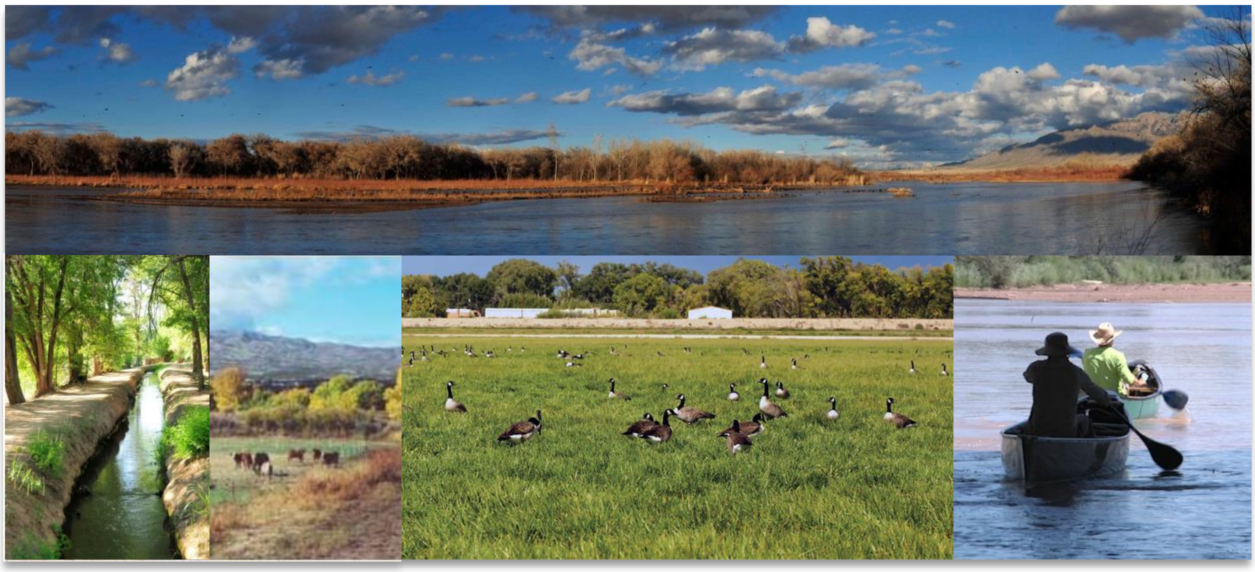
Middle Rio Grande
Conservation Action Plan



Framework and Status Assessment

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Middle Rio Grande Conservation Action Plan

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Executive Summary

We report here on the development of a Conservation Action Plan for sustainable stewardship and enhancement of the natural habitats of the Middle Rio Grande corridor in the context the complex agricultural and urban setting of this vital river landscape. The first steps of the process were to develop ecologically-based framework for stewardship, identify conservation targets, and provide an initial assessment of their current and desirable future status based on measureable indicators. Additionally, major threats or stressors to the conservation targets were identified and evaluated with respect to the severity of their potential impacts. The overall goal of the planning process is to provide a foundation for developing operational strategies that can be applied to meet conservation goals in collaboration with the many partners and stakeholders.

Taking an ecosystem approach, the five conservation targets were identified: 1) riparian and wetland vegetation communities, 2) native bird communities, 3) native fish communities, 4) wildlife corridors, and 5) ditch and drain habitat. Across these five targets, 36 indicators were evaluated and conditions rated from Poor to Very Good (e.g., noxious weeds, fish habitat complexity, bosque forest structure, etc.). More than 60 percent of the individual indicators were rated as fair while about 15 percent were rated as poor and 20 percent as good or very good. The overall current conditions were rated as fair with a desired condition of good as a target for the coming ten years. Downward trends were mostly rated as mild, suggesting that strategies can be developed that can ead to further improvement and achieving a good rating over the next decade for the Middle Rio Grande.

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[1]Natural Heritage New Mexico Report No. 19-421

The identified threats and their potential impacts indicate that the ecosystem, as a whole, is imperiled. Urban development, dam operations, and channelization were identified as the greatest threats to the majority of conservation targets. Overall, the native fish community is the most imperiled target. Most of the threats identified are systemic and due to large-scale ecosystem modifications for human development and water use. These ecosystem modifications are essential to the more than one-million people who live in the Middle Rio Grande Valley. However, management of both the infrastructure and the water resources can be modified within certain legal and management constraints to make use of available water and sediment to mimic natural conditions that can lead to a reinvigorated Middle Rio Grande ecosystem—one that can sustain fish and wildlife communities along with a resilient cottonwood bosque well into the future.

The next step is to develop strategies and specific objectives that can be applied in and specific reaches of the Middle Rio Grande. This conservation action plan provides a well-structured framework for developing strategies, evaluating progress towards meeting conservation goals, and setting the agenda going forward. The vision is that working together towards a healthy Rio Grande ecosystem will not only provide for sustainable fish and wildlife habitat, but also lead to enhanced water quality and availability, lowered fire hazards, improved recreational opportunities and associated economic vitality, and a collective sense of stewardship pride for this world-class river ecosystem.

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INTRODUCTION

Stewardship of the natural habitats of the Middle Rio Grande corridor presents unique and complex management issues in an era of water limitations compounded by changing environments and the complex social fabric of the surrounding communities. The Middle Rio Grande Conservancy District (MRGCD) has had a long history of managing both water in the valley for agricultural production and the riverside natural areas under their purview. Other agencies have responsibilities for flood control, delivery of water to downstream users, and providing water for fish and wildlife habitat maintenance (e.g., Bureau of Reclamation, U.S. Army Corps of Engineers, and the U.S. Fish and Wildlife Service). Against this complex matrix of ownership and responsibilities, there is a growing urban constituency that, while appreciating both the natural areas and the agricultural setting of the river landscape, puts additional demands on that landscape and the water resources that support it. To help meet these challenges for the sustaining the Middle Rio Grande ecosystem, we developed this Middle Rio Grande Conservation Action Plan (MRG-CAP) through a series of workshops with scientists and managers in which they identified and evaluated the status of key conservation targets in the Middle Rio Grande and provided goals for their stewardship. The intent is for the MRG-CAP to provide a foundation for stakeholders (e.g., MRGCD, city and county governments, New Mexico State Parks, tribes, various federal agencies, and NGOs) to develop common strategies and objectives to meet those stewardship goals for natural habitats in the context of changing agricultural and urban environments and associated water needs.

The MRG-CAP takes an ecosystem approach focused on enhancing animal and plant habitats of the channel and adjacent floodplain. Scientists have come to recognize that through careful use of available water and sediment to mimic natural conditions, a reinvigorated Middle Rio Grande ecosystem can be developed that will sustain fish and wildlife communities along with a resilient cottonwood bosque well into the future. In return, a healthy Rio Grande ecosystem can lead to enhanced water quality and availability, lowered fire hazards, additional economic inputs to the local community from improved recreational opportunities, and an overall increase in the perception of Middle Rio Grande as a desired destination both economically and culturally.

The Dynamic Patch Mosaic – A framework for ecosystem-scale stewardship

The MRG-CAP ecosystem approach relies on the concept of managing a river as a diverse and dynamic mosaic of ecological communities that are sustained and restored through natural processes that take advantage of water and sediments afforded by the river[2]. This is the core and unifying element of the multi-agency Bosque Biological Management Plan of 1993[3]. Today, it remains the guiding concept for the stewardship in the MRG and among other rivers of the world where it is termed the Dynamic Patch Mosaic (DPM)[4]. Over the years the DPM concept has been expanded to encompass both terrestrial and aquatic habitats and the linkages between them. On the terrestrial side are the cottonwood forests, willow shrublands, saltgrass meadows, and marshes of the riparian zone along with the birds and other wildlife that find their homes there. Adjacent to and intermixed in the floodplain are the aquatic channel habitats that hold our fishes and the complex food web that supports them. Both the aquatic and terrestrial habitats rely on the rhythm and force of the river to promote variety and change. That is, sufficient base flows, periodic flooding, channel migration, and sediment transport to create a complex and continually changing riverscape. The DPM model provides the framework for defining and assessing conservation targets in the MRG-CAP that in turn provides the foundation for developing objectives for sustainable management of these diverse communities of plants and animals for the long term.

The MRG-CAP Process

Conservation Action Planning is a well-recognized, multi-step planning process that helps guide the development of focused strategies for stewardship and measures of success[5]. It follows the "Open Standards for the Practice of Conservation" and provides a systematic approach to practitioners for planning, implementing, and monitoring their stewardship initiatives so they can learn what works, what does not work, and why — and ultimately adapt and improve their efforts. This document focuses on first part of the process: identifying the conservation targets such as the Cottonwood Bosque and bird communities followed by defining specific attributes of targets with measureable indicators of their current status and desired future condition. This becomes the foundation for the next step: laying out strategies for collaborative stewardship by MRGCD and other stakeholders with specific objectives and approaches to meet the near-term goals for desired future conditions.

To help identify the targets, indicators, and initial strategies we conducted two workshops. One workshop engaged scientists with extensive knowledge of the biology and ecology of the MRG and a second workshop sought the perspectives of resource

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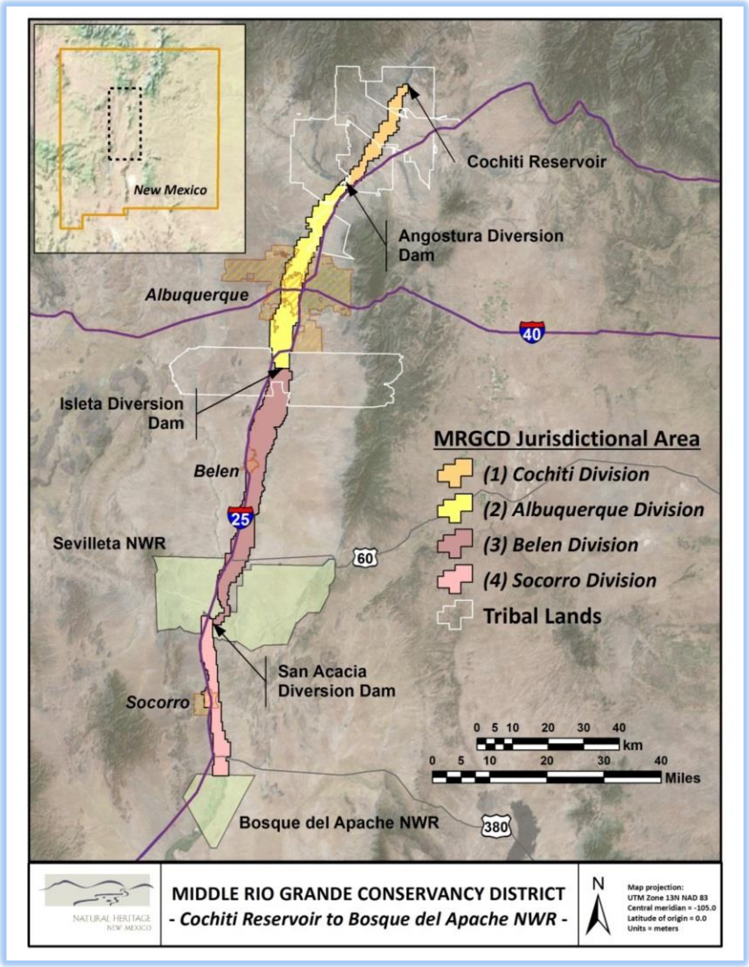
[2] See Hupp and Osterkamp 1996; Richter and Richter 2000; Stromberg 2001; Beechie et al. 2010
[3] See Crawford and others 1993; Robert 2005
[4] See Latterell et al. 2006; Latterell and Naiman 2007; Muldavin et al. 2017
See http://cmp-openstandards.org/

managers in the implementation of the MRG-CAP (see Appendix A for list of participants). All information from the workshops was brought into a standardized worksheet format[6] that generates an analysis of status, threats, and objectives (see Appendices B and C for details on the CAP process).

PLANNING AREA

The Location



The Middle Rio Grande encompasses about 150 river miles between Cochiti Reservoir and Bosque del Apache National Wildlife Refuge (NWR). Within this reach, the MRGCD oversees some 30,000 acres of bosque that they cooperatively manage with city, county, and state agencies. There is also a mix of private and tribal-held bosque along the river as well as several state and federal wildlife refuges. In addition to the bosque, MRGCD has nearly 1,200 miles of waterways and conveyance channels (a complex system of irrigation canals) that deliver irrigation water to approximately 60,000 acres of irrigated farmland outside the riparian corridor. The agricultural areas are intermixed with growing urban areas that include Albuquerque and the Rio communities with a population approaching a million people.

For the MRG-CAP analysis, we followed the MRGCD and divided the MRG into four divisions from north to south corresponding to each of the major irrigation diversions: Cochiti, Albuquerque, Belen, and Socorro. The majority of MRGCD-owned and managed

[6] Developed by The Nature Conservancy https://www.conservationgateway.org/ConservationPlanning/ActionPlanning/

riparian lands are in the Albuquerque, Belen, and Socorro Divisions. Reach 1, or the Cochiti Division, is primarily in Pueblo ownership. These divisions not only reflect where MRGCD diverts and manages its water, they also correspond somewhat to sub-reaches with differing channel and floodplain characteristics, and tend to have differing trends in hydrological conditions[7]. The sub-reaches may also reflect different ecological characteristics, and as necessary, these differences are specified in the MRG-CAP.

The Place

The Rio Grande has not only been a draw for human settlement for thousands of years, it has also been an invaluable resource for wildlife of all types living in and among the many aquatic, wetland, and riparian habitats of the river corridor. These habitats are essential to resident species that use them year-round and to migrants that use them in one or two seasons a year. Among birds, 280 species call the Middle Rio Grande home during some part of the year. There are approximately 60 species of mammals, amphibians and reptiles, and ten native fish. Together, the MRG is one the most diverse reaches of lowland river in the Southwest[8].

Within this setting, the Middle Rio Grande Valley has a rich mix of cultures and a long history of irrigated agriculture. This has resulted in a complex and overlapping jurisdictional landscape. Native Americans were the first to use irrigation farming in the Middle Rio Grande. When the Spanish arrived in 1540 they brought their own long-developed system of irrigated agriculture and built community irrigation ditches or "acequias" throughout the valley. In 1923, the local acequias were consolidated in the MRGCD, which was charged with providing flood protection, draining swamplands, and providing irrigation water to farmlands.

Flooding was always a hazard for those who lived along the river, and major efforts to "tame" the Rio Grande began in the 1920s and intensified after the 1940s floods. From 1923 to 1973, with the assistance of the Bureau of Reclamation and the Army Corps of Engineers, MRGCD constructed levees, dams, public ditches, and riverside drains, and stabilized the main channel. But it was with the construction of Cochiti Dam in 1973, that the MRG became a fully regulated reach of the Rio Grande. The riverside levees and ditches maintained by MRGCD have also become important recreation and green spaces for the valley's growing urban population. In keeping with the growing social

[7] Porter and Massong 2004
[8] Fullerton and Batts 2003

value put on the recreational and green space provided by lands along the river, the work of the MRGCD has evolved and now encompasses the preservation and restoration of the bosque ecosystem in partnership with other agencies and stakeholders.

Although the flood control measures have been successful in their purpose, they have also caused the river to be so altered from it natural function that it does not maintain or create the habitats that it did historically. This has been detrimental for many species that originally made their home in or along the Middle Rio Grande (particularly fish where 40% of the native fish species are now absent from the reach)[9]. There are currently three listed endangered species in the system, and without addressing the ecosystem changes that led to their decline, others are likely to join them. The river as a whole is considered one of the ten most threatened rivers in the world[10].

In this context, the MRG ecosystem has been a focus of intensive conservation and restoration efforts over the past two decades with a wealth of activities being conducted up and down the river by many stakeholders[11]. The MRGCD, Native American pueblos, federal and state wildlife refuges, state parks, the City of Albuquerque Open Space, and private land owners have all been engaged in unilateral and collective restoration and management projects to aid the preservation and restoration of the bosque while addressing other needs. e.g., the MRGCD does so while also continuing to maintain the Rio Grande's irrigation and flood control facilities. Given this complex jurisdictional and management landscape, this Conservation Action Plan was developed as a tool to aid communication among the stakeholders and to provide an overarching framework to guide effective stewardship of the MRG to prevent further losses to this unique ecosystem.

[9] Rinne and Platania 1995
[10] Wong and others 2007
[11] See USACE 2003 for a review of conservation and restoration efforts in the MRG

CONSERVATION TARGETS AND VIABILITY

Within the Dynamic Patch Mosaic (DPM) framework, five major conservation targets for the Middle Rio Grande were identified[12]:

- Riparian and Wetland Vegetation Communities
- Native Bird Habitat
- Native Fish Community
- Wildlife Corridors
- Ditch and Drain Habitat

Given the ecosystem approach of the MRG-CAP, these targets represent the overall plant and wildlife diversity in the project area, not specific species. For each target, we describe a suite of key attributes that reflect landscape context and ecological conditions of the target. For each key attribute, one or more measureable indicators were identified for assessing the current status and trends of the attribute. For example, "hydrologic regime - surface water" is a key attribute for understanding the viability of the "Riparian and Wetland Vegetation Communities," and one measurable indicator of the hydrologic regime is "spring flood frequency." Spring flood frequency status is rated as Poor, Fair, Good, or Very Good following specific definitions provided for each category (See Appendix B for ratings details for each indicator).

The trend in condition is also evaluated for each indicator (heading up or down the scale of Poor to Very Good) and a desired rating for ten years out indicated to provide a goal for conservation strategies and actions.

Riparian and Wetland Vegetation Communities

The Middle Rio Grande Valley supports one of the largest remaining cottonwood forests (bosque) in the Southwest.

<u>Target Description</u>

Importance

Riparian and wetland vegetation communities of cottonwood bosque or woodland, willow shrubland, marshes, and wet meadows provide the backbone terrestrial habitats of the Middle Rio Grande. These communities have been identified as one the largest

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[12] MRG-CAP Science Workshop May 5, 2014; See Appendix A for participants.

ecosystems of this type in North America and of global importance for sustaining wildlife populations[13].

Ecology

The natural ecological dynamics of a Southwestern river are that of periodic spring flooding and sediment deposition followed by a renewing cycle of herbaceous wetland giving way to stands of willows, other riparian shrubs, and young cottonwoods that mature into a cottonwood bosque. The bosque in turn reverts back to marshes and meadows under the impacts of recurring floods. The outcome over time is the development of a shifting patchwork of vegetation communities throughout the river corridor that makes up the terrestrial portion of a Dynamic Patch Mosaic (DPM) along with the in-channel river habitats. While flooding is a critical element for rejuvenation, the vegetation communities are also dependent on consistent groundwater availability for growth and maintenance, particularly through the summer. Together, the health of the vegetation communities is fundamentally dependent on a functional hydrological regime with recurring, appropriately timed (spring) high flows and minimum base flows through the growing season.

Key attributes, indicators, and status

For the Riparian and Wetland Vegetation Communities target, there are five identified key attributes with 14 associated indicators important to conservation management (Table 1). Under the Landscape Context category, there are three attributes related to river hydrology that are key to sustaining and rejuvenating the DPM: groundwater and surface water hydrologic regimes, and channel mobility. The associated indicators of floodplain connectivity [1][14] and spring flood frequency [2] are crucial elements for ensuring cottonwood regeneration within the DPM while groundwater depth [3] is crucial for sustaining the wetlands and bosque at low flows. Channel mobility [4], as measured by bank stabilization extent, is also fundamental to maintaining a dynamic, functioning ecosystem. That is, frequent high flows and sufficient groundwater plus the capacity for channel movement are necessary for long-term sustainability of the bosque.

Condition attributes focus on various aspects of the DPM vegetation community composition as well as species diversity within individual stands. The DPM indicators

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[13] Howe and Knopf 1991

[14] Numbers in brackets follow the indicator numbers in Table 1.

primarily address the relative abundance of the major vegetation communities in the riparian zone. The greater the vegetation diversity of the DPM, the greater the capacity to sustain wildlife diversity and add resilience to the system with respect to fire impacts and development—no one community should dominate a reach [5], but all the major riparian communities should be present to some degree [6-9], and may need to be bolstered by semi-natural means such as planting and seeding. In contrast, as the riparian ecosystem becomes dysfunctional, the encroachment of upland communities is a measure of impairment [10]. Lastly, a healthy cottonwood bosque is made up of a mosaic of different-aged cottonwood stands. Following flood events, cottonwoods can reproduce in large numbers on suitable sites—usually moist sandbars or in side channels—that mature into even-aged stands. With a functioning system the expectation then is an equitable distribution of young to old stands of trees; old, large, and uniform stands of cottonwood reflect a lack of recruitment and dysfunction [11].

Species composition/abundance indicators apply to individual vegetation stands and focus on invasive species impacts on ecosystem processes along with reductions in understory herbaceous species richness and cover. Accordingly, there are two indicators for herbaceous and woody invasive species [12 & 13). Exotic introduced woody species such as Russian olive and saltcedar are well-known problem introductions into the native riparian ecosystems of the Southwest, but herbaceous noxious weeds can also alter ecosystem processes and expression (e.g., ravena grass). Herbaceous cover can also be reduced by management practices [14]. Woody understory fire hazard-reduction practices that leave a deep wood chip litter layer on the ground can suppress that herbaceous element of the ecosystem for many years (livestock grazing can also have impact on ground cover).

The status among the 14 indicators ranged from Poor to Very Good with an overall rating of Fair for the entire MRG (conditions vary among sub-reaches; for details on the individual ratings see Appendix B). While floodplain connectivity [1], spring flood frequency [2], and marsh groundwater depth and duration [3] were rated as Fair overall, bank stabilization extent [4] was given a Poor rating because the great extent of channelization and stabilization in the MRG by jetty jacks. That is, flooding that can re-work the floodplain and provide habitat for cottonwood reproduction is minimal. This has long-term implications for the aging cottonwood bosque [11] and may favor invasive species that are flooding intolerant [12 & 13]. Yet a modicum of the indicators are in the Fair category and the downward trends are mostly mild suggesting that strategies can be developed that can lead to further improvement and an overall goal of a Good rating.

Table 1 Riparian and Wetland Vegetation Communities Key Attributes, Indicators, and Status

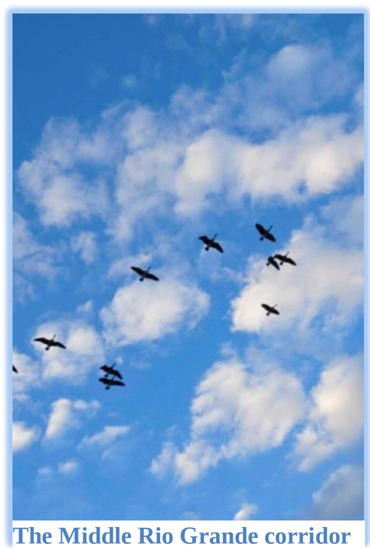
Category	Key Attribute	Indicator	Current Status	Goal
Landscape Context	Hydrologic regime - surface water	[1] Floodplain connectivity	Fair	Good
		[2] Spring flood frequency	Fair	Good
	Hydrologic regime - groundwater	[3] Marsh groundwater depth and duration	Fair	Good
	Channel mobility	[4] Bank stabilization extent	Poor	Good
Condition	Dynamic Patch Mosaic (DPM) - Vegetation	[5] Relative abundance of riparian vegetation types (woodland, shrubland, meadow, or marsh)	Fair	Very Good
		[6] Woodland - minimum relative abundance	Very Good	Very Good
		[7] Riparian shrublands - minimum relative abundance	Good	Good
		[8] Meadows - minimum relative abundance	Fair	Very Good
		[9] Marshes - minimum relative abundance	Fair	Very Good
		[10] Upland vegetation encroachment	Fair	Very Good
		[11] Cottonwood age classes	Poor	Good
	Species composition / abundance	[12] % cover aggressive invasive herbaceous species	Fair	Good
		[13] % exotic woody cover	Poor	Good
		[14] Woodland - % cover herbaceous understory	Fair	Very Good

Native Bird Habitat

Target Description

Importance

Up to 280 bird species are known to use the MRG; about a third of them breed here and the remainder use the river corridor as an important stopover habitat during regional to continental-scale migrations[15].



The Middle Rio Grande corridor is a major contributor to wintering and stopover habitat for birds in North America.

Ecology

A wide variety of bird assemblages occurs across the spectrum of riparian and wetland communities described above along with

[15] Hink and Ohmart 1984; Brand et al. 2013; Finch and Yong 2000; Yongand Finch 2002

in-channel habitats that make up the DPM. There are guilds of birds that primarily use the interior of large tracts of mature cottonwood bosque, while others are restricted to riparian shrublands and herbaceous wetlands, or depend on aquatic environments and open channel habitats. There are specific habitat and population issues that are unique to birds (e.g., invasive bird species and parasitism), but a vital DPM remains inherently important to the bird communities—a shifting mosaic of natural habitats within the riparian corridor and channel leads to the sustainability of diverse bird assemblages.

Key attributes, indicators, and status

This target focuses on the habitat conditions and status of the native riparian bird community of the MRG. Four key attributes and six associated indicators were identified (Table 2). As is well known, birds tend to key in on habitat complexity, and in particular, vertical structure. Hence, there is an indicator that measures bosque forest with multiple tree heights and shrub complexity [1]. The ideal setting should be that the majority but not all bosque stands should have a high vertical structural diversity of shrubs plus subcanopy and overstory trees. Similarly, for birds that thrive in open water and channel habitats, variation in those habitats as part of DPM is important (e.g., channel water habitat diversity [2], sandbar habitat extent [3], and overhanging and bank-edge shrub cover [4]). Given the importance of the MRG as wintering and stopover habitat for birds, an “abundance of food resources” attribute was identified and measured based on berry production in forest and shrubland [5]. Overall, the goal is to enhance species composition of the bird communities and their abundance [6]. That is, reverse the decline of native species that use the MRG corridor and sustain their numbers in equilibrium with maximum available natural habitats within the DPM.

The status among the six indicators was mixed between Fair and Good with none rated as Poor or Very Good (conditions do vary among sub-reaches; for details on the individual ratings see Appendix B). Yet, some indicators are trending downward and in particular, native bird diversity. This is reflected to some degree in the threatened and endangered status of southwestern willow flycatcher and yellow-billed cuckoo but likely extends to the bird community as a whole under the impacts of altered hydrology that is degrading the diversity of channel and near-channel habitats, and fire and exotic shrub management strategies that are reducing vertical structural diversity and berry forage production. The MRG is rich in bird species, but building towards a fully realized DPM will be integral to long-term sustainability of these communities.

Table 2 Native Bird Habitat Key Attributes, Indicators, and Status

Category	Key Attribute	Indicator	Current Status	Goal
Condition	Bird habitat complexity	[1] Bosque forest with multiple tree and shrub heights	Good	Very Good
	Dynamic Patch Mosaic (DPM) - Birds	[2] Channel water habitat diversity	Good	Good
		[3] Sandbar habitat extent	Fair	Good
		[4] Overhanging and bank-edge shrub cover	Good	Good
	Abundance of food resources	[5] Forest and shrubland winter berry forage	Fair	Very Good
	Species composition / abundance	[6] Native bird diversity	Fair	Good

Native Fish Community

<u>Target Description</u>

Importance

Like other large rivers of the Southwest, the Rio Grande once harbored a unique and ancient fish fauna, but the impacts on the river ecosystem over the past century have greatly reduced the number and abundance of native species, particularly with the influx of non-native species[16]. Regardless, the remaining MRG native fish community of 10 species is a major focus of conservation efforts. The extant species include red shiner, flathead chub, fathead minnow, river carpsucker, longnose dace, smallmouth buffalo, blue catfish, and the last remaining endemic species: Rio Grande silvery minnow.

Ecology

Providing a wide variety of channel habitats is key to MRG fish community sustainability.

While now a relatively limited native fish community, the 10 species occupy a wide array of channel habitats through their life cycles[17]. And as with the terrestrial habitats, in a functional river system these habitats are dynamic in space and time and form the aquatic element of the Dynamic Patch Mosaic of the MRG. Under natural conditions, in the aquatic DPM we

[16] Platania 1991; Rinne and Platania 1995; Hoagstrom and others 2010; T. Turner, per. com.
[17] Pease and others 2006

would expect a patch pattern of channel riffles or rapids, eddies, runs, and pools representing variable flow speeds plus side channels, embayments, and floodplain backwaters (the latter is particularly important for species that key in on peak spring floods to spawn and hatch the next generation). Intermixed would be variable riverbed materials (sands and gravels), new depositional areas (shoals, sparsely vegetated bars), large woody debris, and aquatic vegetation zones, all of which harbor fish habitat at various times. While habitat heterogeneity is needed to meet the various species requirements, there also needs to be an overall connectivity up and downstream that allows free movement of individuals—dams and diversions are typically the major impedance to this longitudinal connectivity. And of course above all, there needs to be water in the river in sufficient amounts and at critical times to sustain the fish populations.

Key attributes, indicators, and status

For the Native Fish Community target there were five key attributes with six associated indicators identified as important to conservation management (Table 3). Under the Landscape Context category, two indicators focus on the key elements of the hydrological regime that are critical to fishes: spring peak stream flow extent and duration to ensure recruitment of the next generation [1] and sufficient extent of base flows [2] to ensure population survivorship. Another hydrologically related landscape context feature is the channel river bed status [3]. The degradation (erosion) of the shifting channel sand bed to a relatively stable coarse cobble potentially removes important spawning and rearing habitat for some species. This usually begins downstream of dams or diversions that hold back significant sediment and through time can extend through entire reaches. Alteration of flows and sediment dynamics can have impacts on the overall DPM for fishes and is represented by fish habitat complexity [4], a measure of the number of habitat features along a segment of the river. Preventing barriers to fish movements to sustain fish populations with respect to genetic diversity, a full breath of spawning habitat, and providing escape areas during river drying periods is the focus of the maintaining channel longitudinal connectivity [5] indicator. Overall, the goal is to sustain fish community species richness and their dynamics [6] throughout the MRG and reduce the amount of intensive management that is needed.

The viability of key attributes varied from Poor to Fair, none were rated as Good or Very Good (see Appendix B for details of individual indicators). In addition, the trends point to declines among all indicators, and fish species remain at risk in the MRG.

Table 3 Native Fish Community Key Attributes, Indicators, and Status

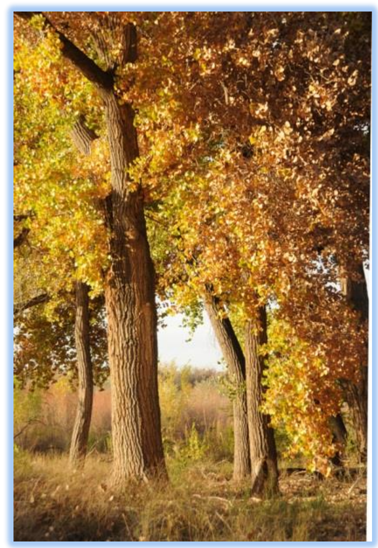
Category	Key Attribute	Indicator	Current Status	Goal
Landscape Context	Hydrologic regime - surface water	[1] Spring peak stream flow extent for recruitment	Fair	Good
		[2] Base flows	Poor	Good
	Channel stability	[3] Channel river bed status	Fair	Good
Condition	Dynamic Patch Mosaic (DPM) - fish	[4] Fish habitat complexity	Fair	Good
	Connectivity among communities & ecosystems	[5] Channel longitudinal connectivity	Fair	Good
	Species composition / abundance	[6] Fish community species richness and dynamics	Poor	Good

Wildlife Corridors

Target Description

Importance

Riparian corridors are significant landscape components in maintaining regional biodiversity yet nearly 80% of the area of corridors in North America has been reduced over the past 200 years [18]. The MRG supports a nearly continuous riparian corridor of over 180 miles that is the longest intact reach in the Southwest.



Nearly contiguous vegetation inside the levees of the MRG makes it ones one the largest extant riparian corridors in the Southwest.

Ecology

It is estimated that 70% of terrestrial vertebrates will use a riparian corridor in some significant way during their life cycle[19]. In the MRG, there are at least 60 species of mammals, amphibians, and reptiles that are known to use the corridor, and an unknown number of insects and other arthropods[20]. A key to sustaining this biodiversity is to maintain local habitat complexity of the DPM and prevent further fragmentation and loss of the corridor in a way that limits wildlife movements and habitat availability.

[18] Naiman and others 1993
[19] Raedeke 1989.
[20] Crawford and others 1993

Key attributes, indicators, and status

For wildlife corridors, the focus is on two key attributes: "connectivity among communities & ecosystems" and "species composition and abundance" with two respective indicators (Table 4). The indicator for the former is river corridor fragmentation and infringement by development and recreation [1] and is measured by the percentage of the area inside the levees that is protected as wildlife habitat, (e.g., wildlife refuges, state parks, etc.). In the context of limiting fragmentation, the goal is to maintain and enhance wildlife species richness and dynamics [2] across all reaches. At this time, wildlife habitat protection is rated as Poor, but because the corridor is still relatively intact, species richness and dynamics is rated as Good for an overall rating of Fair (conditions do vary among sub-reaches; for details on the individual ratings see Appendix B).

Table 4 Wildlife Corridors Key Attributes, Indicators, and Status

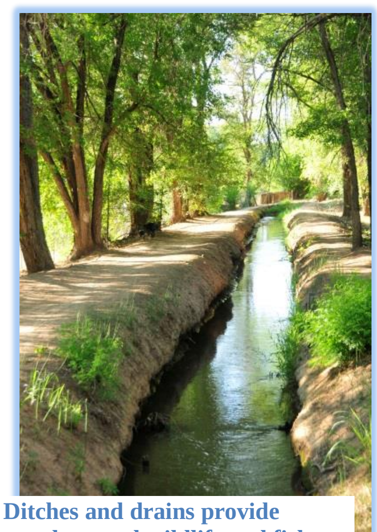
Category	Key Attribute	Indicator	Current Status	Goal
Condition	Connectivity among communities & ecosystems	[1] River corridor fragmentation and infringement by development and recreation	Fair	Good
	Species composition / abundance	[2] Wildlife species richness and dynamics	Good	Very Good

Ditch and Drain Habitat

<u>**Target Description**</u>

Importance

Ditch and drain habitats provide important linkages between the riparian corridor and the surrounding landscape matrix of agricultural and urban lands. They provide supplemental habitat for wildlife (particularly birds) and to a limited degree fishes[21]. In addition, they have become increasingly popular as local natural areas or greenbelts for residents to enjoy.



Ditches and drains provide supplemental wildlife and fish habit as well as greenways and natural areas for people to enjoy.

Ecology

[21] Sallenave and others 2010

Ditches and drains support both natural and semi-natural vegetation and function as interstitial habitats in the matrix of agricultural and urbanized lands of the MRG outside the levees. Like the DPM, vegetation should be a structurally diverse combination of woodland, shrubland, and herbaceous cover with emphasis on the outer portion of the ditch right of ways (ROWs). Ideally, the vegetation should also be dominated by native species where possible and noxious weeds controlled.

Key attributes, indicators, and status

For ditches and drains, the key attribute is vegetation composition and structure with four indicators. To support wildlife, a minimum amount of perennial vegetation cover should be maintained in the ROW [1], a certain amount of the perennial vegetation should be composed of trees and shrubs in the outer ROW [2], and when possible native species encouraged [3]. Lastly, noxious weeds should be minimized since the ditches and drains can act as conduits to the riparian corridor. Currently, the indicators are rated between Fair and Good; the goal for these indicators is a rating of Good or Very Good (conditions do vary among sub-reaches; for details on the individual ratings see Appendix B).

Table 5 Ditch and Drain Habitat Key Attributes, Indicators, and Status

Category	Key Attribute	Indicator	Current Status	Goal
Condition	Vegetation composition and structure	[1] Ditch and drains % cover of perennial vegetation	Fair	Very Good
		[2] Ditch ROW woody vegetation	Good	Very Good
		[3] Exotic woody cover	Fair	Good
		[4] Ditch noxious weeds	Fair	Good

Summary of Conservation Target Viability

Overall, the viability of conservation targets among Landscape Context and Condition attributes rate between Poor and Fair with an overall rating of Fair for the MRG (Table 6). We did not explicitly identify landscape context for Native Bird Habitat, Wildlife Corridors, and Ditch and Drain Habitat, but elements of the surrounding landscape condition were implied in several of the condition metrics for those targets. It must be remembered that there are differences among reaches with some ratings worse than others (See Appendix B). A modicum of the indicators was rated individually as Good or Very Good and most were rated as Fair. Furthermore, downward trends were mostly rated as mild, suggesting that strategies can be developed that can lead to further improvement with the goal of achieving a Good rating over the next decade.

Table 6 Summary of Viability for Conservation Targets on the Middle Rio Grande (See Appendix B for details)

Conservation Target		Landscape Context	Condition	Viability Rank	Viability Rank Goal 2025
1	Riparian and Wetland Vegetation Communities	Poor	Fair	**Fair**	**Good**
2	Native Bird Habitat	---	Fair	**Fair**	**Good**
3	Native Fish Community	Fair	Poor	**Fair**	**Good**
4	Wildlife Corridors	---	Fair	**Fair**	**Good**
5	Ditch and Drain Habitat	---	Fair	**Fair**	**Good**
Project Biodiversity Health Rank				**Fair**	**Good**

CRITICAL THREATS

The viability of the conservation targets is threatened by multiple stresses. These sources of stress, or "critical threats," can negatively affect the viability of species or the integrity of ecosystems. Accurate identification of threats is helpful in pinpointing efficient and effective conservation/management strategies.

Most sources of stress within the Middle Rio Grande ecosystem cannot be wholly removed from the system. And, as the majority of them are related to flood control, water supply, and agricultural needs, their removal would not be desirable, even if it were possible. However, these threats also represent opportunities for creative and innovative management strategies that can preserve and improve the viability of the riverine ecosystem for future generations. Understanding how the threats are currently impacting the ecosystem provides the key for unlocking those opportunities.

The highest ranking critical threats for the Middle Rio Grande are discussed below. Table 7 presents severity ratings for each threat by conservation target. *See Appendix C for the threats analysis and explanation of ratings.*

Channelization

Kelmer jetty jacks were installed along the banks and through the floodplain to stabilize and prevent lateral movement of the river channel.

Over the course of the last 90 years, a variety of methods have been used to channelize the river including levees, groins, Kellner jetty jacks, and dredging. The end result has been a significantly narrower and deeper active channel that flows between raised terraces of deposited sediment within the levee system. This is effective for water delivery and flood control, but is detrimental to the wetland and riparian flora and the native aquatic fauna. As the active channel has become progressively more isolated from the adjacent terraces there has been a decrease in the extent and frequency of overbank flooding onto the terraces, coupled with a retreating groundwater table in the terraces. The lack of overbank flooding means that many of the native riparian woody species can no longer reproduce outside of the active channel. The lack of geomorphological diversity in the active channel and overbank flooding outside the channel also impacts the reproductive success of endangered native fish species. The retreating groundwater has reduced the extent and number of wetland vegetation patches and marshes, and threatens the viability of woody riparian vegetation including mature cottonwood bosque. These effects of channelization are greatest in the Cochiti to Angostura, and the Angostura to Isleta reaches. Channelization is less pronounced in the Isleta to San Acacia reach where the active channel is still somewhat connected to the floodplain. The reach below San Acacia has areas with higher sediment loads and channel aggradation issues, as well as areas with pronounced floodplain disconnection.

Dam Operations

Threats due to dam operations refer only to the larger dams capable of retaining significant amounts of sediment and water in pools. These include Galisteo, and El Vado and Abiquiu in the Chama basin, but Cochiti is the first major dam on Rio Grande itself and the most significant in its effects on the Middle Rio Grande. The smaller irrigation diversion dams that do not create large retention pools (Angostura, Isleta, and San Acacia) are discussed under Diversions. The large dams were constructed from the 1930s to the 1970s and were built for flood abatement and/or water storage.

Cochiti Dam lies at the northern boundary of the MRG reach and is the primary means of water regulation.

The dams create two key stressors on viability for the Middle Rio Grande ecosystem; one is alteration of the timing, volume, and duration of the downstream water flow, and the other is removal of sediment from the flow. Flow regulation by the dams has created a separation of the river from its historical hydrograph such that the amount of water now flowing through the river can be largely unrelated to natural seasonal water availability. Prior to dam construction, the river typically had late spring/early summer peak flows driven by snow melt in its Southern Rocky Mountain headwaters. This peak flow often resulted in floods that spread sediment and water across the floodplain, and provided many opportunities through channel evulsion and floodplain reworking for the formation of new wetlands, the establishment of young stands of native woody species, and the revitalization of others—creating new habitats for numerous native plants and animals. The creation of these new habitats often came at the destruction of existing patches of woodlands, shrubs, or wetlands, keeping the ecosystem in a dynamic state of flux. The spring flood pulse was the driver of the dynamic patch mosaic that was the key to the vitality and diversity of the bosque ecosystem. This spring flood pulse was also a key element in the reproductive cycle of many native fish species, who timed spawning to the time when floodwaters were highest and potential habitat existed across the floodplain.

Yet, spring floods also "reworked" farmland, destroyed homes, and threatened human lives, thus the need for flood control dams that kept the spring runoff contained. However, with the loss of the spring flood flows and their accompanying sediment the river channel became much more static, and the dynamic patch mosaic became dominated by uniform stands of similarly aged cottonwoods, while many native fish species went into decline. Other patch types diminished, and as the water coming out of the dams was sediment depleted, the river began to degrade and become entrenched, and water tables began to drop, leading to a loss of connectivity between the river and the floodplain terraces and a decline in all native riparian vegetation types.

Recently, adaptive management aimed at mimicking the spring flood pulse has been attempted, but the ability to do so has limitations. The most significant is the limits of the existing infrastructure and its ability to handle high flows. Many of the levees and bridges are over 50 years old and were not engineered to modern standards. Many of the older levees within the Middle Rio Grande lack core materials and other engineered features that would prevent them from eroding away in a truly large flow. This limits downstream channel capacity, which is additionally limited by a handful of structures built within the active floodplain. And finally, lack of sediment and the incised channel mean that even when the maximum feasible flow is allowed to pass through the dams, it still has minimal ability to rework the inter-levee floodplain or access the currently perched terraces. In some areas, due to the current channel confinement, larger flows only exacerbate channel degradation.

Housing & Urban Areas

Housing and urban development threaten the riverine ecosystem in two ways. The first is through development in the active floodplain, and the second is through development in the surrounding landscape. The most significant threat comes from development within the active floodplain. The conversion of land from natural ecological systems to permanent structures destroys habitat and removes the area from the natural fluvial processes. These changes in land use

The Albuquerque metropolitan area is continuing to grow and placing increasing demands on water from the river.

are essentially irreversible. In the Middle Rio Grande, development in the floodplain impacts not just the local area but the entire ecosystem. Once in existence, developments must be protected from flooding. Thus they become new channel capacity limitations, restricting the ability to release ecologically significant flows from upstream dams. Housing is not the only kind of permanent structure that can have this effect in the floodplain. Many different types of development, including roads, bridges, utility infrastructure, and paved recreation trails can have the effect of limiting potential for hydrologic reconnection if placed in the active floodplain.

Given that almost all lands outside of the levees have been converted to human use, greater urbanization within the Middle Rio Grande Valley still poses a threat to the riverine ecosystem. The Middle Rio Grande Valley has supported permanent human settlements since the pre-Columbian era. Over the last 100 years, however, a significant portion of the valley has become urban, and has experienced dramatic population growth. This growth creates increased demands on already over-appropriated water resources. Although the San Juan diversion adds some water into the system for use in Albuquerque, continued growth means growing stress on water resources. Additionally, the infrastructure to remove water from the river for urban use brings with it more development within the active floodplain, as well as other disruptions, and has effects that are not yet fully understood.

Beyond increased need for water, the surrounding landscape alterations that accompany urbanization can affect the viability of the ecosystem. These effects include the introduction of trash, non-native predators, exotic plant species, interruption of wildlife corridors, interruption of the riparian corridor with bridges and other developments, urban run-off, waste-water effluent, increased human visitation with the potential for disrupting sensitive wildlife, and the destruction (accidental or deliberate) of wildlife habitat.

An often overlooked but significant threat posed to the ecosystem by urban development is the loss of agricultural lands adjacent to the floodplain. Agricultural lands can provide a buffer to the riparian ecosystem attenuating some of the threats posed by the urban environment and flood irrigation has been shown to sustain or increase the local groundwater table, critical for riparian species. Additionally, active agricultural lands can provide wildlife corridors and important foraging habitat for many of the bird species that make their home in the bosque.

Wildfire

Catastrophic human-caused crown fires in the bosque remain a major threat to the ecosystem not well adapted to them.

Within in the Middle Rio Grande ecosystem human-caused wildfires have become a significant threat. Although fires in the headwaters can also be a threat to water quality, they are not addressed here, as they occur in areas outside of MRG (but are being addressed elsewhere through such projects as The Nature Conservancy Rio Grande Water Fund and the USDA Forest Service Collaborative Forest Restoration Program). Cottonwood bosque is not historically a fire-adapted system, as cottonwoods are relatively fast growing and short-lived trees adapted to well-watered, moist environments. In addition, historically, mature cottonwood stands would have been interwoven with shrublands and wetlands in a patch mosaic of different fuel structures (woody and non-woody) lending resistance to large-scale fires. The changes in hydrology, the introduction of exotic woody species, declining cottonwood vigor, and the overall loss of patch diversity within the floodplain has led to the formation of large, contiguous stands of similar-aged trees with high fuel loads and an increased threat of large, uncontrolled wildfires. When these fires occur they can destroy hundreds of acres of bird and wildlife habitat in hours, and threaten the human communities adjacent to the bosque.

Introduced Species

Non-native shrubs such as Russian olive alter ecosystem processes but also offer habitat for wildlife.

Introduced species are a threat to the flora and fauna of the riparian ecosystem, as well as exacerbating some of the other threats to the system such as channelization and wildfire. Major introduced species of concern include woody and herbaceous plants, as well as birds, fish, and non-native mollusks. While the woody introduced Russian olive and salt cedar have been the species of most concern to date, Siberian elm, tree-of-heaven, and many noxious herbaceous species have the potential to become equally disruptive to the system. A primary concern to managers is the loss of water to introduced species, however, on an ecosystem level the primary concern is the loss of native diversity to non-native species, and the changes to wildlife habitat that entails. Many introduced species, both plant and animal, compete directly with native species and impact reproduction, or prey on native species, and in general disrupt ecological processes.

Diversions

Diversions can become a threat to the system if they are not scaled to current water availability, or if they are poorly timed. High diversions during peak flows can reduce the ability of the river to access the floodplain. Alternatively, high diversions during periods of low flow can dry sections of the channel completely, which can stress riparian vegetation due to lower groundwater availability, kill fish, and remove bird and wildlife habitat.

The Isleta diversion dam provides irrigation water for the MRGCD Belen Division.

The dams and other diversion infrastructure can be a direct threat to fish by impeding movement up or down channel, especially if fish become trapped in areas that may dry completely and create population sinks. Impediment of up- and down-channel movement can also create genetic isolation between fish populations.

Habitat Modification

Habitat modification encompasses treatments for fire suppression, and alterations to improve habitat for individual species, or the ecosystem as a whole. These treatments can include everything from selective removal of individual trees and shrubs to removal of entire vegetation stands, planting of desirable species, or earthwork to remodel portions of the floodplain. The goal of habitat modification is improved health and viability of the ecosystem, but when poorly informed or executed, habitat modification can become a significant threat for some of the conservation targets.

Understory treatments to reduce fire hazards can impact wildlife habitat and vegetation diversity depending on how they are done.

Fire suppression and treatment activities can be a threat or a boon to the ecosystem depending on how they are conceived and carried out. Land managers have addressed habitat modification for fire suppression in two ways. The first approach has been removal or thinning the exotic woody understory in an attempt to directly lower the fuel loads. While risk of fire may be lowered the understory removal can be very detrimental to wildlife and birds, as it removes essential habitat. When treatment crews are not well trained or supervised they may also remove both native and exotic species. Intensive treatment, indiscriminate use of heavy equipment, and spreading of chipped ladder fuels can destroy herbaceous understories, further reducing habitat quality and diversity. Additionally, this type of treatment is labor intensive and expensive, and requires repeat treatment to be effective. Alternatively, an ecosystem approach has been implemented in some reaches that focuses on rejuvenating the dynamic patch mosaic as an efficient way to break up continuous high structure stands and create natural fuel breaks.

Restoration methods often go hand-in-hand with fire suppression efforts, and similarly, can be either a bane or boon to the ecosystem depending on how they are planned and executed. Restoration projects that are heavily focused on removal of exotic woody species can create the same threats as those mentioned for fire suppression activities above. Without restoring ecosystem processes or native plant communities, fire and invasive species management that removes habitat with high structure and species richness leads essentially to contraction of the riparian ecosystem, not its enhancement. In contrast, incorporating earthwork to reconnect the area to be restored with groundwater or directly to river flows can be very successful, though these projects also have to be monitored and often adaptively managed. This type of passive restoration can also create a local patch mosaic that increases ecosystem richness and structure. There are cases where passive restoration may not be possible and the more intensive approach of direct planting of native species will need to be implemented to reach the restoration goals. Regardless, poor timing of restoration projects can decrease the likelihood of revegetation success and increase the likelihood of noxious weed establishment. In addition, any habitat restoration activities need to be timed to limit threats to bird, wildlife, and fish populations, particularly during the breeding season. Overall, for any restoration project to be successful, the limits of the current system must be well understood. The restoration goals need to be defined within these limits, and the hydrologic, geofluvial, and biologic needs of the restoration species/community well understood and planned for.

Drought

Drought and its impact on water flows puts the entire Rio Grande ecosystem at risk.

Drought is a threat in any ecosystem, but particularly for a desert riverine system such as the Middle Rio Grande. While drought is a broad-scale threat, it can be ameliorated somewhat by management activities. The greatest threat of drought to the Middle Rio Grande ecosystem is that non-ecosystem water allocations will take priority or not be scaled in response to a drought. This can lead to severe depletions within the channel and put more species and habitats, aquatic and terrestrial, at risk. Accordingly, there will be a need for on-going communication among water resource managers, scientists, and land managers on strategies for adaptive management during low-flow years to ensure that ecosystem needs are met to prevent endangering additional species and reducing the value of resource as a whole for the state and country.

Recreational Activities

Intensive recreational development such as paved bike paths can impact the wildlife corridor.

Recreational activities can disrupt wildlife activities and impact habitats. Some wildlife species are very sensitive to human disturbance and may be unable to successfully reproduce in areas with high human visitation, or may abandon use of high visitation areas completely. Additionally, recreation can lead to habitat trampling and destruction, introduction of trash, stress and predation from companion animals, introduction of exotic plant and animal species, and collision with vehicles. Creation of permanent structures, paths, and roads to accommodate recreation also destroys habitat, and provides more avenues for introduction of trash, exotic species, etc. Threats from recreation can be reduced through management that focuses high use recreation to limited areas, eliminates excessive or duplicate trails, and protects sensitive and critical habitat. Although unmanaged recreation is a threat, recreation in general is positive for the Middle Rio Grande ecosystem, as it is key to the public appreciation of the ecosystem as a quality of life issue for those who live in the valley.

Summary of Critical Threats

Urban development, dam operations, and channelization pose the greatest threat to the majority of conservation targets (Table 7). This is because all three have major impacts on the long-term viability of riparian and wetland vegetation communities, and the native birds dependent on those communities. Additionally, all three can have significant impacts on in-channel habitat and thus the native fish community. Overall, the native fish community is the most imperiled target based on multiple threats, with drought and diversions also being highly significant threats to fish. However, all targets, except the ditch and drain habitat target, are considered very highly threatened in at least one regard. The identified threats and their potential impacts indicate that the ecosystem as a whole is very imperiled. Most of the threats identified here are systemic, and due to large-scale ecosystem modifications for human development and water use. These ecosystem modifications are permanent as they are essential to the more than one-million people who live in the Middle Rio Grande Valley. However, management of both the infrastructure and the water resources can be modified within certain legal and management constraints, and with a mission to preserve the unique and important Middle Rio Grande ecosystem, adaptive management can be a tool for preservation within the current limitations.

Table 7 Summary of Threats by Conservation Target (See Appendix C for details)

Threats Across Targets	Riparian and Wetland Vegetation Communities	Native Bird Habitat	Native Fish Community	Wildlife Corridors	Ditch and Drain Habitat	Overall Threat Rank
Channelization	Very High	Very High	Very High	High	Low	Very High
Dam Operations	Very High	Very High	Very High	High	High	Very High
Housing & Urban Areas	Very High	Very High	Very High	Very High	High	Very High
Wildfire	High	High	Low	High	Low	High
Introduced Species	High	High	Medium	Medium	High	High
Diversions	High	Medium	Very High	High	Low	High
Habitat Modification	Medium	High	Low	High	High	High
Drought	High	High	Very High	High	High	Very High
Recreational Activities	Medium	High	Low	High	Low	High
Threat Status for Targets and Project	Very High	Very High	Very High	Very High	High	Very High

THE NEXT STEP: CONSERVATION AND STEWARDSHIP STRATEGIES

The MRG-CAP framework, through the identification of major conservation targets with measureable indicators of their current and desirable future conditions, is designed to help set objective stewardship goals for the MRG ecosystem. The next step is to develop strategies that can be applied in and among specific reaches to meet those goals in collaboration with its many partners and stakeholders. While this will be a challenging and complex process, the clear consensus that came out of the MRG-CAP science and management workshops was that these strategies should be built around actualizing the Dynamic Patch Mosaic (DPM) of sustainable aquatic and riparian habitats up and down the river.

The DPM is in keeping with the core concept and recommendations of the original interagency Middle Rio Grande Ecosystem Biological Management Plan of 1993. That plan has provided the foundation for many subsequent project-based planning activities and conservation actions throughout the MRG[22]. Specific approaches and outcomes have differed among agencies and groups, and from place to place[23]. The MRG-CAP now can provide a well-structured framework for evaluating the progress made by these efforts towards meeting conservation goals and help set the agenda going forward.

Based on the MRG-CAP workshops, specific recommendations are:

1. Reconvene parties to the Middle Rio Grande Ecosystem Biological Management Plan to assess progress to date in the context of MRG-CAP conservation targets and the DPM.
    - Sponsor a MRG-CAP Symposium with presentations on successes and lessons learned in the stewardship of the MRG since 1993.
2. Build a MRG-CAP database of management approaches, actions, and outcomes throughout MRG.
    - Evaluate the scale of past and current stewardship projects and duration.
    - Compile exiting monitoring programs and measures of success.
    - Use the database to coordinate across reaches and agencies to meet target goals.
3. Conduct follow-up MRG-CAP workshops to set priorities and target specific conservations actions to further build the DPM.
    - Using the MRG-CAP framework of targets and indicators, design reach-wide actions.

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[22] Najmi, Grogan and Crawford 2005; Najmi and Grogan 2006; Dello Russo and Najmi 2006
[23] Save Our Bosque, Albuquerque Open Space, USACE-Albuquerque, Middle Rio Grande Conservation Initiative (Collaborative)

- Conduct a "gap" analysis of where the most important sites are that can be managed strategically to enhance the DPM and meet the conservation target goals (using the MRG-CAP database in #2).
- Identify data gaps to be filled in support effective reach-wide stewardship.

4. Develop a MRG Stewardship Work Plan to execute those actions within its jurisdictions and organizational capacities.
    - Develop project plans that leverage partnership opportunities.
    - Build in cost-efficient but useful monitoring requirements (including citizen science options).
5. Develop a long-term financial strategy around a multi-agency Restoration Fund (RiverBank).
    - Convene an advisory leadership group of public and private partners to help support the goals of the MRG-CAP.
6. Expand outreach and educational opportunities.
    - Develop a website with relevant information/data to support collaboration.
    - Develop an education program, both internally and externally, to facilitate understanding of how the DPM works.

Prospects for Success

Remembering that the overall MRG-CAP rating for conditions in the Middle Rio Grande is "Fair," there remains significant potential for building a fully realized dynamic patch mosaic and moving the ecosystem to a "Good" rating. Opportunities do exist for managing the water, channel, and floodplain conditions in ways that will lead to a sustainable MRG ecosystem while still serving the needs of the agricultural and urban communities. While there will be the added challenges of environmental change, these recommendations are put forward in that spirit of common cause for building a healthy Middle Rio Grande.

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APPENDIX A - WORKSHOP PARTICIPANTS

The development of conservation targets for the MRG-CAP used a project planning process developed by The Nature Conservancy that is based on more than 50 years of experience in conservation. Critical to the planning process was input from a team of practitioners, managers, and scientists with varied regional expertise. This team of experts participated in workshops where the conservation targets and means of assessing their viability were developed. The scientists worked together to revise and fine-tune the list of conservation targets and means of assessing their viability. The results were presented to the team of managers who provided additional guidance on the targets and brainstormed a list of strategic objectives aimed at improving collaborative planning/management for future work toward improving their status. Organizations and participants in the workshops on May 5 and 8, 2014 are:

Middle Rio Grande Conservancy District	Yasmeen Najmi, Booke Wyan
Bosque Ecosystem Monitoring Program	Kim Eichorst
City of Albuquerque, Open Space Division	Matt Schmader
Geosystems Analysis, Inc.	Todd Capulin
New Mexico Interstate Stream Commission	Grace Haggerty
New Mexico Forestry Division	Doug Boykin
New Mexico Department of Game and Fish	Chuck Hayes, Kristin Madden, Mark Watson
Save Our Bosque Task Force	Gina Delarosa
The Nature Conservancy	Dave Gori
The Pueblo of Santa Ana	Nathan Schroeder
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U.S. Army Corps of Engineers	Michael Porter, William DeRagon
Weber State University	Chris Hoagstrom
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Colorado Natural Heritage Program, CSU	Lee Grunau, Renée Rondeau
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APPENDIX B. VIABILITY ANALYSIS

In general terms, “viability” refers to the likelihood that a species or ecological system will still be present and functioning at a site over some future timeframe (usually 20-100 years). Viability is assessed by evaluating at least one key ecological attribute and its measurable indicator for each conservation target. Key ecological attributes are aspects of the target that, if missing, would lead to loss of the target over time. Indicators for each key ecological attribute are specific, measurable entities that relate to the health of the attribute. The evaluation of key ecological attributes can be grouped into three general categories: size, condition, and landscape context. Size is a quantitative measure of abundance or area of occupancy. Condition is an estimate of the relative quality of each target *within* the site or target occurrence. For species, condition is a measure of the health of populations (successful reproduction, vigor, evidence of disease, etc.). For systems, condition is a measure of species composition and structure (presence of exotics, etc.), development (e.g., early successional stage, old growth), and function of ecological processes such as hydrology. Landscape context is an estimate of the relative quality and connectivity of the habitats and ecological systems *surrounding* the site or target occurrence, and the degree to which the surrounding area may affect conservation targets on the site. For the Middle Rio Grande, the chosen key ecological attributes fall within the categories of condition and landscape context; the size category was considered less useful and was not included in the analysis.

As described above, one or more measureable indicators were identified for assessing the current status of each key ecological attribute. The current status of each indicator is rated as Very Good, Good, Fair, or Poor following specific definitions provided for each category. These indicator ratings provide a consistent and objective basis for evaluating the status of an indicator. Qualitative descriptions of the ratings are listed below[24] and specific ratings definitions for each indicator are presented in Table B-1.

> *Very Good*: The indicator is functioning within an ecologically desirable status, requiring little human intervention for maintenance with the natural range of variation.
> *Good*: The indicator is functioning within its range of acceptable variation, although it may require some human intervention for maintenance.
> *Fair*: The indicator lies outside of its range of acceptable variation and requires human intervention for maintenance. If unchecked, the target will be vulnerable to serious degradation.
> *Poor*: Allowing the indicator to remain in this condition for an extended period will make restoration or prevention of extirpation of the target practically impossible (e.g., it will be too complicated, costly, and/or uncertain to reverse the alteration).

The trend in condition is also evaluated for each indicator (heading up or down the scale of Poor to Very Good) and a desired rating for ten years out indicated to provide a goal for conservation strategies and actions. Where desired future condition is better than current condition, management strategies are needed to enhance or restore that ecological attribute. Where desired future condition and current condition are the

[24] Ratings as defined in The Nature Conservancy. 2007. *Conservation Action Planning Handbook – Developing Strategies, Taking Action, and Measuring Success at Any Scale*. The Nature Conservancy, Arlington, VA.

same, but less than Very Good; management strategies may be needed to avoid further degradation.

Table B-1. Viability Analysis: Middle Rio Grande

Key Attribute	Indicator	Poor	Fair	Good	Very Good	S[1]	R[2]	Current[3]	Trend[4]	Future[5]
Riparian and Wetland Vegetation Communities										
Landscape Context										
Hydrologic regime - surface water	[1] Floodplain connectivity	No spring peak flows that over-bank and wet the floodplain.	**Limited spring peak flows with some over-banking.**	Moderate spring peak flows and over-banking.	High spring peak flows and extensive over-banking.	Exp	1	Overall: F R1: P R2: F R3: F R4: G	SD	G
Hydrologic regime - surface water	[2] Spring flood frequency	Spring over-bank flows of 1 week to 1 month duration occur at greater than 9 year intervals.	**Spring over-bank flows of 1 week to 1 month duration occur at 6-9 year intervals.**	Spring over-bank flows of 1 week to 1 month duration occur at 3-5 year intervals.	Spring over-bank flows of 1 week to 1 month duration occur at 1-2 year intervals.	Exp	1	Overall: F R1: P R2: F R3: G R4: G	MD	G
Hydrologic regime - groundwater	[3] Marsh groundwater depth and duration	Groundwater is seldom within 30cm of the surface (<10% of the year); no surface water ponding/flooding occurs	**Groundwater is sometimes within 30cm of the surface (10-50% of the year); surface water ponding/flooding seldom occurs.**	Groundwater is often within 30cm of the surface (50-90% of the year); ponding/flooding common but seasonally limited.	Groundwater is usually within 30cm of the surface (90% of the year or more); continuous portions of the wetland are ponded/flooded throughout the year.	Est		Overall: F R1: U R2: G R3: P R4: P	MD	G
Channel mobility	[4] Bank stabilization extent	**Channel migration severely limited; >75% channel stabilized either artificially (jetty jacks) or by persistent vegetation; no lateral migration at peak flows within the levees.**	Channel migration limited; 50-75% of channel stabilized either artificially (jetty jacks) or by persistent vegetation; some lateral migration at peak flows within the levees.	Channel migration moderate; 25-50% of the channel stabilized either artificially (jetty jacks) or by persistent vegetation; moderate lateral migration at peak flows within the levees.	Channel migration limited only to protect old, unreinforced levees; <25% channelized and stabilized either artificially (jetty jacks) or by persistent vegetation; extensive lateral migration at peak flows within the levees.	Exp		P	MD	G

Key Attribute	Indicator	Poor	Fair	Good	Very Good	S[1]	R[2]	Current[3]	Trend[4]	Future[5]
Condition										
Dynamic Patch Mosaic (DPM) - Vegetation	[5] Relative abundance of riparian vegetation types (woodland, shrubland, meadow, or marsh)	>70% of the area of a reach composed of a single riparian/wetland vegetation type.	70-60% of the area of a reach composed of a single riparian/wetland vegetation type.	**50-60% of the area of a reach composed of a single riparian/wetland vegetation type.**	<50% of the area of a reach composed of a single riparian/wetland vegetation type.	Res	2	Overall: G R1: P[6] R2: P R3: VG R4: VG[7]	MD	VG
Dynamic Patch Mosaic (DPM) - Vegetation	[6] Woodland - minimum relative abundance	<10% of the reach.	10-25% of the reach.	25-35% of the reach.	**>35% of the reach.**	Res	2	Overall: VG R1: VG[6] R2 :VG R3: VG R4: F	MD	VG
Dynamic Patch Mosaic (DPM) - Vegetation	[7] Riparian shrublands - minimum relative abundance	<10% of the reach.	10-25% of the reach.	**25-35% of the reach.**	>35% of the reach.	Res	2	Overall: G R1: P[6] R2: F R3: G R4: VG[7]	MD	VG
Dynamic Patch Mosaic (DPM) - Vegetation	[8] Meadows - minimum relative abundance	<1% of the reach.	**1-5% of the reach.**	5-10% of the reach.	>10% of the reach.	Res	2	F	MD	VG
Dynamic Patch Mosaic (DPM) - Vegetation	[9] Marshes - minimum relative abundance	**<1% of the reach.**	1-5% of the reach.	5-10% of the reach.	>10% of the reach.	Res	2	Overall: P R1: P[6] R2: F R3: P R4: P	MD	VG
Dynamic Patch Mosaic (DPM) - Vegetation	[10] Upland vegetation encroachment	>25% of the reach.	**10-25% of the reach.**	5-10% of the reach.	<5% of the reach.	Res	2	F	MD	VG

Key Attribute	Indicator	Poor	Fair	Good	Very Good	S[1]	R[2]	Current[3]	Trend[4]	Future[5]
Dynamic Patch Mosaic (DPM) - Vegetation	[11] Cottonwood age classes	**90% of stands mature or old age classes.**	70% of stands mature or old age classes.	50% of stands mature or old age classes; 50% of stands advanced or regeneration (poles) or saplings.	All age classes present and each representing approximately 25% of the stands.	Exp	3	Overall: P R1: U R2: P R3: F R4: P	SD	G
Species composition / abundance	[12] % cover aggressive invasive herbaceous species	10% or more cover aggressive invasive herbaceous species.	**At least 5% but less than 10% cover aggressive invasive herbaceous species.**	At least 1% but less than 5% cover aggressive invasive herbaceous species.	Less than 1% cover aggressive invasive herbaceous species.	Exp		F	SD	G
Species composition / abundance	[13] % exotic woody cover	**40% of cover is non-native trees and shrubs.**	10-40% of cover is non-native trees and shrubs.	5-10% of cover is non-native trees and shrubs.	Less than 5% of cover is non-native trees and shrubs.	Exp	4	Overall: P R1: U R2: F R3: P R4: P	SD	G
Species composition / abundance	[14] Woodland - - % cover herbaceous understory	Herbaceous understory artificially suppressed to <1% cover.	**Herbaceous understory artificially suppressed to 1-5% cover.**	Herbaceous understory artificially suppressed to 5-10% cover.	Herbaceous understory not artificially suppressed.	Exp		F	MD	VG

Key Attribute	Indicator	Poor	Fair	Good	Very Good	S[1]	R[2]	Current[3]	Trend[4]	Future[5]
Native Bird Habitat										
Condition										
Bird habitat complexity	[1] Bosque forest with multiple tree and shrub heights	<10% of woodland stands are Hink & Ohmart Type 1 or 3 (high structure).	At least 10% and less than 40% of woodland stands are Hink & Ohmart Type 1 or 3 (high structure).	**At least 40% but less than 70% of woodland stands Hink & Ohmart Type 1 or 3 (high structure).**	At least 70% of woodland stands are Hink & Ohmart Type 1 or 3 (high structure).	Exp	2	Overall: G R1: U R2: P R3: G R4: G	MD	VG
Dynamic Patch Mosaic (DPM) - Birds	[2] Channel water habitat diversity	No water or little in-channel water habitat diversity in most reaches: deep and fast moving water predominant; others occupy less <10% of the wetted habitat.	Limited mix of in-channel water habitats in most reaches: deep and fast moving water along with shallow slow-moving water predominant, others occupying less <10% of the wetted habitat.	**Moderate mix of water habitats in most reaches in most reaches: deep and fast moving water, shallow slow-moving water, and deep pools present; flooded islands and sidebars occupy <10% each of the wetted area.**	High diversity of water habitats in all reaches: deep and fast moving water, shallow slow-moving water, deep pools present and flooded islands and sidebars present.	Est		Overall: G R1: P R2: F to G R3: G R4: G	MD	G
Dynamic Patch Mosaic (DPM) - Birds	[3] Sandbar habitat extent	<5% of active channel is bank or island bars with no or low vegetation during winter flows.	**5-10% of active channel is bank or island bars with no or low vegetation during winter flows.**	10-25% of the active channel area is island or bank bars with low to no vegetation during winter flows.	>25% of active channel area is island or bank bars with low to no vegetation during winter flows.	Exp		Overall: F R1: P R2: F R3: G R4: VG	F	G
Dynamic Patch Mosaic (DPM) - Birds	[4] Overhanging and bank-edge shrub cover	Little or no bank cover (<10% of banks).	10-25% shrub cover on banks.	**20-33% shrub cover on banks.**	33-50% shrub cover on banks.	Exp		G	F	G

Key Attribute	Indicator	Poor	Fair	Good	Very Good	S[1]	R[2]	Current[3]	Trend[4]	Future[5]
Abundance of food resources	[5] Forest and shrubland winter berry forage	Very little to no berry producing shrubs, comprising <5% of the shrub cover in both forest understories and in shrublands across the reach.	**Berry producing shrubs are 5-15% of the shrub cover with a patchy distribution across the reach.**	Berry producing shrubs are 15-25% of the shrub cover and moderately distributed across the reach.	Berry producing shrubs are >25% of shrub cover and well distributed throughout the reach.	Est		F	MD	VG
Species composition / abundance	[6] Native bird diversity	Losing many species and abundance declining of those that remain.	**Stable number of species; decreasing abundance.**	Moderate increase in the number of species and abundance.	High and stable species richness and abundance; in equilibrium with maximum available natural habitats.	Exp	5	F	MD	G

Key Attribute	Indicator	Poor	Fair	Good	Very Good	S[1]	R[2]	Current[3]	Trend[4]	Future[5]
Native Fish Community										
Landscape Context										
Hydrologic regime - surface water	[1] Spring peak stream flow extent for recruitment	In all reaches, spring peak flows fail to inundate an adequate area of the floodplain for a sufficient duration (>5 days) to get successful fish recruitment.	**In some reaches, spring peak flows inundate an adequate area of the floodplain for a sufficient duration (>5 days) to get successful fish recruitment.**	In most reaches, spring peak flows inundate an adequate area of the floodplain for a sufficient duration (>5 days) to get successful fish recruitment.	In all reaches, spring peak flows to inundate an adequate area of the floodplain for a sufficient duration (>5 days) to get successful fish recruitment.	Exp		Overall: F R1: P R2: P R3: F R4: F	F	G
Hydrologic regime - surface water	[2] Base flows	**River base flow reduction eliminates wetted habitat in many reaches. Fish populations severely impacted; requires major management intervention.**	River base flow reduction reduces wetted habitat and requires active management to sustain existing fish populations.	River base flow reduction has limited effects on wetted habitat; some populations self-sustaining, while some may not be.	River with natural base flows; fish populations not impacted.	Est		Overall: P R1: F R2: F R3: P R4: P	SD	G
Channel stability	[3] Channel river bed status	All reaches degraded to gravel and cobble beds; sediment insufficient to maintain diverse habitats.	**Cochiti reach (R1) degraded and entrenched cobble bed; ABQ reach (R2) partially degraded and entrenched mix of sand and cobble beds; Belen reach (R3) sand bed at equilibrium; San Acacia reach (R4)sand bed aggraded.**	Cochiti reach (R1) degraded and entrenched cobble bed; ABQ reach (R2) and Belen sand bed reaches (R3) at equilibrium with sediment supply; San Acacia sand bed reach (R4) aggraded.	Cochiti reach (R1) partially degraded and entrenched; some sand bed restoration; ABQ, Belen, and San Acacia reaches (R2, R3, and R4) at equilibrium with sediment supply.	Exp		F see ratings descrip-tions for sub-reaches		G

Key Attribute	Indicator	Poor	Fair	Good	Very Good	S[1]	R[2]	Current[3]	Trend[4]	Future[5]
Condition										
Dynamic Patch Mosaic (DPM) - fish	[4] Fish habitat complexity	Little channel habitat complexity (1 habitat feature/river km).	**Some complexity (2-3 habitat features/river km).**	Moderate complexity (4-5 habitat features/river km).	High habitat complexity features, >5 habitat features/river km).	Est		Overall: F R1: P R2: F R3: F R4: F	MD	G
Connectivity among communities & ecosystems	[5] Channel longitudinal connectivity	No possibility of movement over existing barriers between reaches in either direction; major intervention required.	**Upstream movement is impeded between reaches for most species; moderate intervention required.**	Natural and bi-directional movement is physically possible for many species but not all; some intervention required.	Naturally occurring bi-directional movement is unimpeded. Both structural and functional connectivity is realized by the fish community; little or no intervention required.	Exp		F	F	G
Species composition / abundance	[6] Fish community species richness and dynamics	**Continue decline or loss of any more native species (reduction of population abundance, distribution or extirpation). Intensive management required to prevent extinctions.**	Remaining native fish species are still present but require management to be maintained in most reaches, with limited natural recruitment in a few reaches.	Remaining native fish species are present in self-sustaining populations in most reaches, minimal management in a few reaches.	All remaining native fish species present, self-sustaining & maximally distributed. Extirpated native species restored to MRG.	Exp		P	F	G

Key Attribute	Indicator	Poor	Fair	Good	Very Good	S[1]	R[2]	Current[3]	Trend[4]	Future[5]
Wildlife Corridors										
<u>Condition</u>										
Connectivity among communities & ecosystems	[1] River corridor fragmentation and infringement by development and recreation	Little wildlife habitat protection from impacts of development and recreation in the river corridor (<25% of the non-channel area within the levees protected from fragmentation by roads, developed trails, new levees, buildings, & bridges).	**Some wildlife habitat protection from impacts of development and recreation in the river corridor (25-50% of the non-channel area within the levees protected from fragmentation).**	Moderate wildlife habitat protection from impacts of development and recreation in the river corridor (50-75% of the non-channel area within the levees protected from fragmentation).	Extensive wildlife habitat protection from impacts of development and recreation in the river corridor (>75% of the non-channel area within the levees protected from fragmentation).	Est	6	Overall: F R1: P R2: P R3: P R4: F[8]	F	G
Species composition / abundance	[2] Wildlife species richness and dynamics	Wildlife species (not including birds) richness and population numbers declining across all reaches.	Wildlife species richness stable but population numbers declining across most reaches	**Wildlife species richness and population numbers stable.**	Wildlife species richness and population numbers at equilibrium with available natural habitats.	Exp		G	MD	VG

Key Attribute	Indicator	Poor	Fair	Good	Very Good	S[1]	R[2]	Current[3]	Trend[4]	Future[5]
Ditch and Drain Habitat										
Condition										
Vegetation composition and structure	[1] Ditch and drains % cover of perennial vegetation	<25% of ROW with perennial vegetation.	**25-50% of ROW with perennial vegetation.**	50-75% of ROW with perennial vegetation.	>75% of ROW with perennial vegetation.	Exp		F	SD	VG
Vegetation composition and structure	[2] Ditch ROW woody vegetation	<10% woody vegetation in the outer ROWs.	10 -25% woody vegetation in the outer ROWs.	**25-33% woody vegetation in the outer ROWs.**	33-50% woody vegetation in the outer ROWs.	Exp		G		VG
Vegetation composition and structure	[3] Exotic woody cover	>50% of cover is non-native trees or shrubs.	**Between 25% and 50% cover of non-native trees and shrubs.**	Between 10% and 25% cover of non-native trees and shrubs.	Less than 10% cover is non-native trees.	Exp		P		G
Vegetation composition and structure	[4] Ditch noxious weeds	>10% New Mexico Class A & B weeds.	**5-10% Class A & B.**	1-5% Class A & B.	<1% New Mexico Class A & B weeds.	Exp		F		G

[1] S= Ratings Source
Est = Estimated; Exp = Expert Knowledge; Res = Onsite Research

[2] R = Current Indicator Measurement Reference
1= Stream gauge data; 2= GIS analysis of Hink and Ohmart MRG vegetation maps from 2002; 3= Tree ring studies [ages of most trees exceed 50 years because of synchronous reproduction events with channel stabilization with jetty jacks beginning in the 1950s]; 4= Current amount >40% (ERM & MH NHNM); 5 = Hink and Ohmart Transects (HAI, USACE); 6= GIS analysis of ownership: federal wildlife refuges and state parks reflect protection [as of 2014, 34% or 2720 ha out of 7640 ha].

[3] Current = Current Viability Rating
VG = Very Good; G = Good, F = Fair; P = Poor; U = Unknown
Sub-reaches designated R1 through R4, where R1 = Cochiti Division, R2 = Albuquerque Division, R3 = Belen Division, R4 = Socorro and San Marcial Divisions (refer to map on page 3 for locations of divisions).

[4] Trend = Trend in Viability Rating
F = Flat; MD = Mild Decrease; SD = Strong Decrease

[5] Future = Future Desired Rating
VG= Very Good; G = Good

[6] Estimate based on limited mapping

[7] Rated as Very Good but vegetation includes exotic species

[8] Includes tribal lands

APPENDIX C. THREATS ANALYSIS

Threats (i.e., sources of stress) were ranked on a scale of Low to Very High in order to help identify where management actions are most needed. The threats analysis for each conservation target is presented in Table C-1. In the table, each threat is rated in terms of its severity, scope, and irreversibility[25]. The threat magnitude is based on the severity and scope of the threat and the threat rank is based on the magnitude and irreversibility of the threat.

Severity – the level of damage to the conservation target at the site that can reasonably be expected within 10 years under current circumstances.

Very High: The threat is likely to destroy or eliminate the target over some portion of the target's occurrence at the site.
High: The threat is likely to seriously degrade the target over some portion of the target's occurrence at the site.
Medium: The threat is likely to moderately degrade the target over some portion of the target's occurrence at the site.
Low: The threat is likely to only slightly impair the target over some portion of the target's occurrence at the site.

Scope – the geographic scope of impact on the conservation target at the site that can reasonably be expected within 10 years under current circumstances.

Very High: The threat is likely to be very widespread or pervasive in its scope, and affect the target throughout the target's occurrence at the site.
High: The threat is likely to be widespread in its scope, and affect the target at many of its locations at the site.
Medium: The threat is likely to be localized in scope, and affect the target at some of the target's locations at the site.
Low: The threat is likely to be very localized in its scope, and affect the target at a limited portion of the target's location at the site.

Irreversibility – the degree to which the effects of a direct threat can be restored.

Very High: The effects of the threat are not reversible.
High: The effects of the threat are reversible, but not practically affordable.
Medium: The effects of the threat are reversible with a reasonable commitment of resources.
Low: The effects of the threat are easily reversible at a relatively low cost.

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[25] Severity, scope, and irreversibility as defined in The Nature Conservancy. 2007. *Conservation Action Planning Handbook – Developing Strategies, Taking Action, and Measuring Success at Any Scale*. The Nature Conservancy, Arlington, VA.

Table C-1. Threats Analysis: Middle Rio Grande

Target #1 -- Riparian and Wetland Vegetation Communities

Threats	Severity of Threat	Scope of Threat	Threat Magnitude	Irreversibility	Threat Rank
Channelization	Very High	Very High	Very High	Medium	Very High
Dam Operations	Very High	Very High	Very High	Medium	Very High
Housing & Urban Areas	Very High	High	High	Very High	Very High
Wildfire	Very High	High	High	Medium	High
Introduced Species	High	Very High	High	Medium	High
Diversions	High	Very High	High	Medium	High
Habitat Modification	High	Medium	Medium	Medium	Medium
Drought	High	Very High	High	Medium	High
Recreational Activities	Medium	High	Medium	Medium	Medium

Target #2 -- Native Bird Habitat

Threats	Severity of Threat	Scope of Threat	Threat Magnitude	Irreversibility	Threat Rank
Channelization	Very High	Very High	Very High	Medium	Very High
Dam Operations	Very High	Very High	Very High	Medium	Very High
Housing & Urban Areas	Very High	High	High	Very High	Very High
Wildfire	Very High	High	High	Medium	High
Introduced Species	High	High	High	High	High
Diversions	Medium	High	Medium	Medium	Medium
Drought	High	Very High	High	Medium	High
Recreational Activities	High	High	High	Medium	High
Habitat Modification	Very High	High	High	Medium	High

Target #3 -- Native Fish Community

Threats	Severity of Threat	Scope of Threat	Threat Magnitude	Irreversibility	Threat Rank
Channelization	Very High	Very High	Very High	Medium	Very High
Dam Operations	Very High	Very High	Very High	Medium	Very High
Housing & Urban Areas	High	High	High	Very High	Very High
Wildfire	Medium	Low	Low	Medium	Low
Introduced Species	Medium	Very High	Medium	High	Medium
Diversions	Very High	Very High	Very High	Medium	Very High
Habitat Modification	Low	High	Low	Low	Low
Drought	Very High	Very High	Very High	High	Very High
Recreational Activities	Low	High	Low	Medium	Low

Target #4 -- Wildlife Corridors

Threats	Severity of Threat	Scope of Threat	Threat Magnitude	Irreversibility	Threat Rank
Channelization	High	Very High	High	High	High
Dam Operations	High	High	High	High	High
Housing & Urban Areas	Very High	High	High	Very High	Very High
Wildfire	Very High	High	High	Medium	High
Introduced Species	Medium	Medium	Medium	High	Medium
Diversions	High	High	High	Medium	High
Habitat Modification	Very High	High	High	Medium	High
Drought	High	Very High	High	Medium	High
Recreational Activities	Very High	High	High	Medium	High

Target #5 -- Ditch and Drain Habitat

Threats	Severity of Threat	Scope of Threat	Threat Magnitude	Irreversibility	Threat Rank
Channelization	Low	Low	Low	Low	Low
Dam Operations	High	Very High	High	Medium	High
Housing & Urban Areas	High	Medium	Medium	Very High	High
Wildfire	Medium	Low	Low	Medium	Low
Introduced Species	High	High	High	High	High
Diversions	Low	High	Low	Low	Low
Habitat Modification	Very High	High	High	Medium	High
Drought	High	Very High	High	Medium	High
Recreational Activities	Low	Very High	Low	Medium	Low