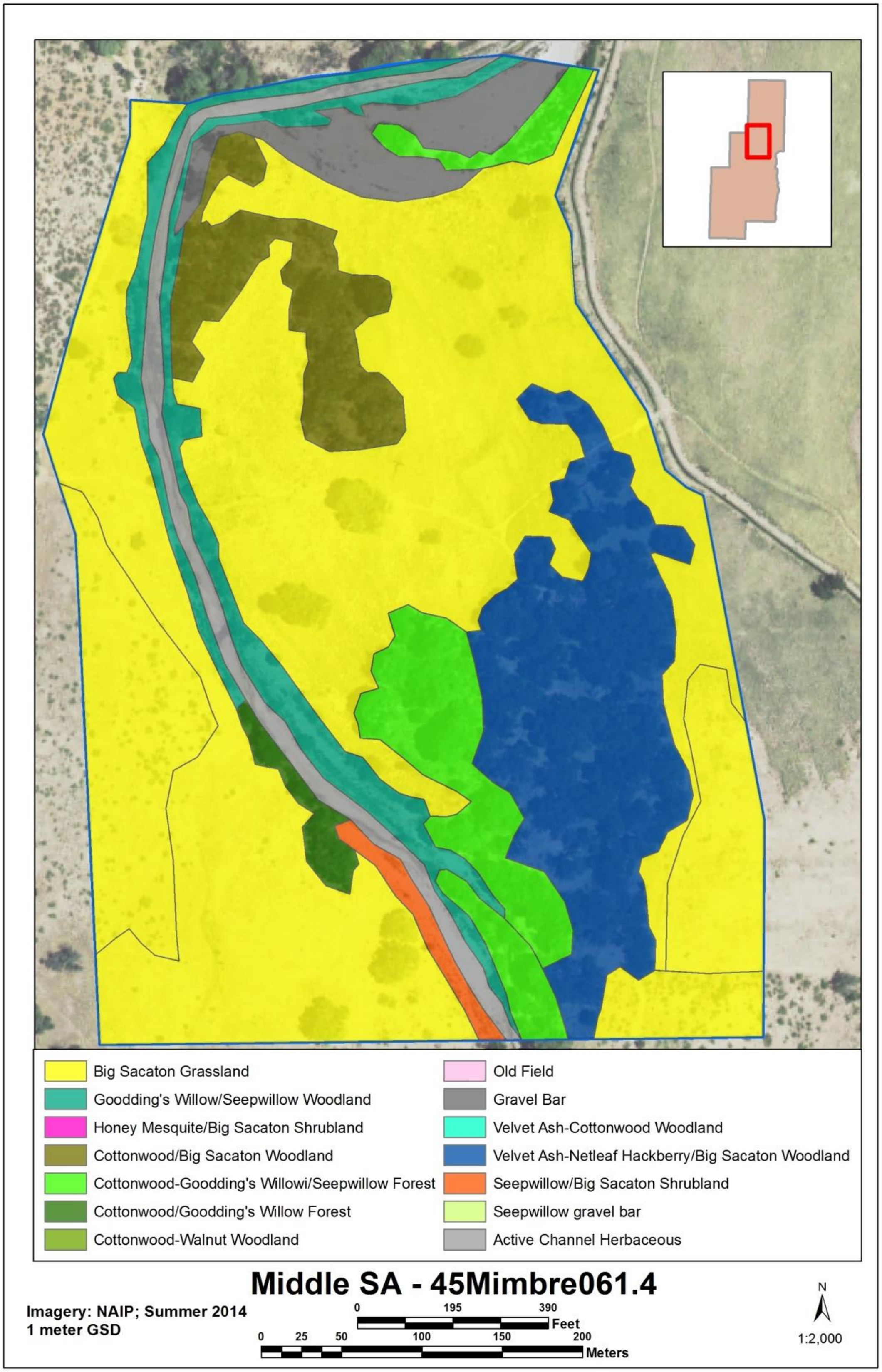

Figure 15. Vegetation Polygon Map for Middle SA - 45Mimbre061.4.

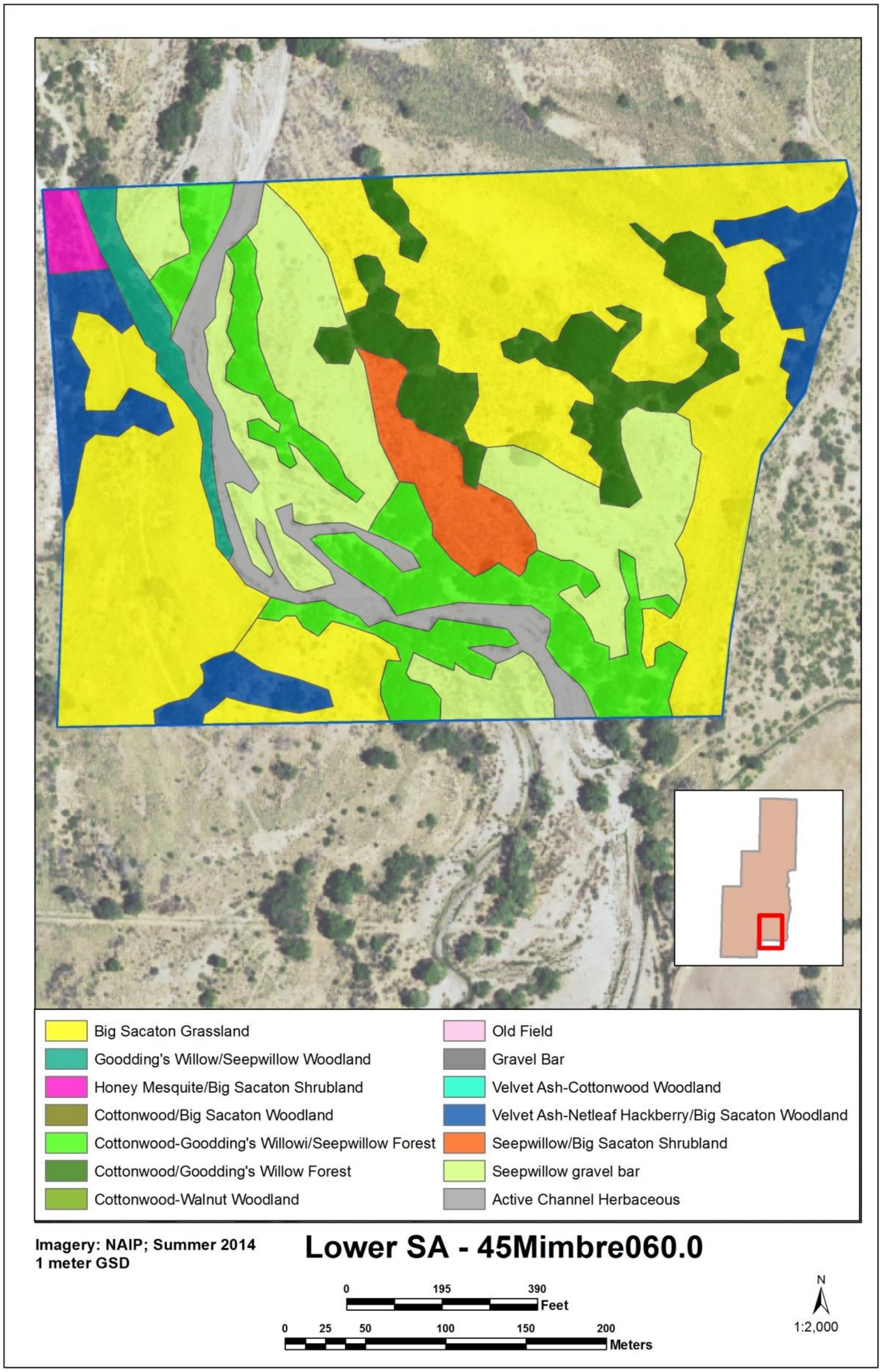

Figure 16. Vegetation Polygon Map for Lower SA - 45Mimbre060.0.

Discussion

The remoteness of the River Ranch from urban and town centers provides favorable landscape context for the site and this is reflected by the high Landscape Context ratings. But there are water-management issues involving upstream and downstream users that will need to be addressed to improve ecological conditions within the property. While the ranch is in overall excellent condition, there are indications that without management intervention ecological conditions will decline. The abiotic and biotic data point to a history of highly dynamic fluvial process that lent to the inherent riparian vegetation and habitat diversity on the ranch. However, the data also show that the system has become less hydrologically connected with limited overbank or terrace flooding and possibly lowered groundwater tables that are impacting the health of the site.

Overall, the River Ranch supports high quality stands of globally rare and important riparian forest habitat (Figures 14 to 16). However, indications from the NMRAM assessment are that some of these forest stands are relatively old (125+ years), and young reproduction is absent. Most of the forest stands on the ranch consist of old mature trees, with minimal or no riparian shrub understory, which is reflected in the Poor Vertical Vegetation Structure score. Lack of a shrub layer suggests a lowered groundwater table that fails to support wetland obligate and facultative species such as coyote willow (*Salix exigua*) and seepwillow (*Baccharis salicifolia*) (Stromberg and Tiller 1996). Further vegetative indicators of a lowered groundwater table were seen in the upland or facultative herbaceous species, such as big sacaton that made up the forest herbaceous understories. Big sacaton, which tolerates deeper water tables than even mature riparian trees (Stromberg and Tiller 1996), also occurred as large nearly monotypic grasslands on the terraces in between the mature forest patches.

Forests with understory shrub layers provide necessary high structure habitat for many riparian bird species. A healthy, well connected riparian zone would be expected to have a mix of both high structure, shrub rich, forests, and lower structure mature forest stands with open understories. Of note, the upper SA, which is above the irrigation diversion dam, had a better Vegetation Vertical Structure score than the other two SAs, both of which were below the irrigation diversion dam, possibly due to a higher and more stable groundwater table from an undiverted base flow in the river.

The low Vegetation Vertical Structure scores were also related to a paucity of Riparian shrublands across the ranch. In addition to the obligate and facultative wetland shrub species mentioned above, many riparian shrublands include young riparian trees, which are more sensitive to groundwater depletion than mature trees (Stromberg and Tiller 1996). The limited riparian shrublands on the ranch may also be related to the history of grazing. Coyote willow is highly palatable to cattle, particularly when they are young. Additionally, trampling and soil disturbance from cattle in the active channel and along banks can be deleterious to riparian shrubs. Significant improvements in riparian shrub and herbaceous habitat have been seen with removal from gazing on the Nature Conservancy properties on the Mimbres upstream of the River Ranch[11]. Riparian shrublands provide excellent habitat for many bird and animal species, as well as contributing to higher overall species diversity (Milford and Muldavin 2004), and are an important part of a dynamic riparian patch mosaic.

Many of the large mature trees were showing signs of water stress with partial die back, dropped limbs, and tree death. These indications also suggest stress from a lowered groundwater table and they were more pronounced in the SAs below the earthen irrigation diversion dam. If the dam diverts the majority of the river flow throughout the growing season, as it was during the May site visit, then it could have a significant effect on hyporeic flow and groundwater depth on the ranch downstream. In turn, the drop in groundwater can lead to habitat degradation throughout the lower portions of the ranch. Lower in-stream flows can also be related to irrigation diversions and groundwater pumping upstream off the ranch, however, the dam on the ranch is one cause of lower stream flow that can possibly be addressed and ameliorated by ranch management.

Big sacaton poses a fire hazard for the existing stands of mature riparian trees as the big sacaton grasslands are adjacent to, and in many cases, underneath the forest patches. Tigner grove is one area of particular concern, as it contains some of the largest mature velvet ash trees in New Mexico and is also one of the largest stands of mature forest on the ranch. Removal of big sacaton within and adjacent to the forests is recommended in the short-term to protect the grove, and similar forest patches on the ranch. In the long-term activities aimed at improving hydrologic connectivity, and reconnection of the floodplain should help encourage growth of new riparian shrublands and woodland allowing them to replace big sacaton in areas with improved groundwater.

Almost no native riparian tree regeneration was observed during the sampling of the ranch. The reproduction that was observed was mostly sucker, or root sprouts (Figure 11). Only one seedling cottonwood was observed (on the lower SA), along with a handful of seedling walnut, soapberry and netleaf hackberry scattered across the ranch. There were also a handful of younger mature trees, but the majority the riparian trees on the ranch were old mature individuals. For germination, cottonwood and Goodding's willow need moist bare areas, generally fresh post-flood sediment splays. The areas need to maintain a high water table through the first growing season. Water should not recede faster than 3cm/day for optimal survival (Mahoney and Rood 1991). Finally, those areas of bare, moist ground must occur when seeds are dispersing in the spring. These riparian trees have evolved to take advantage of spring flood flows, and time seed dispersal relative to historic flood periods. The trees establish best at flood flows greater than or equal to seven-year return events (Stromberg 1993).

On the ranch there are three ways that this process may have been interrupted. First, the missing cohort of young trees may have been removed by cattle while seedling or saplings. Young cottonwoods and Goodings' willow are palatable and desirable browse to cattle

[11] Personal communication, John Money, Surface Water Quality, New Mexico Environment Department, Silver City, NM.

(Stomberg 1993; Samuleson and Rood 2004). Velvet ash reproduction is also affected by grazing (Szaro and Pase 1983). Second, the extensive stands of big sacaton may have limited the available bare ground for seedling establishment. Finally, rapid draw down of the water in the active channel for irrigation in the early summer, and the concomitant drop in the hyporheic zone, may have been too extreme for those seedlings that did establish to survive. Keeping cattle out of the riparian zones, especially when woody riparian vegetation would be most vulnerable in the early spring and summer will prevent loss of young trees to browsing. Maintaining a growing season base flow in the river will aid in maintaining a water table high enough for young trees and shrubs to establish. If, after significant flood events, the two above suggestions are not resulting in native woody reproduction, active earthwork could be used to lower some of the riverside terraces currently dominated by big sacaton, and reconnect them to the river at lower peak flows. This would aid reproduction by both providing bare ground for seed germination, and a higher groundwater table for young trees. It is a technique that has been used with good results on the Rio Grande (Robert 2005; Zeedyk 2009; Muldavin et. al. 2012)

Although all SAs on the ranch scored in the Excellent range for Invasive Exotic Weed Cover, there were scattered individual invasive exotic trees observed. Treating and removing these trees now could prevent a future problem. One Russian olive was observed along the river channel at the lower edge of the upper SA, and there were several scattered individual saltcedars observed in the lower SA. Many of them were marked on the vegetation field maps and invasive exotic weeds are also tracked at the polygon level on the NMRAM datasheets (see digital addendum). Although not considered an invasive exotic species, the introduced shrub bird-of-paradise (*Caesalpinia gilliesii*) was found in scattered patches on the high terraces, particularly on the eastern side of the ranch. It is not yet widespread enough to affect the Relative Native Plant Community Composition metric, but may continue to spread on the drier floodplain terraces if not addressed.

From the perspective of multi-channel lowland systems, the ranch appeared to be relatively well connected hydrologically. However, there were indications that it was not fully hydrologically connected, particularly in the center of the ranch, just below the irrigation dam. When entrenchment ratio was used to assess hydrologic connectivity, it again was lowest for the center SA. This suggests that the dam is interfering with the hydrologically connectivity, and that the effect is greater proximal to the dam. Although of limited use in a multi-channel system, entrenchment ratios for both the upper and middle SAs indicate an active channel that is relatively entrenched, and limited in its ability to access the floodplain. This may stem from water withdrawals upstream of the ranch, however management aimed at limiting disturbance to the active channel and floodplain, and addressing the hydrological alterations caused by the dam on the ranch, should aid hydrologic connectivity in the long term. Although the lower SA was the one with the most limited base flows, it showed the greatest level of hydrologic connectivity on all measures, with indications of highly dynamic fluvial processes, a promising sign of potential for success with restoration on the middle and upper SAs.

There were some indications of aggradation on the ranch from the Channel Stability metric, but any conclusions based on this metric are very tentative, as most of the indicators available to score the metric were only applicable to sandy bottom systems. For a multi-channel, lowland, sand-bedded river aggradation during large flood events is to be expected. The one portion of the ranch where this may be of concern is in the upper SA, which was dominated by rocky pools prior to the fall 2014 flood.[12] During the May 2015 site visit the entire upper SA had a flat sand bed. Due to the 2013 Silver Fire in the Black Range, the 2014 flood may have been carrying an abnormal amount of sediment. As the upper watershed revegetates sediment loads in the river will return to normal, and this portion of the reach should scour back to its natural rock bed.

There were also indications that the river banks throughout the ranch may have suffered a loss of vegetation and stability, likely due to grazing, in the past. With rest from grazing these banks should recover, and become more heavily vegetated. Relatively rapid vegetation and bank recovery has been observed in similar riparian systems after exclusion from grazing in as little as 4 to 6 years (Milford et al. 2015; Belsky et al. 1999; Krueper et al 2003; Magilligan and McDowell 1997). Recovery of the vegetation and bank stability will improve not just the terrestrial habitat, but also improve in channel habitat for fish and other aquatic fauna (McIver and McInnis 2007). Additionally better vegetated and stable banks lead to decreased evaporation, which can increase hyporheic exchange (Magilligan and McDowell 1997; Kauffman et al. 1983; Theurer et al. 1985).

Summary of Recommendations

In summary, we make the following recommendations for riparian habitat management on the ranch:

1. Maintain the maximum possible base flow in the active river channel throughout the year, but particularly during the growing season and in keeping with the property water rights. Negotiate to redesign the earthen diversion dam in the center of the ranch, such that it does not cross the entire active channel. Also, limit flows in the irrigation ditch to only those times when the water is being actively used for downstream irrigation.

2. If future grazing is considered, it will need to be actively managed to protect woody riparian tree and shrub reproduction and recovery. Regardless, current livestock should be kept out of the active channel and adjacent riparian zone for at least two years or more to allow young shrubs and trees to establish and grow to a size where they will be less desirable browse. This will also allow the herbaceous wetland vegetation and the river banks to recover to a more stable state. Once the vegetation has recovered,

[12] Personal communication from Mark Watson, NMDGF

livestock use will need to be carefully monitored and, if possible, their access the active channel should remain limited or excluded.

3. If recommendations 1 and 2 do not produce increases in woody riparian vegetation, particularly in tree recruitment following the next large (5 to 10 year) spring flood event, then active restoration should be considered. Removal of big sacaton from selected terrace areas adjacent to the active channel, with lowering of the terrace such that it will be easily flooded during the next high flow can be planned for one or two terraces areas of an acre or more each. Earthwork should be done in the winter, so that the cleared area can be accessed by high water the next spring. If this sort of restoration is attempted, it should be designed by an engineer with an understanding of fluvial processes, and familiar with this type of riparian restoration work. (Examples of successful projects of this type can be found on the Rio Grande (Robert 2005; Muldavin et. al. 2012)

4. Big sacaton stands around large mature tree stands should be managed to reduce fire risk to the forests. Creating fire breaks in the big sacaton at the edges of the forest should be sufficient in the short term, and can be achieved mechanically. Burning of the big sacaton is not recommended, as this would pose a risk to the trees. Also, removal of entire big sacaton stands is not recommended, except as part of active restoration activities mentioned above in recommendation 3.

5. Removal of Invasive Exotic tree species (saltcedar, Russian olive) now could save money and environmental disruption in the future. There were only a handful of saltcedar and Russian olive individuals observed, and these could be cut down, and treated with topical herbicide efficiently. Left in place these trees may interfere with native riparian tree reproduction.

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