A report card for the

Upper Rio Grande Basin

THE UPPER RIO GRANDE REGION

The river's seasonal flows affect communities and wildlife

Much of the water that flows through the Upper Rio Grande begins as snow in the Rocky Mountains. Each spring, rising temperatures melt snow, and the meltwater flows into streams and tributaries that feed the Upper Rio Grande. This annual pulse of water has sustained forest, wetland, and brushland ecosystems along the Upper Rio Grande for thousands of years, in addition to a diverse array of mammals and birds. The river has also sustained human settlements for centuries: pre-European Pueblo societies to modern day indigenous tribes and reservations; high-altitude acequia communities; and modern-day rural and urban communities. Today, the Upper Rio Grande's flow is controlled through a network of dams to provide the public with a more consistent supply of water throughout the year. This allows residents to have a reliable source of drinking water, recreational areas, and enough water for farmers to grow their crops; however, growing competition for water and increasingly severe droughts linked to climate change cause the Upper Rio Grande to dry periodically, preventing the flow of water to downstream communities.

Rio Grande streamflow is heavily altered but still sustains important ecological functions

The Rio Grande natural hydrology from its headwaters in Colorado to below Elephant Butte Reservoir is driven by the spring snowmelt runoff, with some short-duration flows in the summer rainy season and low flows during drier times of the year. The magnitude, timing, and duration of these flows are critical to sustain ecological functions including native aquatic and riparian species, like the endangered Rio Grande silvery minnow and the Rio Grande cottonwood and willow forests. The natural spring flow of the river and flows during dry times make up the heartbeat of the river. Water management, infrastructure, water use, and climate change have left these natural flows altered and depleted leading to dry river sections, wetland loss, decreased riparian vegetation, and extinct or absent native fish populations.

Luckily, the first 100 miles of the Rio Grande in Colorado maintain a close to natural flow. At the border between Colorado and New Mexico, the spring flow has been reduced to 16% of what it was over a century ago—leading to degraded riparian vegetation and impaired streams. The river's flow increases in the central part of New Mexico, due to water management, though the river often dries in this area. Things get dramatically more dire below Elephant Butte Reservoir in southern New Mexico, where the natural heartbeat of the river is almost entirely obliterated and native fish and animal species are gone. Further south near Fort Quitman, TX at the border with Mexico, called the "forgotten reach," the flow has flat-lined, and the river here is dry.

Management in each state is supporting the river. In Colorado, the Rio Grande Basin Implementation Plan has made progress toward sustainable water use by identifying projects and methods to meet basin specific needs for different users.

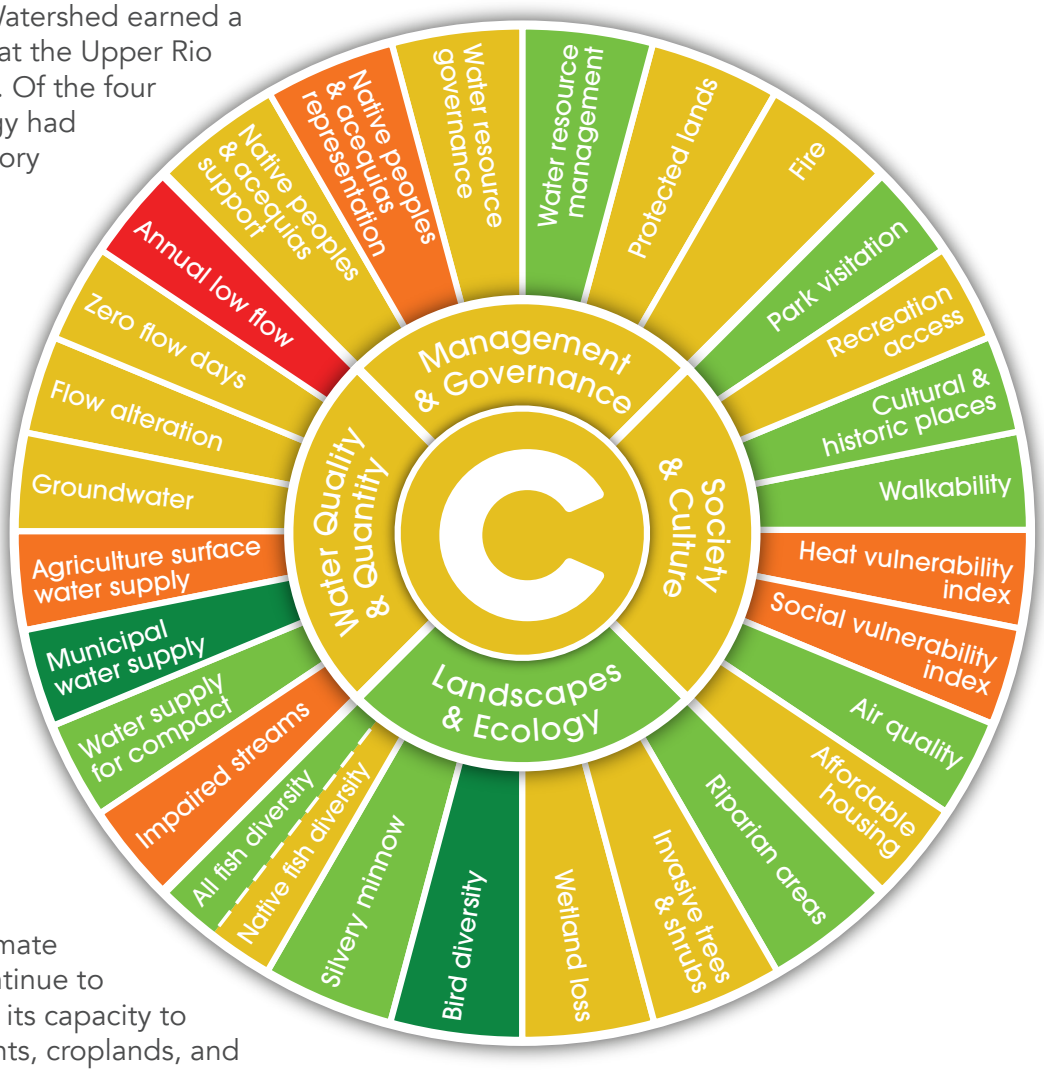
In New Mexico, the coordinated efforts by water management agencies and the Middle Rio Grande Endangered Species Collaborative Program are helping to conserve the Rio Grande silvery minnow. Once the most abundant minnow species in the Rio Grande, the silvery minnow is now absent from 90% of its historical reach and only lives in a 150-mile-long reach in Central New Mexico. The groups participating in this program contribute to the release of flows from temporary storage to keep drying parts of the river wet. By protecting the water needs of the silvery minnow, the Rio Grande in central New Mexico has been kept alive, benefiting the cottonwood trees, birds, and people.

Additionally, in the Lower Rio Grande, there are ongoing efforts to restore the river. The International Boundary and Water Commission is implementing riparian restoration projects at 30 sites. Similarly, the restoration at Rio Bosque Wetlands Park in El Paso shows promise.

Photo by Paul Tashjian

THE UPPER RIO GRANDE BASIN IS IN MODERATE CONDITION

Overall, the Upper Rio Grande Watershed earned a score of 54%, a C. This means that the Upper Rio Grande is in moderate condition. Of the four categories, Landscapes & Ecology had the highest and only good category score, 61%, a B-. The other three categories had moderate scores. Society & Culture scored 57%, a C+. Management & Governance scored 49%, a C. Water Quality & Quantity had the lowest score, 47%, a C.



The lowest scoring indicator was Annual low flow, with 18% (F), a very poor score. The highest scoring indicator was Municipal water supply, with 95% (A+), a very good score. Although Annual low flows are declining, municipalities have still been able to supply residents with adequate water.

While most indicators had B's and C's, four indicators had D's. Human-driven factors such as climate change and land use change continue to stress the Upper Rio Grande and its capacity to provide enough water for residents, croplands, and wildlife. Increasingly severe droughts and wildfires will maintain water stress.

Improvement is urgently needed to ensure that people and wildlife have access to the water and resources they need. Current water resource governance and management are inadequate to equitably distribute water across communities within the Upper Rio Grande. Resilience can be achieved through adaptation.

Despite these many threats, communities and governments within the region are engaged and motivated to work through today's environmental issues for the promise of a more sustainable future.

Grade scale

A

Very Good (100—80%): All indicators meet thresholds. Indicators in these locations strongly support social, economic, and environmental values.

B

Good (79—60%): Most indicators meet thresholds. Indicators in these locations support social, economic, and environmental values.

C

Moderate (59—40%): Some indicators meet thresholds. Indicators in these locations moderately support social, economic, and environmental values.

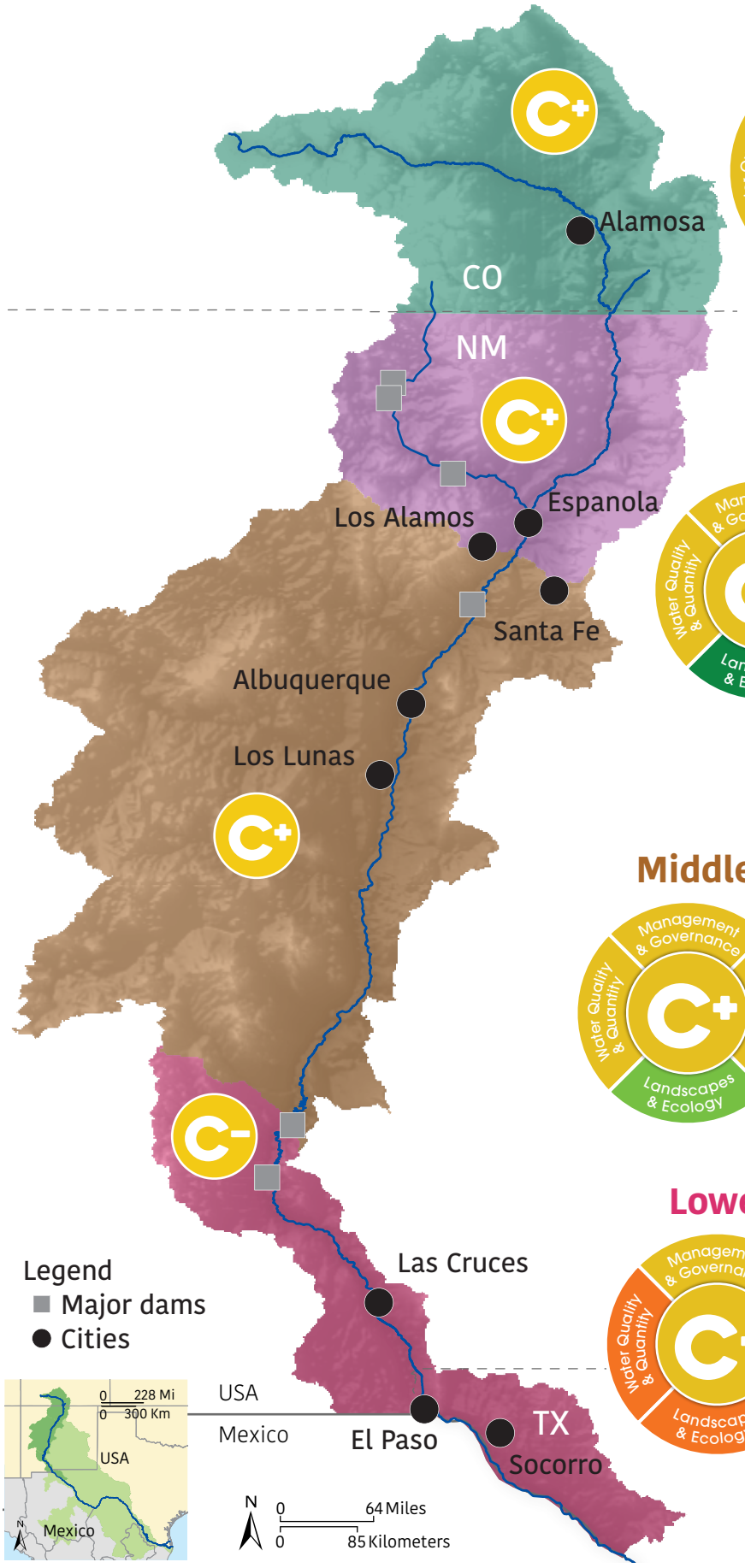
D

Poor (39—20%): Few indicators meet thresholds. Indicators in these locations struggle to support social, economic, and environmental values.

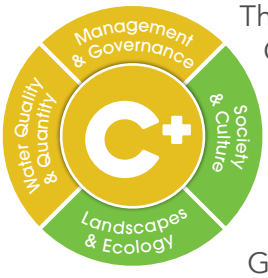
F

Very Poor (19—0%): Very few indicators meet thresholds. Indicators in these locations fail to support social, economic, and environmental values.

Region scores worsen from north to south

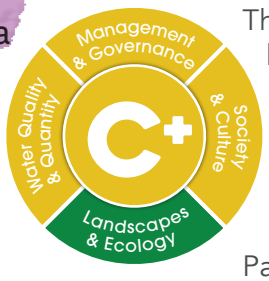


Upper Rio Grande: CO



The Upper Rio Grande: Colorado had a moderate score, 56%, a C+. The highest scoring indicators were Park visitation and Bird diversity. The lowest scoring indicators were Groundwater, Annual low flow, and Social vulnerability index. This region had the best regional Social & Cultural score and the only B-.

Upper Rio Grande: NM



The Upper Rio Grande: New Mexico had a moderate score, 57%, a C+. The highest scoring indicators were Wetland loss, Bird diversity, and Riparian areas. The lowest scoring indicators were Annual low flow, Social vulnerability index, and Park visitation. Overall, this region had the best Landscapes & Ecology score of any region, the only A-. It also had the best Management & Governance score, a C.

Middle Rio Grande

The Middle Rio Grande had a moderate score, 55%, a C+. The highest scoring indicators were Municipal water supply, Bird diversity, and Walkability. The lowest scoring indicators were Annual low flow and Impaired streams. Overall, this region had the best Water Quality & Quantity score of any region, a C.

Lower Rio Grande

The Lower Rio Grande had a moderate score, 41%, a C-. The highest scoring indicators were Municipal water supply and Bird diversity. The lowest scoring indicators were Zero flow days, Fish diversity, and Wetland loss. Overall, this region had the worst scores for Water Quality & Quantity and Landscapes & Ecology of any region, both Ds.

The intimate connection between the river and its people

The Rio Grande is a unique and special river, and its watershed has been a home for people for thousands of years. Native peoples such as Native American tribes, Pueblos, and Spanish acequias have relied on the river for water, food, and shelter. In this region these groups include the Acoma, Apache, Mescalero Apache, Cochiti, Isleta, Ysleta del Sur, Jemez, Jicarilla Apache, Laguna, Nambé, Navajo, Ohkay Owingeh, Picuris, Piro, Pojoaque, Sandia, San Felipe, San Ildefonso, Santa Ana, Santa Clara, Kewa, Taos, Tesuque, and Zia.

The Rio Grande's headwaters are in the Rocky Mountains of Colorado and the river flows through New Mexico, down into Texas and Mexico before emptying into the Gulf of Mexico. The river is ecologically a montane-desert river that has experienced wet and dry cycles periodically over the years.

The range of natural features of the river and the diversity of ecosystems and habitats supports a plethora of plants and wildlife communities. The Rio Grande is one of the five longest rivers in the US, and is an American Heritage River and a Wild & Scenic River. Major challenges for the river are droughts, climate change, and population pressure.

People enjoy canoing on the river, by Paul Tashjian.

Report cards and models assess basin health

The resilient rivers approach of using report cards with scenario modeling is a novel method to better inform resource management. Watershed report cards are powerful tools used around the world to describe ecosystem status, increase public awareness, and inform and influence decision makers to act to improve the health of a watershed. This is the first Upper Rio Grande Watershed Report Card, and it reflects the collective effort of more than a hundred stakeholders that manage land, water, and wildlife in the Upper Rio Grande watershed. Several categories of indicators were selected to evaluate the overall health of the watershed: Water Quality & Quantity, Social & Cultural, Management & Governance, and Landscapes & Ecology. Status of indicators within these categories was evaluated by comparing data to scientifically-derived thresholds or goals. Each region score is area-weighted or population-weighted to attain the overall Upper Rio Grande Watershed score. A scenario modeling approach of examining hydro-economic-ecological variables under different scenarios called Freshwater Resilience by Design, assesses climate vulnerabilities and tests how different actions could impact the basin at large. These scenarios provide a series of alternative paths for the future of the basin and recommendations for which actions can best raise the grade and mitigate threats to the system like climate change and population growth. This 7-step process is illustrated below.

1	2	3	4	5	6	7
CONCEPTUALIZE	MEASURE	GRADE	MODEL	FORECAST	ACT	IMPROVE
Define the system	Assess status of the system		Develop & implement management options			Build resilience

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Indicators help us measure basin health

Management & Governance

Native peoples and acequias representation examines whether indigenous communities can equitably participate in water management.

Water resource governance examines if people think water resources are being governed effectively.

Protected lands examines areas of protected lands in the basin to meet the goal of 30% protection by 2030.

Native peoples and acequias support considers the level of government and state funding for tribal nations, Pueblos, and acequias.

Water resource management examines citizen perception of water resource management.

Fire measures preventative burn treatments for forests with potential fire impact.

Water Quality & Quantity

Annual low flow examines the mean flow of the driest 7-day period in any given year.

Flow alteration assesses the current flows alteration compared to the historic natural flows.

Municipal water supply scores the trend in domestic water use per capita.

Groundwater analyzes the change in water level for aquifers in the basin.

Zero flow days analyzes the number of days when perennial streams or the river are dry.

Agriculture surface water supply evaluates the surface water delivered to agricultural users.

Impaired streams is the streams deemed impaired by the EPA compared to unimpaired streams.

Water supply for compact evaluates if states meet the compact between NM, CO, and TX.

Society & Culture

Cultural & historic places examines if people think cultural and historic sites are being respected and maintained.

Social vulnerability index measures how vulnerable a community is to hazardous events.

Affordable housing assesses the amount of income spent on housing.

Air quality assesses air pollutants such as ozone and nitrogen oxide.

Park visitation scores the number of state and national park visitors from the most recent year against visitation from previous years.

Walkability assesses if people in urban areas can walk to a park in 10 minutes.

Heat vulnerability index measures climate-safe neighborhoods, including tree canopy, impervious surface, temperature, and poverty.

Recreation access examines if people think public access to outdoor recreation is adequate.

Landscapes & Ecology

Silvery minnow assesses the last remaining population, which only occurs in the Middle Rio Grande, by looking at the catch per unit effort per river length.

Invasive trees and shrubs assesses riparian area of native versus non-native trees and shrubs.

Fish diversity calculates the Simpson's Diversity Index for native fish species and all fish species in the region.

Bird diversity calculates the Simpson's Diversity Index for all bird species in the region.

Riparian areas calculates the loss of riparian vegetation area compared to the historic area.

Wetland loss calculates the net loss of wetland habitat.

SCENARIO MODELING HELPS US MAKE

A scenario model informs water planning

For this project, a digital computer model was created including data about hydrology, ecology, and economics of the river basin. The model runs a simulation of hydrology, infrastructure, agriculture, and municipal processes from the headwaters in Colorado to Fort Quitman in Texas. The model includes data on the natural hydrology in the headwaters, infrastructure operations (including the policies that guide them), and agricultural and municipal water uses that divert and return water along the river. The model is used to determine how conditions could be in the future and can forecast how indicators could change with changing rainfall and temperatures. Based on the results, decision makers can manage the river for the best possible outcomes and improve conditions overall.

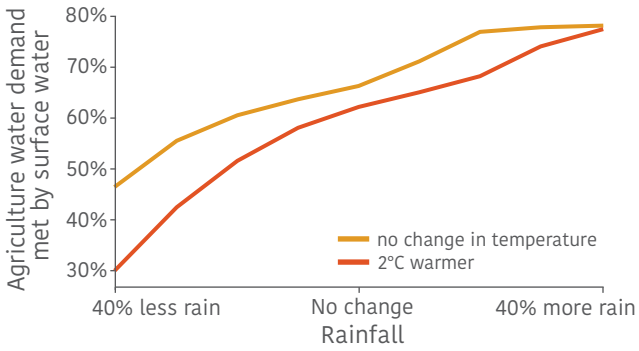
Projected climate change worsens basin indicators

This model analyzes the possible impacts of climate change for key indicators in the Rio Grande like surface water supply for agriculture, inflow to Elephant Butte reservoir (water supply for Compact), and annual low flow (at San Marcial). Climate change anticipates temperatures that are about 3° Celsius (5.4° Fahrenheit) warmer by 2050 and variable precipitation changes. These climate changes have a significant effect on Rio Grande indicators. Both warming temperatures and declining precipitation pose challenges to the basin's health. The model showed that managers should focus adaptation efforts on these areas to raise the grade and improve basin health.

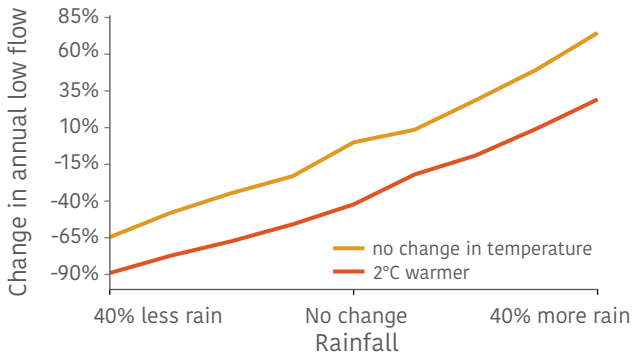
The projections for the surface water supply for agriculture indicator show high sensitivity to climate change (top graph). Irrigation for agriculture is an important water use in the Rio Grande and changes in water demand are a real challenge to current water management. The model shows that in the Middle Rio Grande Conservancy District, warmer temperatures are causing less surface water to be available for agriculture. This is the case whether there is more or less precipitation.

For annual low flow, there is also less flow with increased temperatures (middle graph). With conditions where precipitation is 40% less, there will be almost no flow under future climate projections. The inflows to Elephant Butte are related to the water supply for compact indicator. Similar to the annual low flow results, there is less water with higher temperatures and less water with decreased precipitation (bottom graph). Overall, less water will cause indicators to decline unless sufficient management options are in place.

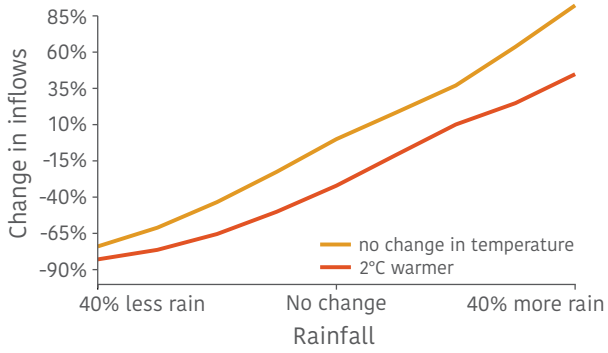
Future surface water for agriculture in the Middle Rio Grande



Future change in annual low flow at San Marcial



Future change in inflows to Elephant Butte Reservoir



Modeling results showing potential future changes in water indicators.

DECISIONS ON WATER MANAGEMENT

Potential management options for the future

There are management options or actions that can be taken to mitigate the impact of climate change and improve conditions in the Rio Grande. Several options show promise for maintaining flows in the Rio Grande. The table below indicates the effect of these options on basin health indicators.

	Water supply for Compact	Annual low flow	Near-zero flow days	Spring pulse (Flow days > 1500cfs)	Agricultural water supply (MRGCD)	Agricultural water supply (EBID)	Municipal water supply (Albuquerque)
Baseline (current status)							
Reduce irrigation losses	↑	↑	↑	↑	↑	↑	—
Fallow agricultural land	↑	↑	—	↑	↓	—	—
Reduce municipal water demand	—	—	—	↑	—	—	↓
Maintain minimum ecological flows	↑	↑	↑	↑	—	—	—

Colors indicate improvement (dark blue), some improvement (light blue), and decline (orange) in water indicators for each management option. Gray shows no change.

Reduce irrigation losses: This option simulates improvements in the irrigation conveyance system that delivers water to the Middle Rio Grande Conservancy District (MRGCD) farms. Reduced water use is quantified and returned to the river for environmental purposes.

Fallow agricultural land: For this option, a fraction of the total farmland is taken out of production for the simulation period. A range of specific fractions is simulated for the MRGCD, from 5% to 25%. Reduced water use is quantified and returned to the river for environmental purposes.

Reduce municipal water demand: In this option, small reductions in the quantity of water diverted for the Albuquerque County Water Authority are implemented. A range of cuts are simulated, from 10% to 30%. Reduced water use is quantified and returned to the river for environmental purposes.

Maintain minimum ecological flows: In this option, a condition to maintain flows of at least 50cfs at San Acacia is implemented as a proxy for maintaining dry period flows in the Middle Rio Grande for the Rio Grande Silvery Minnow and other ecosystem benefits.

Laser leveling and GPS guided tractors reduce irrigation losses in the Middle Rio Grande Conservancy District, by Enrique Prunes.

Other options are being explored, including re-operation of reservoirs to reduce evaporative losses from downstream storage and improving spring river flows. All options will be evaluated to identify an optimal portfolio of investments that can reduce vulnerabilities in the Rio Grande and contribute to basin resilience.

COLLECTIVE ACTION IS NEEDED

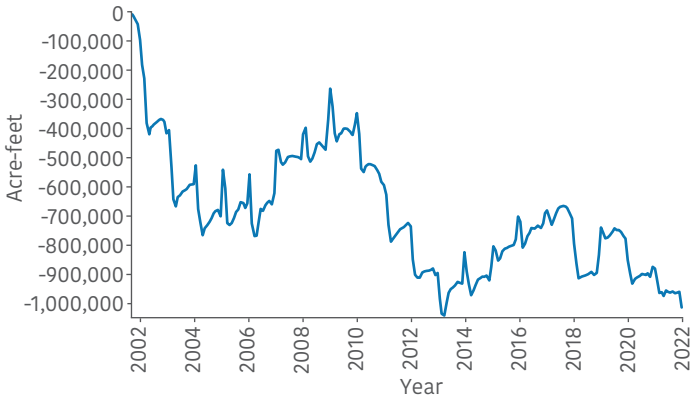
Agricultural water supplies running thin

Much of the southwest has been in the grips of a record-breaking 'megadrought' since 2000. Farmers along the Rio Grande in Colorado and New Mexico have been struggling to make due with less water.

New Mexico receives a portion of Rio Grande's water each year, as set by the Rio Grande Compact, an interstate water sharing agreement. With reduced water flowing into the state from Colorado, irrigation deliveries to farms in both the middle and the southern parts of the state are diminished by early summer. Elephant Butte Reservoir in southern New Mexico—which could store water to irrigate nearly 200,000 acres—has been nearly dry in recent years. This is due not only to the drought but also to ongoing aridification of the basin.

Upstream in the San Luis Valley of Colorado, the water level of a massive aquifer underlying the valley has plummeted as climate change reduces groundwater recharge. Facing the threat of having their wells shut down by the state engineer, farmers formed a water management district and a plan to pay participating farmers to leave their cropland unplanted. Rising aquifer levels during 2013–2018 brought great hope for management success, but the unrelenting and intensifying drought in recent years has erased optimism. However, increasing creative efforts to manage water use can bolster the positive impact of already ongoing actions.

Aquifer storage decreasing over the past twenty years



Unconfined aquifer levels in the San Luis Valley have plummeted in recent decades due to less groundwater recharge and continued heavy pumping during the current drought. Graph from Rio Grande Conservation District.

Southwestern willow flycatcher thriving but still needs support

The southwestern willow flycatcher is an endangered subspecies found in the southwest US, including in Colorado, New Mexico, and Texas. This bird requires native plant-based habitats and does not thrive where invasive species like saltcedar are dominant. In the Middle Rio Grande, the flycatcher is common during migration in the spring and fall and breeds in willow-dominated riparian areas. The number of flycatcher-preferred territories in the Middle Rio Grande has greatly increased since 2000.

Both the Elephant Butte and Middle Rio Grande management units are meeting the recovery goals for flycatcher territories. This is quite promising and shows that protecting flycatcher preferred habitats is working. The Middle Rio Grande management unit has exceeded its recovery goal of 100 flycatcher territories for the past 18 consecutive years. However, ongoing threats of native habitat decline, reliance on non-native saltcedar, tamarisk beetles, variable nest success, and dynamic reservoir elevations at Elephant Butte indicate this management unit requires continued monitoring and investigation to support the flycatcher and its habitat.

Southwestern willow flycatcher and nest, by Scarlett Howell.

NOW TO CONSERVE THE RIVER

Regional water management reflects a diverse and complex network of governance

The river supports an overwhelming magnitude of competing uses, from agriculture and domestic uses to use by fish, wildlife, and plant communities. However, there is no single authority for management of the Rio Grande—federal, state, and local organizations have authority in different cases.

The cultural importance of water to Rio Grande communities contributes to the resilience of the Rio Grande Basin. Generally, farming is not corporate, there are many acequias with their own local governance and the Pueblos and Tribes use the river for religious ceremonies and farming. In the headwaters the river still flows almost un-impounded except for at Cochiti Dam on the mainstem until the Elephant Butte Reservoir. Irrigation structures are mostly rudimentary with some exceptions.

Over time, the government approach to farming changed the nature of the river below Elephant Butte. Concerning the headwaters, they are under threat due to fires, less snowmelt, and reduction in winter precipitation. Water is the lifeblood of the Upper Rio Grande, the lack of it and the importance for survival are not lost on the people that live here.

Acequias and Native American communities are important water managers, have a deep understanding of the river, and their water rights are senior. Coping with water shortages through reservoir storage may threaten the survival of traditional acequia-focused culture and communities in Colorado, New Mexico, and Texas. The Rio Grande Compact between these three states is an agreement on how much water each should receive. Its goals are to remove present and future controversy among the states and equitably divide the water allocated. The river below Cochiti Dam is heavily managed and there is work occurring to manage the system for many needs but metrics are not yet there to guide new management approaches. There are some conflicts between management groups, and not all groups feel that they have a seat at the table. In the end, there is not enough water for all the people and places where it is needed.

Left: Rio Grande in Colorado, by Paul Tashjian; Right: Cochiti Dam, by Grendelkhan, CC BY-SA 3.0 <https://creativecommons.org/licenses/by-sa/3.0>, via Wikimedia Commons.

You can help—every action makes a difference

Monitor and minimize your water use

Most water indicators score poorly across the region. Although municipal water supply scores fairly well, any water withdrawal impacts indicators across the wheel—including groundwater supply and animal diversity. To minimize your impact and safeguard continued water availability, don't use more water than necessary.

Advocate for collaborative water management

Survey participants indicated that indigenous communities and tribal nations are not adequately represented in water management and planning. You can address this by learning how water is managed and contacting water resource managers and government representatives to advocate for a collaborative approach to water management.

Remove invasive trees and shrubs

Invasive plants use resources needed by native plants, crowding them out. This destroys habitat and food sources that wildlife rely on. Many volunteer groups hold invasive species removal events to tackle this problem. Join one of these efforts, or commit to removing invasives and planting only native species on your own property.

Dry riverbed (top), by Audra Melton. Acequia near Las Trampas, NM, (middle) by David Groenfeldt. Invasive Russian Olive (bottom), by Paul Tashjian.

Acknowledgments

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Cover photo by Paul Tashjian.

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