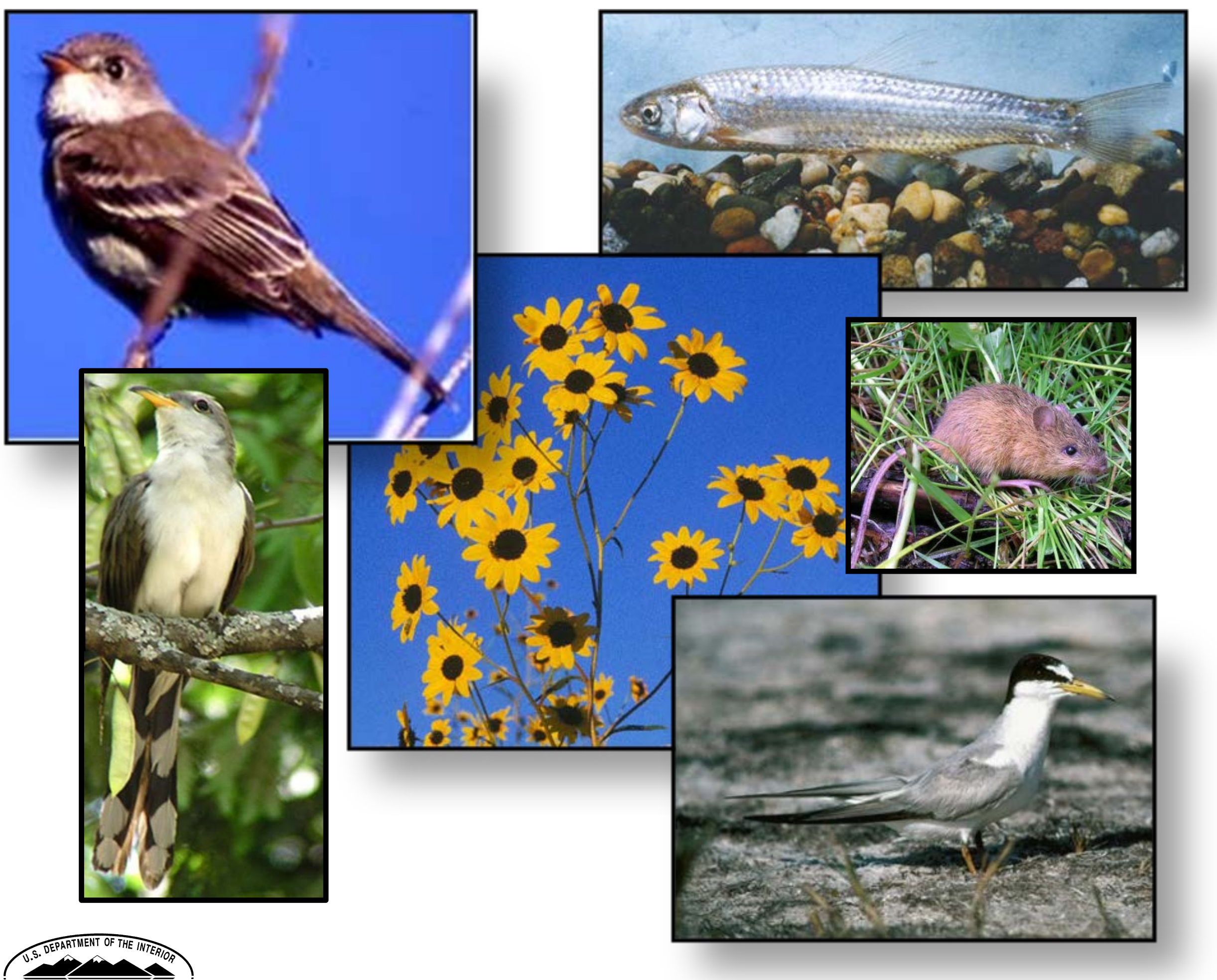
RECLAMATION

*Managing Water in the West*

# Joint Biological Assessment

## Bureau of Reclamation, Bureau of Indian Affairs, and Non-Federal Water Management and Maintenance Activities on the Middle Rio Grande, New Mexico

**Middle Rio Grande Project, New Mexico**
**San Juan-Chama Project, New Mexico**
**Upper Colorado Region**



**U.S. Department of the Interior**
**Bureau of Reclamation**

**August 2015**

# Mission Statements

The U.S. Department of the Interior protects America's natural resources and heritage, honors our cultures and tribal communities, and supplies the energy to power our future.

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

The Bureau of Indian Affairs' mission is to enhance the quality of life, to promote economic opportunity, and to carry out the responsibility to protect and improve the trust assets of American Indians, Indian tribes and Alaska Natives.

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## Part I – Action Area and Species-Related Information

**Middle Rio Grande Project, New Mexico**
**San Juan-Chama Project, New Mexico**
**Upper Colorado Region**

**Submitted to the U.S. Fish and Wildlife Service**

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|---|---|
| **Rio Grande Silvery Minnow** | **Southwestern Willow Flycatcher** |
| **Yellow-billed Cuckoo** | **New Mexico Meadow Jumping Mouse** |
| **Pecos Sunflower** | **Interior Least Tern** |

**U.S. Department of the Interior**
**Bureau of Reclamation**

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# 1. Introduction

## 1.1 Biological Assessment Content and Scope

Section 7(a) (2) of the Endangered Species Act (ESA) requires federal agencies to consult with the U.S. Fish and Wildlife Service (Service) over any discretionary actions that the agency authorizes, funds, or carries out, to ensure that those actions are not likely to jeopardize the continued existence of a listed species or result in the destruction or adverse modification of critical habitat (50 Code of Federal Regulations [CFR] 402.01). The Bureau of Reclamation (Reclamation) and Bureau of Indian Affairs (BIA), along with the State of New Mexico (the State) and the Middle Rio Grande Conservancy District (MRGCD) as non-federal members of the Middle Rio Grande Endangered Species Collaborative Program (Collaborative Program), are initiating a new consultation to obtain compliance with sections 7 and 9 of the ESA for water management actions described in this joint biological assessment (BA) and undertaken in and affecting the Middle Rio Grande (MRG) that may have ESA implications.

This BA analyzes water management effects on listed species in the project area: the Rio Grande silvery minnow (*Hybognathus amarus)* (silvery minnow), the Southwestern willow flycatcher (*Empidonax traillii extimus)* (flycatcher), the yellow-billed cuckoo (*Coccyzus americanus)* (cuckoo), the New Mexico meadow jumping mouse (*Zapus hudsonius luteus)* (jumping mouse), the Pecos sunflower (*Helianthus paradoxus),* and the interior least tern (*Sternula antillarum athalassos*) (tern). The bald eagle (*Haliaeetus leucocephalus*) was removed from the federal list of threatened and endangered species in August 2007, and is therefore not considered in this BA. There is no requirement to discuss delisted species in an ESA consultation; however, activities conducted in the course of water management will be carried out in accordance with the Bald Eagle Protection Act and the Migratory Bird Treaty Act.

Reclamation and its non-federal partners are also consulting on the programmatic aspects of river and infrastructure maintenance and restoration activities as part of this ESA section 7(a)(2) process. Collectively in this BA, the term "river maintenance" is used to represent these river and infrastructure maintenance and restoration activities, as described in Part III.

### 1.1.1 Scope of Consultation Compared to 2003 BO

The approach to this consultation differs in several ways from the approach of the 2003 consultation, which resulted in the March 17, 2003 Biological Opinion[1] (2003 BO). In the 2003

[1] 2003 Biological and Conference Opinions on the Effects of Actions Associated with the Programmatic Biological Assessment of Bureau of Reclamation's Water and River Maintenance Operations, U.S. Army Corps of Engineers Flood Control Operation, and Related Non-Federal Actions in the Middle Rio Grande, New Mexico. U.S. Fish and Wildlife Service, Albuquerque, New Mexico.

consultation, Reclamation and the U.S. Army Corps of Engineers (Corps) prepared a joint BA, which used a total river depletions-based analysis that looked only at the amount of water not reaching the species and critical habitat. It did not examine each action taken, the effect of discrete actions, or the extent of discretion exercised by each entity. As a result of this undifferentiated view of depletions, incidental take coverage was extended to most federal and non-federal MRG activities without evaluating the individual impacts associated with those activities.

At the time of the previous MRG consultation, the scope of federal discretionary authority was uncertain, pending a decision from the Tenth Circuit Court of Appeals in *Rio Grande Silvery Minnow* v. *Bureau of Reclamation*. The 2003 BA proposed several measures that the federal agencies (Reclamation and the Corps) could take to avoid jeopardy to the silvery minnow, depending on the court's determination. Then, in December 2003, Congress enacted a rider to the 2004 Energy and Water Development Appropriations Act, which placed San Juan-Chama Project (SJC Project) water beyond Reclamation's discretionary reach for ESA purposes (Section 1.2.1). This meant that Reclamation could no longer use SJC Project water to enhance flows in the Rio Grande for the benefit of listed species, namely the silvery minnow. Additionally, in 2010, the Tenth Circuit Court ordered that all prior rulings of the district court regarding the litigation be vacated, which included all of the lower courts' holdings regarding the scope of Reclamation's discretionary authority (601 F.3d 1096). In its opinion, the Tenth Circuit Court stated that the 2003 consultation was based on the "effects of total river depletions on listed species, without identifying particular aspects of the overall actions as 'discretionary or nondiscretionary'" and further found this approach to be incorrect[2].

To comply with the opinion of the 10th Circuit Court and to more fully meet the requirements of section 7(a)(2) of the ESA, for this BA Reclamation set out to more specifically identify and describe each of its actions, and the actions of non-federal members of the Collaborative Program that are included in this BA. Reclamation parsed its discretionary actions related to the Middle Rio Grande Project (MRG Project or the Project) from the actions within the MRGCD's authority. Reclamation determined that the owners of the natural flow rights have a property right to use the MRG Diversion Dams to divert their water rights under the 1951 Repayment Contract.

[2] This 2013 Biological Assessment and its revisions contain Reclamation's characterizations of the historical context concerning prior consultations, the history of ESA litigation in the MRG, prior holdings of the federal courts, and the reasons for using the action-by-action approach for proposed actions and their effects. It is acknowledged that the BA Partners do not agree with all of those characterizations.

### 1.1.2 Scope of Consultation Related to San Juan Chama Project

Reclamation's proposed operation of the SJC Project, as described in this BA, includes only the release of SJC water from Heron Reservoir, the storage and release of SJC water from El Vado Reservoir, and MRGCD storage and release of SJC water in Abiquiu. Due to the beneficial effects from these actions for listed species and critical habitat, and the absence of adverse effects, Reclamation would not normally include these actions in a request for formal consultation. However, Reclamation is requesting informal consultation from the Service on SJC actions in the BA as part of the larger programmatic consultation for convenience and efficiency, and to provide a more holistic view of management actions in the basin.

## 1.2 Overview of Project Components

This section provides background information on the SJC Project and the MRG Project; this information is necessary to identify the nature and limitations of both Reclamation's discretionary actions and non-federal actions. The project components in this BA are covered fully in Parts II, III, and IV. Part II of this BA describes the proposed actions and effects of water operations covered in this BA. Part III of this BA describes the proposed actions and effects of river and infrastructure maintenance and restoration covered in this BA, including Appendix A, which specifically addresses Delta Channel maintenance activities. Part IV of this BA addresses the conservation measures and beneficial actions undertaken to offset adverse effects and meet obligations under ESA sections 7(a)(2) and 7(a)(1). This overview section provides background information relevant to those sections of this BA. Part V of this BA provides the summary species determinations for the proposed actions and several procedural considerations related to the programmatic consultation.

### 1.2.1 The San Juan-Chama Project

Reclamation's SJC Project provides water for use in the Rio Grande Basin in New Mexico. The firm yield[3] of the SJC Project is limited by statute to 96,200 acre-feet per year (AFY), which provides Supplemental Water supplies for various communities and irrigation districts in the MRG.

Reclamation maintains this water in a Project pool at Heron Reservoir; depending upon the available supply, Reclamation allocates the water to contractors on January 1 of each year. The releases from Heron for SJC Project contractors are limited by statute and contract.

[3] Firm yield is the amount of water that can be provided by a basin and reservoir system with reasonable certainty each year.

This influx of water into the Rio Grande Basin is allowed because Congress authorized the SJC Project in 1962 (Public Law 87-483), which amended the Colorado River Storage Project Act of 1956 (Public Law 84-485) to allow diversion of a portion of New Mexico's allocation of Colorado River Basin water into the Rio Grande Basin of New Mexico. The SJC Project water must be beneficially consumptively used in New Mexico.

#### *1.2.1.1 Heron Dam and Reservoir*

Heron Dam and Reservoir (Heron) is located on Willow Creek in northern New Mexico; it was built in the late 1960s and is the principal storage reservoir for SJC Project water from the San Juan River system of the upper Colorado River Basin. Only imported SJC Project water may be stored in Heron Reservoir, requiring all native flows to be bypassed; therefore, Rio Grande Compact requirements do not apply to Heron operations.

Contractors take possession of the water at the outlet works of Heron Dam upon release, and are required to take delivery of their annual allotment by December 31 unless a waiver for delivery in the subsequent year is authorized. Carryover storage across multiple years is not currently authorized at Heron Reservoir; therefore, water not used by the required date reverts to the SJC Project pool.

#### *1.2.1.2 Nondiscretionary Duties and the Minnow Rider*

Reclamation has discretion over the timing of releases of SJC Project water to the extent that those releases are consistent with the contractors call for water. Reclamation has the following nondiscretionary duties with the respect to Heron Reservoir:

- Meet contract obligations within the SJC Project firm yield to contractors, consistent with calls from contractors regarding timing and volume of releases.
- Maximize storage to yield sufficient water to fulfill contracts in current year and out-years.
- Keep within a safe storage amount of approximately 401,000 acre-feet (AF).

In 2004, Congress enacted legislation that limited Reclamation's discretion to use SJC Project water for ESA purposes (Public Law 108-447). Section 208(a) of the legislation states:

> "Reclamation, may not obligate funds… and may not use discretion…to restrict, reduce, or reallocate any water stored in Heron Reservoir or delivered pursuant to SJC Project contracts…to meet the requirements of the Endangered Species Act, unless such water is acquired or otherwise made available from a willing seller or lessor and the use is in compliance with the laws of the State of New Mexico…."

While not challenged directly, the Tenth Circuit Court of Appeals construed the statute as a permanent bar to nonvoluntary use of SJC Project water for ESA purposes, which is a significant restriction in Reclamation's discretion over the use of SJC Project waters[4].

### 1.2.2 The Middle Rio Grande Project, Including the MRGCD

The MRG Project consists of El Vado Dam and Reservoir on the Rio Chama, and the Diversion Dams on the mainstem Rio Grande, which are used to divert water and deliver it to lands within the MRGCD service area, including lands of the Six MRG Pueblos. Reclamation owns and operates El Vado Dam and Reservoir and owns the Diversion Dams; however, MRGCD operates and maintains the Diversion Dams, as well as the delivery infrastructure and riverside drains and wasteways. The owners of the natural flow rights have a property right to use the MRG Diversion Dams to divert their water rights under the 1951 repayment contract.

#### *1.2.2.1 The History of the MRG Project*

Irrigated agriculture in the MRG dates back to the Pueblos' diversion of the waters of the Rio Grande for irrigation and other purposes. Spanish colonists utilized a system of pre-existing acequias during the 17th and 18th centuries. Irrigated agriculture further expanded during the 19th century. However, during the first half of the 20th century the habitability and agricultural productivity of the MRG Valley declined because of inefficient water delivery, poor drainage, and frequent floods. The MRGCD was formed to address these problems in a comprehensive manner.

In 1923, the New Mexico legislature passed the Conservancy Act (New Mexico [NM] Stat. Section [§] 73-14-1 through 73-19-5), which provided the legal framework for the organization and operation of conservancy districts throughout the State. On August 26, 1925, pursuant to that law, New Mexico's District Court approved the organization of the MRGCD, which is a quasi-governmental entity with established geographic boundaries, a publicly elected board of directors, and specific powers and authorities, including the power to make assessments within its boundaries for services. One of its purposes was to rehabilitate existing irrigation systems and to consolidate the river headings of approximately 80 independent acequia associations into a more efficient and manageable system. MRGCD originally combined these headings into six locations, later reduced to four diversions off the Rio Grande. In addition, a system of drains and wasteways was created to return unused water back to the Rio Grande, eliminating water logging and alkali problems that had plagued the early acequia systems.

MRGCD's plan to reclaim land and provide a more stable water supply in the MRG included the construction of drainage and irrigation works, levees for flood control, and El Vado Dam and

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[4] *Rio Grande Silvery Minnow v. Bureau of Reclamation*, 601 F.3d 1096, 1108 (10th Cir. 2010)("The 2003 minnow rider placed the San Juan-Chama water beyond Reclamation's discretionary reach").

Reservoir. The geography of the MRG Valley is such that the lands of the Six MRG Pueblos are interspersed between non-Indian lands. Therefore, engineering logistics and the need for rights of way on Pueblo lands required that MRGCD include the Pueblos in its plan to reclaim the valley. Additionally, because the project would benefit those Pueblos, MRGCD sought a contribution of construction costs, as well as future operation, maintenance, and betterment (OM&B) works costs from the United States on behalf of the Pueblos.

Congress passed the Act of March 13, 1928 (1928 Act) (45 Stat. 312) to support the Conservancy Project, authorizing the U.S. government to enter into an agreement with MRGCD to provide conservation, irrigation, drainage and flood-control works for the Pueblo lands within the conservancy district. The 1928 Act recognizes and acknowledges Pueblo water rights for:

1. Lands that were irrigated at the time whose water rights were "prior and paramount to any rights of the district or any property holder therein"
2. Lands designated "newly reclaimed" that were not under production at the time of the 1928 Act

The 1928 Act also states that "water rights for the newly reclaimed lands shall be recognized as equal to those of like district lands and be protected from discrimination in the division and use of water." Pursuant to the 1928 Act, the BIA and the MRGCD entered into an agreement (the 1928 Agreement) whereby MRGCD agreed to construct works and provide conservation, irrigation, drainage and flood-control works on Pueblo lands. Congress's subsequent Act of August 27, 1935 (49 Stat. 887) (1935 Act) requires the MRGCD to recognize the prior and paramount water rights for the Pueblos' lands and obligated the MRGCD to provide OM&B work for such lands free of charge. The 1935 Act also provided that the newly reclaimed lands would bear a proportional share of costs for operation and maintenance. A subsequent 1936 agreement between the Secretary of the Interior and the MRGCD solidified the 1935 Act by MRGCD's agreement to perform OM&B services within Pueblo lands and to be paid for those services on newly reclaimed lands.

Beginning in 1930, the MRGCD created drains, levees, and diversion dams, consolidated the irrigation network through a system of new main and lateral canals, and built El Vado Dam and Reservoir on the Rio Chama. In 1935, construction was effectively completed, and El Vado Reservoir began operating. However, after construction, MRGCD had difficulty raising tax revenue in the agricultural valley struggling under the Great Depression. Catastrophic flooding in 1941 and 1942 destroyed the ability of the Rio Grande to efficiently transport water to Elephant Butte Reservoir. Coupled with a series of dry years following the flooding, New Mexico fell into a debit status on its obligation to deliver a portion of Rio Grande water to Texas under the Rio Grande Compact. In 1947, Reclamation and the Corps completed a comprehensive plan intended to improve and stabilize the Rio Grande through the MRG and to facilitate Rio Grande Compact deliveries to Texas. This plan included dams for flood and sediment control, rehabilitation of the MRG Valley's irrigation and drainage system, and extensive river channelization works. Congress authorized the recommended plan in the Flood Control Acts of 1948 and 1950 (Public Law 80-858; Public Law 81-516). Congress authorized the Corps to construct flood control reservoirs and levees for flood protection, and authorized Reclamation to undertake the rehabilitation of the Conservancy Project and maintenance of the river channel, and to pay off outstanding MRGCD bond indebtedness.

In exchange for rehabilitating its project and paying its debts, MRGCD entered into a repayment contract with Reclamation in 1951 (1951 Contract), whereby it agreed to convey to the United States title to MRGCD's "works" and its storage permit at El Vado. [5,6] The 1951 Contract confirmed MRGCD's obligation for OM&B of the MRG Project for the Pueblos and authorized Reclamation to eventually relinquish OM&B duties associated with the Diversion Dams to the MRGCD. In the 1970s, Reclamation fulfilled its statutory requirement under Reclamation law to transfer OM&B duties associated with project irrigation works to the owners of the lands irrigated, by transferring OM&B duties associated with the Diversion Dams to the MRGCD.[7] Reclamation exercised its statutorily authorized discretion to retain the OM&B duties associated with storage and release of water at El Vado, but MRGCD became obligated to pay for those services.

#### *1.2.2.2 El Vado Dam and Reservoir*

MRGCD initiated construction of El Vado Dam in 1929 and completed it in 1935. Reclamation operates El Vado Dam and Reservoir pursuant to the 1951 contract with the MRGCD. The total maximum storage of El Vado Reservoir is about 196,000 AF, though sediment and operational restrictions have reduced its effective capacity to about 180,000 AF. El Vado is used to store native Rio Grande and SJC Project water for MRGCD and to store native flows to ensure that there is sufficient prior and paramount water for the lands of the Six MRG Pueblos pursuant to the *Agreement: Procedures for the Storage and Release of Indian Water Entitlement of the Six Middle Rio Grande Pueblos*, approved by the Secretary of the Interior December 28, 1981, (1981 Agreement) (discussed below). MRGCD is not a party to the 1981 Agreement. When

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[5] Section 6 of the Reclamation Act of 1902 states: "title to and the management and operation of the reservoirs and the works necessary for their protection and operation shall remain in the Government until otherwise provided by Congress." (32 Stat. 389)

[6] Paragraph 13(e) of the 1951 Contract, obligates the MRGCD to pay OM&B costs associated with the Pueblos' newly reclaimed lands if Congress fails to appropriate sufficient funds to cover the costs.

[7] Section 6 of the Reclamation Act of 1902 (32 Stat. 389) states: "when payments required by this Act are made for the major portions of the lands irrigated from the waters of any of the works herein provided for, then the management and operation of…irrigation works **shall** pass to the owners of the lands irrigated." See the August 24, 2011, Memorandum from the Regional Solicitor, Intermountain Region, to the Regional Director, Bureau of Reclamation, Upper Colorado Region (finding that Acts of Congress subsequent to the 1902 Act have not altered the requirement that irrigation districts take over operation and maintenance of the project's "irrigation works" once the users have made the required payments to Reclamation).

space is available, Reclamation and MRGCD may store SJC Project water in El Vado Reservoir for other users and other purposes. Storage of large volumes of SJC Project water may take place for extended periods of time.

Consistent with Article XVI[8] of the Compact, water is stored in El Vado each year regardless of Article VII restrictions to ensure that water can be provided to meet the demand for the Six MRG Pueblos. Such water is tracked separately with a daily accounting model run by BIA and released at varying times to meet the needs of the Pueblos. Pursuant to the 1928 Act, the Pueblos have the prior and paramount right to divert Rio Grande natural flow; however, due to diversions by others, sufficient natural flow may not always be available to the Pueblos when needed. Consequently, the Secretary of the Interior provides space in El Vado to ensure that prior and paramount water is available for the Six MRG Pueblos should the natural flow prove insufficient. This water can be released to meet irrigation needs for Pueblo lands, as discussed below.

Within El Vado Dam sits a Federal Energy Regulatory Commission-regulated hydroelectric plant that is owned and operated by Los Alamos County. The plant operates as a "run of the river" facility; therefore, releases are not made for the sole purpose of generating power, but power is a byproduct of releases made for MRG Project purposes.

#### *1.2.2.3 The MRGCD Divisions*

MRGCD consists of four divisions—Cochiti, Albuquerque, Belen, and Socorro—serving irrigated lands from Cochiti Dam to the Bosque del Apache National Wildlife Refuge (BDA). At the downstream end of the MRGCD, remaining water from the MRGCD system is delivered onto the BDA.

##### *1.2.2.3.1 Cochiti Division*

MRGCD diversions begin at Cochiti Dam to the Cochiti East Main and Sile Main Canals and deliver water to irrigators on both sides of the Rio Grande. Diversions at the Cochiti Dam serve the Cochiti, Santo Domingo, San Felipe, and Santa Ana Pueblos, together with the communities of Peña Blanca, Sile, and Algodones.

##### *1.2.2.3.2 Albuquerque Division*

Angostura Diversion Dam, a concrete low-head fixed weir, diverts water from the Rio Grande to serve the Albuquerque Division of the MRGCD. The Albuquerque Division provides irrigation water for the Sandia, Santa Ana, and Isleta Pueblos and non-Indian irrigators from various

[8] "Nothing in this Compact shall be construed as affecting the obligations of the United States of America to Mexico under existing treaties, or to the Indian Tribes, or as impairing the rights of the Indian Tribes."

communities, including Bernalillo, Corrales, Alameda, Albuquerque, Los Ranchos, and the South Valley area.

##### *1.2.2.3.3 Belen Division*

Isleta Diversion Dam diverts water from the Rio Grande to serve the Belen Division of the MRGCD. Isleta Dam is a low-head (4.3-foot) structure consisting of a series of radial gates, which may be lifted entirely from the water if desired, or lowered to whatever position is required to provide the operating head for the intake works. Isleta Diversion Dam is located on Isleta Pueblo. Belen is the largest division in the MRGCD, accounting for nearly 50 percent (%) of irrigated lands. The Belen Division serves Isleta Pueblo, several New Mexico Department of Game and Fish (NMDGF) refuges, the Sevilleta National Wildlife Refuge (NWR), and irrigators from various communities, including Bosque Farms, Peralta, Los Lunas, Tome, Los Chavez, Belen, Casa Colorado, and Las Nutrias.

##### *1.2.2.3.4 Socorro Division*

About 55 miles downstream from the Isleta Diversion Dam, the San Acacia Diversion Dam provides water for the Socorro Division of MRGCD. San Acacia Diversion Dam is similar to Isleta Dam, being a series of radial gates across the Rio Grande, though with a larger operating head of approximately 7.5 feet. In addition to San Acacia Dam, the Socorro Division relies substantially on return flows from Belen Division via the Unit 7 Drain. At the southern end of the Socorro Division, two canals and two drains have delivered water onto the BDA, in addition to the Low Flow Conveyance Channel (LFCC).

#### ***1.2.2.4 The MRG Project Diversion Dams***

MRGCD constructed the Diversion Dams in the 1930s, including the Isleta Diversion Dam, which was constructed on lands belonging to the Isleta Pueblo. Pursuant to the MRG Project authorization, Reclamation rehabilitated Isleta Diversion Dam in 1955, San Acacia Diversion Dam in 1957, and Angostura Diversion Dam in 1958. In 1975, the original Cochiti Diversion Dam was demolished by the Corps during construction of Cochiti Dam and was replaced by intake works for the Sile Canal and Cochiti Main Canals incorporated into the Corps' structure. After completion of Cochiti Dam construction, the Corps transferred the rebuilt canal headworks to Reclamation. MRGCD currently operates the Diversion Dams as "transferred works" under the 1951 Contract, within the bounds of federal law, and within the scope of its conferred authority.

The annual quantity of water that the MRGCD has diverted over 10 years (2001-2011) is as follows:

Total surface water diversion from Rio Grande: 368,610–375,772 AFY

| | | |
|---|---|---|
| Average surface water diversion from Rio Grande: | | 371,516 AFY |
| Cochiti Diversion: | 58,623–68,030 AFY | Average: 63,802 AFY (17%) |
| Angostura Diversion: | 77,511–86,692 AFY | Average: 81,833 AFY (22%) |
| Isleta Diversion: | 206,417–208,866 AFY | Average: 207,951 AFY (56%) |
| San Acacia Diversion: | 14,923–21,364 AFY | Average: 17,931 AFY (5%) |

#### *1.2.2.5 The MRG Project and MRGCD Water Rights*[9]

In 1930, the MRGCD obtained New Mexico Office of the State Engineer (NMOSE) Permit No. 1690 (Storage Right) to appropriate and store up to 198,110 AF of water in El Vado Reservoir for lands newly reclaimed by the MRGCD (both Pueblo and non-Pueblo lands). In 1931, the MRGCD obtained NMOSE Permit No. 0620 (Natural Flow Diversion Right), which changed the points of diversion for natural flow water rights appurtenant to lands irrigated prior to the formation of the MRGCD from 71 existing irrigation systems (acequias) to the Diversion Dams, and authorized use of the Diversion Dams to divert water for those lands.[10]

In accordance with federal Reclamation law and New Mexico law, the MRGCD and/or the property holders served by the MRGCD, including the Six MRG Pueblos, retain the Natural Flow Diversion Right (Permit No. 0620). Pursuant to the 1951 Contract, as security for repayment of that contract, on May 28, 1963, the MRGCD executed a "Transfer and Assignment of Water Rights," whereby it conveyed Storage Right (Permit No. 1690) to the United States; however, in accordance with Section 8 of the Reclamation Act of 1902, which requires Reclamation to follow state law, the right to use the water appropriated under that permit remained appurtenant to the land irrigated in the MRGCD. The 1951 Contract has now been fully repaid. MRGCD erroneously attempted to transfer the Natural Flow Diversion Right pursuant to the 1951 Contract; however, the New Mexico Supreme Court ordered the MRGCD to retain its right (Permit No. 0620) to divert the natural flow through the Diversion Dams.[11] The Court stated that the MRGCD was only permitted by New Mexico law to transfer "new filings and new water" to Reclamation.

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[9] The water rights of the property holders served by the MRGCD, or any possible water rights of the MRGCD itself, have not yet been quantified or adjudicated.

[10] In its application for Permit No. 0620, the MRGCD asserted water rights appurtenant to 123,267 acres of land: 80,785 acres of land irrigated prior to the Conservancy Project; and 42,482 acres of land reclaimed through the Conservancy Project.

[11] Middle Rio Grande Water Users Association v. Middle Rio Grande Conservancy District, 57 NM 287, 299–300 (1953).

#### *1.2.2.6 The Low Flow Conveyance Channel*

The floods of the early 1940s and the drought of the 1950s created a condition where the Rio Grande river channel below BDA had become a series of disconnected segments separated by sediment plugs and delta deposits. Depletions due to evaporation and use by growing vegetation increased, and caused difficulties for New Mexico to meet its Compact delivery obligations beginning in the mid-1940s.

To reduce consumption of water, provide more effective sediment transport, and improve valley drainage, and as part of the MRG Project's river channelization program, Reclamation constructed a 54-mile-long artificial channel, the LFCC, running alongside the Rio Grande between San Acacia, New Mexico and Elephant Butte Reservoir. The LFCC is protected from the river by a continuous spoilbank levee, and is the subject of complex hydrologic interactions between the Rio Grande and irrigated lands. Operation and maintenance of the LFCC are continuing Reclamation responsibilities.

The basic concept behind the LFCC is that depletion of water can be reduced by diverting some or all of the river's flow into a narrower, deeper, and more hydraulically efficient channel. The LFCC exposes relatively less water surface area to evaporation and is less prone to loss of water by seepage than the natural river channel. The higher flow velocities in the LFCC can also move more sediment than the river, especially at lower discharges. The LFCC has a nominal capacity of 2,000 cubic feet per second (cfs), and the maximum recorded mean daily discharge of the LFCC at San Acacia is 1,950 cfs.

At its upper end, the LFCC behaves as a canal, but downstream from Escondida, New Mexico, it transitions to function as a drain. The LFCC can discharge to the Rio Grande under certain conditions at the 9-mile outfall near Escondida; however, there is typically little or no flow in the LFCC at that point.

### 1.2.3 Responsibilities and Actions of the State of New Mexico

#### *1.2.3.1 Administration of the Rio Grande Compact*

The New Mexico Interstate Stream Commission (NMISC) is charged with the administration of all interstate stream compacts to which the State is a party, including the Rio Grande Compact of 1938 (Compact). The ISC proposes to continue its Rio Grande Compact related activities, including the relinquishment of New Mexico Accrued Credit Water and allocation of New Mexico relinquished compact credits.

#### *1.2.3.2 Administration of Surface Water and Groundwater Supplies*

The NMOSE proposes to continue to administer the surface water and groundwater resources to maintain hydrologic system balance by executing his statutory duties with respect to transfers of valid existing surface water rights and compliance with valid existing state water declarations, permits, licenses, and court adjudication. Specifically:

- Continue to evaluate applications and issue permits to water rights owners to change the place and/or purpose of use of valid water rights in accordance with statutes and NMOSE policy and guidelines, including the following:
  - Issuance of permits to transfer valid existing surface water rights, established prior to the March 17, 1907 Water Code as acquired by groundwater right owners to comply with offset requirements.
  - Issuance of permits authorizing return flow credits to the river, pursuant to NMOSE approved return flow plans, for offset requirements.
- Continue to administer compliance of existing water rights in accordance with NMOSE permits and licenses and the adjudications of the courts.
- Oversee the NMOSE Letter Water Program for the release, and/or storage by exchange, of SJC Project water.

#### *1.2.3.3 Administration of Domestic, Municipal, Livestock, and Temporary Uses*

The NMOSE will continue to administer groundwater resources within the allowable limits in the following manner:

- The NMOSE will continue to issue permits for small domestic, livestock, and temporary uses as required by NMSA 1978 Sections 72-12-1.1 through 72-12-1.3, in accordance with the *OSE 2006 Rules and Regulations Governing the Use of Public Underground Waters for Household and Other Domestic Use*.

## 1.3 Overview of Water Operations

Beginning as early as March of each year, water management agencies, including Reclamation, the MRGCD, the State, the Service, the BIA, the Albuquerque Bernalillo County Water Utility Authority (ABCWUA), and the United States Geological Survey (USGS), participate in coordination calls to share information regarding current river flows, reservoir storage, target releases, areas of drying, the status of the silvery minnow, and other timely issues.

The tools that Reclamation uses for its water operations include flow and storage data provided by stream gages and computer models that predict water availability and account for water as it moves through the reservoir and river system of the MRG. Reclamation uses these tools to operate its facilities, account for the movement and comingling of SJC Project and MRG Project water supplies, and develop annual operating plans based on forecasted snowmelt runoff and other factors. Water operations are facilitated by monitoring to ensure that desired flows are achieved.

Reclamation's primary tool for meeting the forecasted ecological needs of listed species is its Supplemental Water Program (Program), which is included as a conservation measure in this BA. The Program consists of:

1. Water acquisition and storage
2. SJC Project waivers of mandatory release dates from Heron Reservoir
3. Pumping and conveying water from the LFCC to the Rio Grande

### 1.3.1 The Rio Grande Compact and Article VII Storage Restrictions

The 1938 Rio Grande Compact (Compact; 53 Stat. 785) is a federal law that imposes significant restrictions on water management in the MRG. The Compact apportions the native waters of the Rio Grande among the States of Colorado, New Mexico, and Texas, and the provisions of the Compact are administered by the Rio Grande Compact Commission. For purposes of the Compact, "New Mexico" is the reach between Otowi gage and Elephant Butte Reservoir. The allocation excludes tributary inflows along this reach of river; these inflows are not subject to Compact restrictions. Article XVI of the Compact states:

> "Nothing in this Compact shall be construed as affecting the obligations of the United States of America to Mexico under existing treaties, or to the Indian Tribes, or as impairing the rights of the Indian Tribes."

Also, SJC Project water is imported transbasin water, subject to the terms of the Upper Colorado River Compact; however, after diversion by Reclamation, this water is not subject to Rio Grande Compact restriction.

The Compact does not require Colorado or New Mexico to deliver the exact amount of water scheduled annually each and every year, but allows for the accumulation of over-deliveries (credit) and under-deliveries (debit). Although it is up to each state to decide how its water is used, any new use has to be balanced by reduction of an existing use or through the use of a new or imported source of water, such as SJC Project water, as the Compact puts an upper limit on basinwide water depletions.

Regardless of how wet a period may be, New Mexico's depletions between Otowi gage and Elephant Butte Reservoir are capped at 405,000 AFY plus local tributary inflows. In wet years, the increasingly higher flows must be delivered downstream, and associated carriage losses for that water must be made up for out of New Mexico's allocation; in very wet years, these carriage losses can deplete New Mexico's entire allocation. For this reason, wet years are more likely than dry years to result in a Compact debit; in many cases, debits accrued in wet years must be made up for in dry years. This eliminates the possibility of "saving" water in wet years for use to meet the needs of endangered species in dry years.

Several Compact restrictions affect reservoir operations in post-Compact reservoirs (constructed after 1929) and associated surface water management. Reclamation's Heron Reservoir is excluded from these restrictions because it is only authorized to store imported transbasin SJC Project water.

Under Article VI of the Compact, New Mexico's maximum accrued debit is limited to 200,000 AF. If New Mexico is in debit status, New Mexico must retain water in storage at all times to the extent of its accrued debit. If a spill occurs, the accrued credits for Colorado or New Mexico, or both, are reduced in proportion to their respective credits by the amount of the actual spill. Colorado or New Mexico may release accrued credits in part or in full in advance of an actual spill. Following an actual or hypothetical spill, all accrued debits for Colorado or New Mexico, or both, are cancelled.

Under Article VII of the Compact, whenever usable water in the Rio Grande Project storage account at Elephant Butte and Caballo Reservoirs is less than 400,000 AF, New Mexico and Colorado may not increase the storage of native Rio Grande Basin water in upstream reservoirs constructed after 1929. Usable water is defined as water in Elephant Butte and Caballo Reservoirs that is available for release to the Rio Grande Project. In New Mexico, the primary impacts of Article VII storage prohibitions are experienced at El Vado Reservoir. Article VII also provides that, upon acceptance by Texas, New Mexico may relinquish accrued delivery credits so that New Mexico may store an equivalent amount of water in post-1929 upstream reservoirs when storage restrictions are in effect.

### 1.3.2 Water Accounting

All water flowing through the basin is accounted for to ensure that it is used in compliance with applicable laws. This includes SJC Project water that moves between reservoirs or is released for contractors, water acquired and stored under Reclamation's Supplemental Water Program, and MRGCD's irrigation water. All reservoir storage and flows at particular gages are accounted for to ensure that Colorado is meeting its Compact obligation to New Mexico and that New Mexico is meeting its obligation to Texas.

### 1.3.3 Snowmelt Forecasting and the Upper Rio Grande Water Operations Model

The snowmelt runoff forecast for a given year is a key factor in Reclamation's annual water operations. Starting in January or February, Reclamation begins monthly tracking of the Natural Resources Conservation Service (NRCS) snowmelt runoff forecasts. NRCS operates and maintains an extensive, automated system (SNOwpack TELemetry, or SNOTEL) designed to collect snowpack and related climatic data in the Western United States and Alaska. NRCS field staff collects and analyzes data on depth and water equivalent of the snowpack and provides estimates of annual water availability and spring runoff on a monthly basis from January–May. Reclamation, in coordination with the Corps, enters the projected March–July runoff volumes into the Upper Rio Grande Water Operations Model (URGWOM) to model the flows for the entire year. URGWOM is a set of daily time-step, river reservoir models for the basin using RiverWater® software. URGWOM was used for the hydrologic effects analyses in this BA.

### 1.3.4 The Annual Operating Plan

Each year, Reclamation's Albuquerque Area Office develops the Middle Rio Grande Annual Operating Plan (Annual Operating Plan) in coordination with the Corps and with additional input from water users such as the MRGCD, the NMISC, the ABCWUA, and the City of Santa Fe. The planning process includes compiling the necessary data, making key assumptions, and modeling water operations to estimate actual operations from the present through the remainder of the year. The Annual Operating Plan combines compiled data and major assumptions, such as (1) the runoff forecast, (2) predicted monsoon conditions, (3) forecasted environmental needs, (4) river recession[12], (5) silvery minnow recruitment flows, and (6) drought storage of Supplemental Water. The model includes the following:

- Snowmelt runoff projection
- Projection of percentage of average Heron Reservoir inflow
- Whether MRGCD can anticipate a full irrigation season
- How much storage MRGCD will need to utilize through the irrigation season
- How much native water should be maintained in El Vado to assure that the Six MRG Pueblos have sufficient water to satisfy their prior and paramount needs
- How forecasted environmental needs will be met throughout the irrigation season
- Whether and the degree to which Supplemental Water Program releases will be needed to meet environmental needs
- Whether additional Supplemental Water supplies may be needed
- Whether or for how long Article VII of the Compact will remain in effect
- When weekend recreational flows can be provided on the Rio Chama

The Annual Operating Plan estimates for each reservoir the daily amount (in AF) stored and the rate of inflow and outflow for a period of time beginning April 1 and ending December 31. The

[12] Drying of the river after June 15 must be managed carefully so that the drying limits outlined in the 2003 BiOp are not exceeded. Reclamation, the Corps, NMISC, and the MRGCD determine the plan for the managed recession.

Annual Operating Plan is presented in April to respective agency staff, as well as to the public. Figure I-1 is an example of an operating plan hydrograph for El Vado Reservoir. The Annual Operating Plan is a prediction and rarely plays out through the year precisely as expected. While snowpack projections are generally sound by mid-April, variability in the pattern of melt and, in particular, the amount and distribution of summer precipitation tends to cause actual water flow and management to increasingly deviate from the Annual Operating Plan as the year progresses.

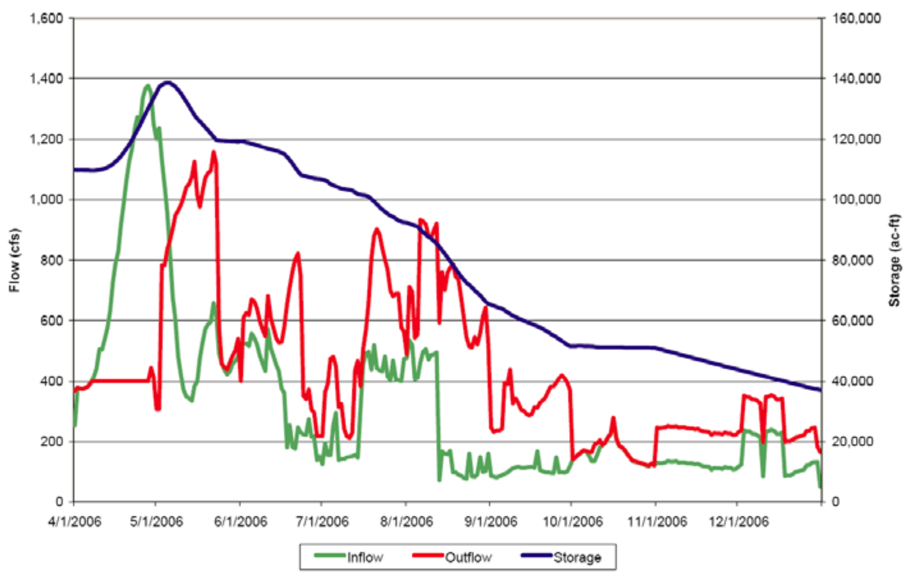


**Figure I-1. Annual operating plan hydrograph for El Vado Reservoir**

### 1.3.5 Prior and Paramount Operations

The 1981 Agreement between the Six MRG Pueblos Irrigation Committee,[13] the Secretary's Designated Engineer, BIA, and Reclamation established U.S. Department of the Interior policy for designating a volume of water in storage at El Vado to ensure that prior and paramount water demand on the Pueblos' lands can be met each year. The 1981 Agreement sets out the often overlapping responsibilities and authorities of Reclamation, BIA, and the MRGCD related to ensuring the Pueblos' prior and paramount water rights for their lands, although the MRGCD is not a party to the 1981 Agreement.

The 1981 Agreement provides that Reclamation, jointly with the BIA Designated Engineer, calculate the storage requirements of the Six MRG Pueblos, and that Reclamation and MRGCD annually store water in and release water from El Vado Reservoir to satisfy Pueblo water

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[13] The Six Middle Rio Grande Pueblos Irrigation Committee was the predecessor organization to the Coalition of the Six Middle Rio Grande Pueblos.

entitlements. It also provides the protocol for the Six MRG Pueblos to call for releases of the water stored for their prior and paramount water needs. MRGCD is obligated by statute, contract, and State permit to divert water for the Pueblos; those actions are included in the description of MRGCD's proposed actions. The prior and paramount operations ensure that the Pueblos will receive an adequate supply of water to meet their prior and paramount needs.

### 1.3.6 MRGCD Water Management

MRGCD operates pursuant to federal and state statute and contractual authority. MRGCD meets irrigation demand with smaller diversions than allowed by such authority. This, in turn, allows MRGCD to remain in full operation for a longer irrigation season or to save water for subsequent seasons.

MRGCD regularly coordinates its operations and plans with other water management agencies, which helps ensure that sufficient water is available to meet irrigation demands as well as the needs of listed species. MRGCD's coordination includes:

- Regular participation in Reclamation's MRG Coordination Conference calls, in which the MRGCD relays information on:
  - Plans for diversion at each of its diversion structures, and any plans it has for "bypass" of flows (leaving of water in the river rather than diverting it).
  - Changes in conditions or operations that may affect Reclamation's requirement to release Supplemental Water.
- Coordination with Reclamation's RiverEyes program and the Service's fish rescue program. As noted previously, MRGCD has, at times, intentionally routed flows to wasteways or drains to assist the Service with rescue.
- Emergency flow releases at specific locations as needed for ESA purposes.

#### *1.3.6.1 MRGCD Borrow/Payback Arrangements*

MRGCD participates in "borrow/payback" arrangements with Reclamation and the ABCWUA for water storage and movement between Heron, El Vado, and Abiquiu Reservoirs. These arrangements may be made either to increase flows on the Rio Chama Wild and Scenic portion to an appropriate level for recreational whitewater rafting or to increase winter base flows for health of sport fisheries on the Rio Chama. "Borrow/payback" arrangements most commonly involve moving water for ABCWUA water from Heron Reservoir to Abiquiu. For a variety of practical reasons (measurement, gate adjustment, evaporation loss, etc.), the movement of this water sometimes occurs by borrowing MRGCD's SJC Project water from El Vado Reservoir and replacing it at a later date with the ABCWUA's SJC Project water from Heron Reservoir. The "borrow/payback" arrangements also sometimes may involve Reclamation's Supplemental Water for the silvery minnow.

#### *1.3.6.2 MRGCD Measurement*

MRGCD operates and maintains a system of measurement stations, or gages, along its canal and drain network. These gages report water level and rates of flow back to the MRGCD at 30-minute intervals. This includes information on water diverted from the Rio Grande, how water is being distributed to various canals or service areas, and water being returned to the Rio Grande through wasteway and drain outfalls. Data are collected via FM radio telemetry, processed (converted from raw electronic signals to usable values and units), then transferred by the current file transfer protocol to three separate computer databases (MRGCD, Reclamation, and the Corps). This entire process occurs automatically, 24 hours a day, throughout the year. Reclamation hosts a website, created and maintained jointly by Reclamation and MRGCD, on which these data are publicly displayed. Data are displayed in near real-time (20 to 30 minutes after collection).

At present, MRGCD provides data from about 130 sites on its system and continues to add several new locations each year. In addition, MRGCD collects, processes, and distributes data from Reclamation's silvery minnow pumping sites in Socorro County and the NMISC's silvery minnow Atrisco habitat project in Bernalillo County. Processed information also is collected from other entities, including the USGS (stream flow gages on the Rio Grande) and the ABCWUA (diversion from and return flow to the Rio Grande). All of these data are displayed along with MRGCD information on the Reclamation website, allowing both the public and water managers to quickly observe water movement and distribution throughout the MRG.

MRGCD maintains its gage network through periodic calibration measurements using a variety of flow measuring devices. In addition, MRGCD makes flow measurements in ungaged areas of its system and along the Rio Grande itself. Measurements made on the Rio Grande by MRGCD are often used to understand where nontypical or unexpected loss is occurring. MRGCD shares this information with Reclamation, the USGS, and other water management entities.

## 1.4 Overview of River and Infrastructure Maintenance and Restoration

River and infrastructure maintenance and restoration activities covered in this BA include river maintenance strategies, priority/monitored river maintenance sites, and ecosystem restoration activities, all of which involve the utilization of river maintenance methods (Part III). For the purposes of this BA, the term "river maintenance" refers to both river and infrastructure maintenance as well as restoration actions. River maintenance support activities and processes for identifying adaptive management work, unanticipated work, interim work, and new site work are also described.  The river maintenance strategies presented in this BA are an example of a geomorphically viable river management practice for the MRG.  The implementation of river maintenance strategies on a reach scale represents a significant shift in addressing river maintenance concerns on the MRG—one that addresses the causes and not just symptoms of the observed geomorphic trends.

The described actions for Reclamation's other MRG maintenance and the MRGCD's maintenance describe operation and maintenance of MRG facilities and represent ecologically viable actions that maintain the biological integrity and improve conditions of the listed species.

The State proposes to continue to collaborate with Reclamation to fund river conveyance and flood control projects, including maintaining the Delta Channel at the headwaters of the active pool of Elephant Butte Reservoir.  More specifically, the State proposes to continue to contribute funding for certain types of projects described in the river maintenance activities section of this BA.  The MRG river maintenance program, including State and MRGCD actions, is described in Part III of this BA.

## 1.5 Projects Not Included in the Biological Assessment

Two projects, located along the Rio Grande to the north and south of the MRG Project, are outside of the action area and will not be considered in this BA.  These are the San Luis Valley Project, which is located in Colorado and includes the Closed Basin Division and the Conejos Division, and the Rio Grande Project, which is located in southern New Mexico and western Texas.

The San Luis Valley Project, Closed Basin Division, located near Alamosa, Colorado, uses wells to salvage groundwater from high water table conditions to assist Colorado in meeting its Compact delivery requirements and the requirements of the 1906 Treaty between the United States and Mexico, to stabilize water levels in San Luis Lake, and to provide mitigation water for the Alamosa Wildlife Refuge and the Blanca Wildlife Habitat Area.  Flows delivered to the Rio Grande from the Closed Basin Division are part of the overall water supply available to Colorado, allowing Colorado to consume a like amount of water at a point upstream in the basin.

The San Luis Valley Project, Conejos Division, located in south-central Colorado, includes the Platoro Dam and Reservoir, which is operated for flood control and storage for irrigation, benefitting about 10,000 people on farms and six villages in the Conejos River area.  The Conejos Division is a component of Colorado's Compact accounting and state line deliveries, and any changes in diversions simply would allow Colorado to minimize the accrual of debits or credits.

The Rio Grande Project, authorized by the U.S. Congress on February 25, 1905, extends from Elephant Butte Reservoir (New Mexico) to Ft. Quitman, Texas, and stores water for delivery to the Elephant Butte Irrigation District (EBID) in New Mexico, the El Paso County Water Improvement District No. 1 (EP#1) in Texas, and Mexico. Irrigation release rates and times are determined by Mexico, EP#1, and EBID and are calculated to meet daily irrigation demands. Reclamation manages water storage in Elephant Butte and Caballo Reservoirs in a manner that minimizes evaporation and maximizes the irrigation function of the Rio Grande Project. The total amount of water in storage in the Rio Grande Project is the result of inflows dictated by Compact guidelines for New Mexico and Colorado. The needs of irrigators and irrigation delivery orders are nondiscretionary. Reclamation cannot restrict or increase releases to affect Article VII restrictions on upstream States. The only discretionary measure in Reclamation's operational criteria not based upon irrigation delivery orders is when water is evacuated via a prerelease of storage water from Elephant Butte Reservoir to maintain space available for flood control purposes. Reclamation also has discretion to store SJC Project water in Elephant Butte Reservoir. Reclamation is working on an Environmental Impact Statement and corresponding ESA consultation (targeted for completion in 2016) for the proposed continued implementation of the 2008 operating agreement over its entire remaining term, through 2050. The operating agreement is a written description of how Reclamation allocates, releases from storage, and delivers Rio Grande Project water for users within the Elephant Butte Irrigation District, the El Paso Water Improvement District No.1, and to users covered by treaty with Mexico. The storage of 50,000 AF of SJC Project water in Elephant Butte Reservoir will also be covered.

## 1.6 Reclamation's Tribal Trust Responsibility and ESA Compliance

The U.S. government has a trust responsibility to protect and maintain rights reserved, recognized, or granted to Indian tribes, implicitly or explicitly, by agreement, treaties, statutes, and Executive Orders. Reclamation shares this responsibility and carries out its activities to protect such trust assets and to avoid adverse impacts to tribes when possible. Consistent with the June 7, 1997, Secretarial Order on "American Indian Tribal Rights, Federal-Tribal Trust Responsibility, and the Endangered Species Act" (Secretarial Order No. 3206), the BIA has the primary responsibility for carrying out the federal responsibility to protect and administer tribal trust property. The BIA also represents tribal interests during formal section 7 consultation under the ESA. Reclamation implements its ESA responsibilities to respect tribal sovereignty over the management of Indian lands and tribal trust resources.

The federally recognized tribes of Cochiti, Santo Domingo, San Felipe, Santa Ana, Sandia, and Isleta Pueblos (the Six MRG Pueblos or Pueblos), as well as the San Ildefonso, Ohkay Owingeh, and Santa Clara Pueblos, exist within the action area of this BA. The interests of other federally recognized pueblos or tribes may also be affected. Reclamation is aware that the pueblos and tribes do not concede that the ESA applies to their actions. Nonetheless, through this BA process, Reclamation has initiated government-to-government consultations with all pueblos and tribes in the action area or that may be affected by the actions to provide each with an opportunity to voice its comments and concerns. Reclamation has endeavored to address each pueblo's comments and concerns to date in this BA.

### 1.6.1 Indian Water Rights Settlements

Several long-standing water rights adjudications involving Indian claims to water rights in the Rio Grande Basin (Basin) have recently reached settlement. This BA does not include the actions or impacts related to the Indian water right settlements described below, as they will be included in separate consultations.

The Aamodt Adjudication is a complex, long-running adjudication of water rights in the Nambe-Pojoaque-Tesuque watershed north of Santa Fe involving pueblo Indian water rights. It began in the 1960s and has involved numerous lawsuits and appeals. In 2000, after a series of court rulings, settlement discussions began in earnest. A settlement has been reached that involves a large water development project. On December 8, 2010, Congress signed the Claims Resolution Act of 2010 (Public Law 111-291) into law. Title VI of that Act authorizes the Aamodt Litigation Settlement and allocates major federal funding to implement the regional water system project.

The other recent settlement involved the adjudications of the Rio Pueblo de Taos and Rio Hondo stream systems, which were filed in federal court in 1969. The cases were consolidated and are now often referred to simply as *Abeyta*. In 2006, a settlement was reached among the Taos Pueblo, the State, the Taos Valley Acequia Association, the Town of Taos, El Prado Water and Sanitation District, and the 12 Taos-area Mutual Domestic Water Consumer Associations regarding the pueblos' and non-Indian water rights. In Title V of the Claims Resolution Act of 2010, Congress authorized the Taos Pueblo Indian Water Rights Settlement and appropriated significant funding toward its implementation.

For the Aamodt Settlement, Reclamation will contract for 1,079 AFY of SJC Project water for use by the San Ildefonso, Pojoaque, Nambe, and Tesuque Pueblos. This water is intended, in part, to compensate the pueblos for agreeing to not fully exercise their right to call priority within the Rio Grande Basin. This water may not be physically exported out of the Basin. For the Abeyta Settlement, Reclamation will contract for 2,621 AFY of SJC Project water to the Taos Pueblo (2,215 AFY) and to the other settlement parties (406 AFY).

Like the claims of other non-Indian water users in the basin, the claims of other tribes that assert rights to water in the Rio Grande Basin, including the Six MRG Pueblos, are not yet quantified, are not in adjudication, and are not in settlement negotiations. The federal Indian water rights of these pueblos and tribes are not:

1. Impaired by the Rio Grande Compact of 1938 (53 Statute [Stat.] 785).
2. Subject to State law restrictions.
3. Administered by the State.

Reclamation recognizes that who depletes and the amount they deplete based on these unquantified and unadjudicated rights may vary from year to year and in the future. Consequently, Reclamation and the non-federal water users assume the risk that the future development of senior water rights, including Indian pueblo and tribal water rights, may impact water deliveries to junior users.

## 1.7 The Middle Rio Grande Endangered Species Collaborative Program

In April 2002, Reclamation together with the Corps, the State, Pueblos, MRGCD, City of Albuquerque, and other parties executed a Memorandum of Understanding (MOU) to establish the Collaborative Program. In 2008, Congress directed the Secretary of the Interior (Secretary) to establish an Executive Committee for the Collaborative Program consistent with the Collaborative Program's bylaws (Bylaws) (110 Public Law 161). Subsequently a new Memorandum of Agreement (MOA) was signed by the parties. The Bylaws cite section 4(f)(2) of the ESA as authority for the Collaborative Program: the Secretary is directed to develop and implement plans for the conservation of endangered species, and the Secretary may enlist the services of public and private agencies, individuals, and institutions in developing and implementing such recovery plans.

The purpose of the Collaborative Program as described in the 2008 MOA is two-fold:

- First, to prevent extinction, preserve reproductive integrity, improve habitat, support scientific analysis, and promote recovery of the listed species within the Program area in a manner that benefits the ecological integrity, where feasible, of the MRG riverine and riparian ecosystem.
- Second, to exercise creative and flexible options so that existing water uses continue and future water development proceeds in compliance with applicable federal and state laws.

To achieve these ends, the Program may not impair state water rights or federal reserved water rights of individuals and entities, federal or other water rights of Indian nations and Indian individuals, or Indian trust assets, SJC Project contractual rights, and the State's ability to comply with Rio Grande Compact delivery obligations.

The Collaborative Program receives funding through congressional appropriations to implement projects designed to benefit the federally listed endangered silvery minnow and flycatcher. The Collaborative Program implements activities required by the 2003 BO to support compliance with the BO providing ESA coverage for the two federal action agencies and broad coverage for participating non-federal entities. The 2003 BO also serves as a tool to conserve listed species, assist with species recovery, and help protect critical habitat.

To help identify and guide species' recovery needs, section 4(f) of the ESA directs the Secretary to develop and implement recovery plans for listed species or populations. Recovery Recommendations identified in these plans are advisories aimed at lessening or alleviating the threats to the species and ensuring self-sustaining populations in the wild. The general Collaborative Program goals consistent with these recovery plan recommendations are:

- Alleviate jeopardy to the listed species within the scope of the Collaborative Program.
- Conserve and contribute to the recovery of the listed species:
  - Stabilize existing populations.
  - Develop self-sustaining populations.
- Protect existing and future water uses.
- Provide public outreach and education to communities within the scope of the Collaborative Program.

In November 2006, the Collaborative Program adopted a Long Term Plan (LTP) (Collaborative Program 2006) with the following objectives:

- To serve as a road map for implementing activities within the scope of the Collaborative Program.
- To provide accountability through measurable objectives and an annual Collaborative Program assessment process.
- To help integrate federal and non-federal budget processes for providing funding for future activities.

In August 2009, the Collaborative Program began drafting a new LTP to include future activities through 2020 that are linked to the silvery minnow and flycatcher recommended recovery activities and are within the scope of the Collaborative Program.

Collaborative Program activities are generally organized by seven LTP element categories: (1) habitat restoration and management, (2) water management, (3) population augmentation/ propagation, (4) water quality management, (5) research, monitoring, and adaptive management,

(6) public outreach, and (7) program management. Work groups such as the Executive Committee and the Coordination Committee engage in an iterative, annual work plan process to identify and prioritize activities needed in the upcoming year for BO compliance and to assist with recovery.

There is currently disagreement within the Collaborative Program on many of the aspects of silvery minnow life history, monitoring techniques, and interpretation of associated scientific information, indicating the appropriateness of an adaptive management approach to address scientific and management uncertainty in the basin.

In 2009, the Collaborative Program directed efforts to pursue implementation of a Recovery Implementation Program (RIP) to further the interests of efficiency and increased emphasis on species recovery and ESA compliance. A draft Cooperative Agreement, Program Document, and RIP Action Plan were endorsed by the Program's Executive Committee in July 2013. This BA identifies the establishment of a RIP as a Conservation Measure. It is anticipated that the RIP will be formally established by the signing of a Cooperative Agreement following issuance of the BO.

## 1.8 Consultation and Litigation History

Reclamation has completed numerous ESA consultations since 1996, including individual and joint consultations with the Corps for federal water operations on the MRG. From 1996–1999, Reclamation and the Corps consulted informally on their water operations and river maintenance activities in the MRG. In May 1998, Reclamation and the Corps submitted to the Service a joint Programmatic BA addressing both agencies' water management actions.

In November 1999, environmental groups collectively filed suit *Rio Grande Silvery Minnow v. Keys, et al.*, CIV 99-1320-JP/KBM, against Reclamation and the Corps for alleged ESA and National Environmental Policy Act (NEPA) violations. The plaintiffs identified the central issue as the scope of discretionary authority that Reclamation and the Corps have over the MRG and SJC Projects' water deliveries and river operations.

Reclamation and the Corps resubmitted a joint BA June 2001, resulting in a BO covering actions during the period June 2001 through December 2003.

> "Completion of consultation resulted in the issuance of a Biological Opinion (BiOp) by the FWS in June of 2001, which was subsequently challenged by the plaintiffs. They sought to require that the BOR exercise discretion to utilize San Juan-Chama water from Heron Reservoir and curtail deliveries of water to the San Juan-Chama contractors to meet the minimum flows required for the minnow. They also sought curtailment of native Rio Grande water deliveries to irrigators, primarily in the MRGCD. The Federal

> district court ruled in April 2002,[14] upholding the 2001 BiOp but also holding that the Reclamation had discretion over use of both the SJC Project and native water in the MRG Project for ESA purposes while the Corps did not have such discretion over its operations." (Kelly 2011)

In June 2002, Reclamation predicted it would not be able to meet the 2001 BO flow requirements due to extreme drought:

> "Environmental plaintiffs filed for emergency injunctive relief to seek release of a limited amount of SJC water from Heron Reservoir in order to comply with the June 29, 2001, and avoid massive drying in the Middle Rio Grande. A hearing was held immediately and the court subsequently ruled in favor of the plaintiffs that the September 2002 BiOp was arbitrary and capricious. However, the Court imposed its own interim flow standards, allowing the U.S. to meet lower flow levels than those required by the 2001 BiOp. The Court directed Reclamation to take SJC water from the contractors if necessary…The ruling on the injunctive relief was immediately appealed to the Tenth Circuit Court of Appeals by the Federal defendants and interveners, which stayed the ruling pending the appeal. Oral arguments were heard in January 2003 before a three-judge panel, which affirmed the district court's ruling in June 2003.[15] The Federal defendants and interveners petitioned for rehearing *en banc*." (Kelly 2011)

Meanwhile, in August 2002, Reclamation and the Corps reinitiated section 7 consultation to address proposed water management through December 2002. In September 2002, the Service issued a new "jeopardy" biological opinion with no Reasonable and Prudent Alternative (RPA). Late-season rains enabled Reclamation to maintain operations consistent with the June 2001 BO, including the incidental take statement; therefore, the June 2001 BO remained in effect.

In February 2003, Reclamation and the Corps jointly reinitiated consultation with the Service; subsequently, a BO was issued in March 2003 covering continued operations through February 2013. In 2004, Congress enacted legislation that limited Reclamation's discretion to use SJC Project water for ESA purposes (Public Law 108-447), known as the "minnow rider," which also confirmed the 2003 BO as legally sufficient under the ESA.

> "In October 2003, the Tenth Circuit requested additional briefing from all parties on the question of whether the case was moot and its June 2003 ruling should be vacated. On January 5, 2004, the Tenth Circuit vacated the panel opinion as moot because the time frame covered by the District Court's 2002 ruling had expired. Furthermore, the New Mexico delegation had introduced, and Congress later enacted, legislation restricting the Federal Government from using San Juan-Chama Project water to meet ESA obligations. The district court was ordered to determine whether there were unresolved issues to be tried.
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> . . .
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> Plaintiffs filed a Motion to Dismiss Remaining Claims without prejudice. The defendants responded that the prior rulings (Memorandum Opinions and Orders of April 19, 2002, and September 23, 2002) should be vacated for mootness and lack of subject matter jurisdiction. Subsequently, on April 26, 2004, plaintiffs withdrew their motion to dismiss. Plaintiffs asked Judge Parker not to vacate his rulings but to incorporate

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[14] *Rio Grande Silvery Minnow* v. *Keys, et al.*, CIV 99-1320-JP/KBM, April 2002, Memorandum Opinion and Order.
[15] *Rio Grande Silvery Minnow* v. *Keys,* 333 F.3d 1109 (10th Circuit Court, 2003).

> them into a final judgment that could be appealed yet again to the Tenth Circuit should defendants wish to do so.
>
> …
>
> On November 22, 2005, the Court ruled on the mootness and vacatur issues sent down from the 10th Circuit Court of Appeals from the appeal in 2003. Judge Parker held that, because of the 2003 and 2004 minnow riders, the issue of BOR discretion to reduce water deliveries to the San Juan-Chama Project was moot. However, he ruled that because Congress was silent on the issue of BOR discretion regarding Middle Rio Grande Project waters, this issue remained justiciable." (Kelly 2011)

The judge ruled that, in future consultations under the ESA, Reclamation must consult with the Service over the full scope of Reclamation's discretion concerning MRG Project operations. Judge Parker's November rulings were appealed to the 10th Circuit Court of Appeals.

> "On April 21, 2010, the [Tenth Circuit Court of Appeals] ruled that the intervening 2003 Biological Opinion and subsequent minnow riders had mooted the claims of the environmental groups. The court based its mootness ruling on the fact that the environmental groups' claims and relief sought were related to consultation over discretionary aspects of the 2001 and 2002 BiOps. Therefore, even though the Middle Rio Grande Project water was not explicitly mentioned in the minnow riders, the 2003 BiOp had superseded the earlier BiOps, taking away any claim for relief." (Kelly 2011)

The Court dismissed the appeal, and remanded to the district court to vacate its memorandum opinions and orders of 2002 and 2005, and to dismiss the environmental groups' complaint with regard to their scope-of-consultation claim under the ESA.

### 1.8.1 Early Coordination Efforts

As early as 2006, Reclamation anticipated insufficient supplies of Supplemental Water available to meet environmental needs (Supplemental Water) coupled with hydrologic conditions that would prevent Reclamation from meeting the flow requirements of the 2003 BO in the future. Therefore, Reclamation and the Corps began planning for reinitiating section 7 consultation with the Service.

In 2007, the Collaborative Program's ad hoc workgroup, Population and Habitat Viability Assessment/Hydrology (PHVA Workgroup), was created to perform hydrologic analyses and develop water management scenarios for use in this consultation process and for input into the Population Viability Assessment (PVA) species models developed by the PVA Ad-hoc Workgroup. The PHVA Workgroup began this work by performing an interagency review of potentially hydrologically viable actions that might impact or benefit listed species in the MRG ecosystem. It evaluated available water, operational flexibility, management considerations in key reaches (Angostura, Isleta, and San Acacia Reaches), and biological considerations for the silvery minnow, and identified a suite of alternate water management scenarios or strategies for evaluation to meet operational and ESA needs (Norris et al. 2008).

Originally, 11 operational scenarios were identified and modeled. Supplemental Water needs to meet target flows for the 11 scenarios were identified, and shortages against the projected available Supplemental Water were quantified. Reclamation completed a screening procedure to rank scenarios considering numerous parameters, including the duration and extent of river drying in critical river reaches, May–June flow volumes to promote effective species reproduction, Supplemental Water use requirements, and the ability to bank Supplemental Water for critical situations.

By 2009, the PHVA workgroup had narrowed the suite to five management scenarios that considered the use of available water to support the habitat needs of the silvery minnow while maintaining operational flexibility to adapt to unforeseen circumstances. These five scenarios included:

- **BO Targets:** The same operations and flow targets as were specified under the 2003 BO.
- **Dry-Year Targets:** Use in all years of the flow targets specified in the 2003 BO for "dry years."
- **BO Targets - No Continuous Flow:** Use of the 2003 BO flow targets without the requirement for continuous flows in the winter.
- **Angostura-Isleta Management A:** Flow targets in the Angostura Reach (100 cfs at Central Avenue gage at all times) and Isleta Reach (100 cfs at Isleta diversion structure at all times) only.
- **Angostura-Isleta Management B:** Flow targets in the Angostura Reach (100 cfs at Central Avenue gage at all times) and Isleta Reach (50 cfs at Isleta diversion structure at all times) only.

From these scenarios, Reclamation implemented a screening process that identified Angostura-Isleta Management B option as the initial preferred option.

The five alternative management scenarios, along with the recommendation from Reclamation, were presented at the April 16, 2009 meeting of the Executive Committee of the Collaborative Program. This information also was presented to the Service at that time, but further evaluation was needed. Therefore, no alternate water management scenarios are presented in this BA for consideration or analysis.

In February 2009, the Corps decided to pursue its own section 7 consultation and to develop a BA addressing only the Corps' authorized, discretionary flood control operations. On November 26, 2013, the Corps withdrew its BA and suspended consultation. On June 13, 2014, the Corps informed the Service that the Corps had performed a critical and comprehensive reassessment of all its continuing reservoir operations in the MRG and determined the Corps is not required to consult on its reservoir operations in the MRG largely because the Corps' discretion to regulate water flows for the benefit of endangered species does not exist.

Reclamation has requested, and the Service has tentatively agreed, that the new biological opinion will have an initial term of 15 years, with the option for extensions in five-year increments as long as certain conditions are met.

## 1.9 Quiet Title Litigation History

> "In 2002 the MRGCD filed a cross-claim to quiet title to ownership of El Vado Reservoir and the Angostura and San Acacia Diversion Dams and other land and irrigation works within the MRGCD. MRGCD also sought a declaratory judgment interpreting the effect of their 1963 transfer of State Water Rights Permit No. 1690 to the United States. The Federal defendants opposed this claim and environmental plaintiffs sided with the Federal Government on this issue." (Kelly 2011)

The United States' position in this cross-claim was that the MRGCD conveyed the MRG Project properties to the United States and that these properties remain in the name of the United States until, among other things, Congress authorizes title transfer; additionally, the repayment contract also stays in effect until such time.

> "On July 25, 2005, the Federal District Court ruled on the cross-claim by MRGCD to quiet title to El Vado Reservoir and other Middle Rio Grande Project works. The District Court ruled the 12-year statute of limitation under the Quiet Title Act had run because MRGCD had been on notice since 1951 that the United States claimed an adverse interest in the properties. The District Court went on to rule that ownership of these properties and certain specific tracts identified in the cross-claim was declared to be in the United States of America. The Court also ruled that Permit No. 1690 must remain in the name of the United States unless Congress authorizes its conveyance to the MRGCD. The MRGCD appealed.
>
> …
>
> The 10th Circuit Court of Appeals ruled…[i]n March [2010] that the District Court did not clearly err in finding that the MRGCD action to quiet title in El Vado Reservoir and the other properties conveyed to [Reclamation] through the 1951 contract was untimely under the 12-year statute of limitations.[16] The Court adopted the District Court's account of the evidence as plausible, and ruled against MRGCD's argument that because the property may have been conveyed as easements and not in fee simple, that the MRGCD did not have notice of the adverse claim of the United States until 2000. The Court held further that any abandonment of property rights by the United States would have to be explicitly authorized by Congress. However, because timely filing of a quiet title action is what confers jurisdiction on the Court, the lack of timely filing meant that the District Court did not have jurisdiction to rule on the merits. The 10th Circuit vacated the District Court's judgment on the merits quieting title in the [Reclamation]. Therefore, the title issue remains unresolved." (Kelly 2011)

[16] *Rio Grande Silvery Minnow v. Bureau of Reclamation*, 599 F.3d 1165 (2010).

For the purpose of this BA, Reclamation acknowledges that the MRGCD disagrees with Reclamation's position regarding title to El Vado, the Cochiti heading, and Angostura, Isleta, and San Acacia Diversion Dams (Diversion Dams), other land and irrigation works within the MRGCD, and NMOSE Permit No. 1690 for storage in El Vado Reservoir. El Vado was constructed and paid for by MRGCD funds, and MRGCD claims that title to El Vado was never transferred to Reclamation; even if it were, it would have been only as a security interest for repayment of the 1951 Contract. That contract having been paid, MRGCD contends the title reverted as a matter of law.

# 2. Action Area

The project area is the area where Reclamation's, BIA's, and the non-federal entities' proposed actions occur, and the action area is defined as "all areas to be affected directly or indirectly by the federal action and not merely the immediate area involved in the action" (50 CFR 402.02). For all components of this BA, the project area and action area are considered to be the same.

The entire action area for this consultation is composed of the action areas for Reclamation's water operations and river maintenance activities, BIA's activities, the State's activities, and the MRGCD's activities (Figure I-2). The composite boundaries for this overarching action area are from Heron Reservoir on Willow Creek, the Rio Chama from the confluence with Willow Creek downstream to the Rio Grande, from the New Mexico state line with Colorado on the mainstem Rio Grande downstream to the full reservoir pool of Elephant Butte (EB) Reservoir (considered to be at River Mile [RM] 62), and in specific cases, the Delta Channel, which begins at RM 57.8 and extends downstream to the active EB Reservoir level. The lateral extent of the action area generally is defined by the riverside drains and associated levees located to the east and west of the river; for the Delta Channel the action area includes maintenance of access roads in the area from RM 62 downstream. In situations where levees do not exist, the lateral extents are confined by the historical floodplain, as delineated by geological or anthropogenic constraints. This action area also includes the entire length of the LFCC from RM 116.2 to 60.6, as well as the footprint (facility structure/drain, operation and maintenance [O&M] roads, spoil levees, and immediately adjacent property) of the MRG Project drains and irrigation and flood control structures and facilities between Cochiti Dam and the BDA.

The RM designations used in this document are those included in the 2002 controlled aerial photography. Caballo Dam is considered RM 0, and mile designations increase in an upstream direction.

The component action areas are described in more detail in the following subsections.

## 2.1 Reclamation and BIA

Reclamation's Action Area includes the areas associated with its water operations and river maintenance activities. BIA's Action Area is encompassed within the overall Action Area for Reclamation.

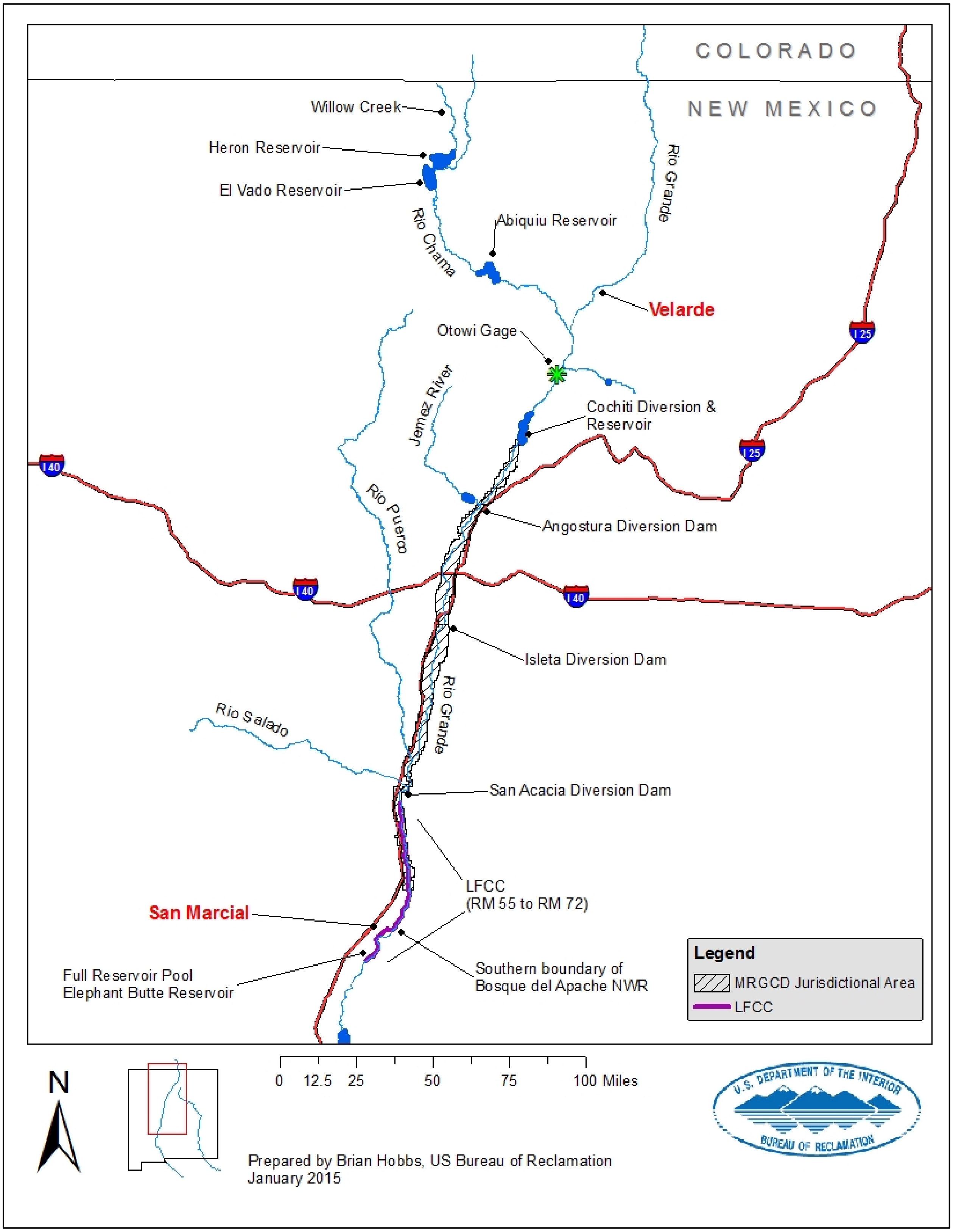


**Figure I-2. Overview map of the entire Action Area**

### 2.1.1 Water Operations

The action area for water operations activities includes Heron Reservoir and Willow Creek downstream from Heron Dam, the Rio Chama downstream from the confluence with Willow Creek, and the Rio Grande from Velarde (RM 286) downstream to San Marcial above the full pool of Elephant Butte Reservoir (RM 62) (Figure I-2). Below Cochiti Dam, the lateral extent of the action area generally is defined by the riverside drains and associated levees located to the east and west of the main stem of the river. In situations where levees do not exist on either or both sides, the lateral extents are confined by the historical floodplain as delineated by geological constraints, such as terraces and rock outcroppings, or anthropogenic constraints, such as irrigation facilities.

### 2.1.2 River Maintenance

The action area for river maintenance activities includes the MRG and Delta Channel, described in more detail in the following subsections.

#### *2.1.2.1 Middle Rio Grande*

The action area for MRG river maintenance activities under this consultation is defined as the Rio Grande from Velarde, New Mexico (RM 286), to the full reservoir pool of Elephant Butte Reservoir (considered to be at RM 62), and in specific cases, the Delta Channel, which begins at RM 57.8 and extends downstream to the active Elephant Butte Reservoir level. The lateral extent of the action area generally is defined by the riverside drains and associated levees located to the east and west of the river, and for the Delta Channel the action area includes maintenance of access roads in the area from RM 62 downstream (Figure I-2). Below Cochiti Dam, the lateral extent of the project area is generally defined by the levees located east and west of the mainstem of the river. Under certain (likely limited) circumstances, the levees may be relocated to provide more area for river migration. In situations where levees on one or both sides are missing, the lateral extents are confined by the historical floodplain (geological constraints, such as terraces and rock outcroppings).

This action area also includes the entire length of the LFCC (Figure I-2). The LFCC parallels the river from the San Acacia diversion dam downstream to the full pool of Elephant Butte Reservoir. The two exceptions to the LFCC being adjacent to the levee are around RM 111 and roughly between RM 72.5 and RM 69. At RM 111, there are two additional areas (total length of about 2,200 feet) where the LFCC footprint is extended (average additional width of 250 feet) to allow space for stockpiling materials used for river maintenance activities. Between RM 72 and RM 69, the LFCC separates from the Rio Grande, with the Rio Grande bounded on the west by the Tiffany Levee. The area between the Tiffany Levee and the LFCC farther to the west, and including the LFCC, is also a potential work area for river maintenance (an average distance of approximately 7,000 feet). At RM 60.5, the LFCC no longer follows a well-maintained path;

rather, it follows the lowest point in the valley, along the west side of the full reservoir pool area, reconnecting to the main stem of the Rio Grande just below RM 55.

The Delta Channel, which begins at RM 57.8 and extends downstream to the active Elephant Butte Reservoir level, is also maintained annually. See Section 2.1.2.2 for more information on the Delta Channel action area.

Reclamation also conducts river maintenance work between Elephant Butte Dam and the I-25 Bridge south of Caballo Dam, but this work is outside the action area for this BA and not part of this consultation.

#### *2.1.2.2 Delta Channel*

Reclamation and the NMISC have entered into a cooperative agreement for water salvage on the MRG. In this agreement, the parties have committed to jointly maintain the existing Delta Channel to facilitate delivery of water and sediment so that the State can meet its water delivery obligations under the Rio Grande Compact. Delta Channel maintenance activities begin at RM 57.8 and extend downstream to the active reservoir pool (RM 38 as of October 2014) (Figure I-2). While the Delta Channel starts at RM 57.8, the action area extends up to RM 62 to include the maintenance of an access road in that area.

## 2.2 Other Reclamation MRG Activities

The project and action areas for other Reclamation MRG activities include the footprint (drain, O&M roads, spoil levees, and immediately adjacent property along the drain corridor) of the MRG Project drains (Drain Unit 7, Drain Unit 7 Extension, La Joya Drain, San Francisco Drain, San Juan Drain, Elmendorf Drain, and the Escondida Drain) and the LFCC. The LFCC is typically adjacent to the western levee, relative to the river, and maintenance activities may occur between the eastern toe of the western spoil levee and the toe drain to the west of the western O&M access road (an average distance of 230 feet, with occasional distances up to 300 feet).

## 2.3 State of New Mexico

The action area for the State’s proposed water operation actions covers the Rio Grande Basin from the New Mexico state line with Colorado to the full pool of Elephant Butte Reservoir (Figure I-2). The action area for State river maintenance activities is the same as that described for Reclamation.

## 2.4 Middle Rio Grande Conservancy District

The action area for the MRGCD MRG activities includes the footprint (facility structure, O&M roads, spoil levees, and immediately adjacent property) of irrigation and flood control structures and facilities between Cochiti Dam and the northern boundary of BDA.

# 3. Species Description, Federal Listing Status, and Life History

## 3.1 Rio Grande Silvery Minnow

### 3.1.1 Species Description

The Rio Grande silvery minnow (*Hybognathus amarus*) (silvery minnow) is a small-bodied minnow reaching a maximum size of approximately 4 inches (Sublette et al. 1990). The silvery minnow is part of the genus *Hybognathus* that has at least seven recognized species, which are similar morphometrically (Bestgen and Propst 1996). The taxonomic status of silvery minnow has changed several times since its original description by Girard in 1856 from specimens collected in the vicinity of Brownsville, Texas. Pflieger (1980) was the first to separate the silvery minnow as its own species, *H. amarus.* This status has been supported by several publications investigating morphometric and genetic characteristics (Cavender and Coburn 1988, Hlohowskyj et al. 1989, Mayden 1989, Cook et al. 1992, Schmidt 1994, Bestgen and Propst 1996).

### 3.1.2 Distribution and Abundance

Historically, the silvery minnow is purported to have occurred in the Rio Grande from Española, New Mexico to the gulf coast of Texas and in larger tributaries including the Pecos River, an area encompassing more than 1,500 river miles (2,400 kilometers [km]). There is also some historical information from tribal sources that silvery minnow may have occupied the Rio Chama up to approximately Abiquiu (Parametrix 2010). Today, the silvery minnow is restricted to the reach of the Rio Grande in New Mexico, much of which is susceptible to drying, from the vicinity of Bernalillo downstream to the headwaters of Elephant Butte Reservoir. The occupied distance is approximately 10% of its presumed historical range (approximately 150 river miles [241 km]). This area is encompassed by the action area for this consultation. The last silvery minnow collected outside the MRG was in the Pecos River in 1968 (Museum of Southwestern Biology Records).

There had been no silvery minnow collected in the Big Bend Reach of the Rio Grande in Texas since 1961. Silvery minnow from the propagation facilities supported by the Collaborative Program have been stocked in the Big Bend Reach since 2008 as a nonessential experimental population, authorized by section 10(j) of the ESA (73 Fed Reg 74357). Initial surveys showed evidence of reproduction (i.e., eggs), though it is too early to determine if the population will become self-sustaining.

The portion of river between Cochiti Dam and Angostura Diversion Dam is still considered to be occupied, but very few surveys have been conducted in this reach in recent years. Since completion of Cochiti Dam in 1975, this river reach has been depleted of sand and sediment believed to be an important component of silvery minnow habitat. Egg monitoring conducted in the early 2000s in the Angostura Canal, just downstream from the Angostura Diversion Dam, yielded only three eggs in 2003, but these were not preserved to confirm species identification. In the Cochiti Reach, the species has either been extirpated or only occurs in very low densities (Service 2010), and Angostura Diversion Dam appears to restrict upstream movement of silvery minnow into this reach.

#### *3.1.2.1 Population Monitoring*

There are several ongoing activities that are performed to monitor the current status of silvery minnow in the project area. Reclamation, through the Collaborative Program, funds silvery minnow population monitoring that occurs each month except for January and March using seines and collects catch per unit effort (CPUE) data on the small bodied fish community of the Rio Grande. Similar methods have been used since 1993. Principal objectives of this study are to provide timely monitoring of the temporal trends for silvery minnow within the Rio Grande.

October surveys are used as indicators of annual population status and recruitment during a time of year with generally stable base flow conditions and warm water temperatures (Collaborative Program 2006, Appendix A) that help to reduce sampling variability (SWCA 2010a, Task 1). In recent years, additional repeated sampling occurred annually at all 20 monitoring sites in November to investigate the level of sampling variation for this type of sampling, with results showing that variation within that timeframe is low and consistent for studies in 2009 and 2010 (Dudley and Platania 2011a, 2011b). In addition to the contracted monthly population monitoring, Reclamation biologists conduct silvery minnow presence/absence surveys within the MRG Project area. These include surveys at sites throughout the MRG (Angostura, Isleta, and San Acacia Reaches) using electrofishing, as well as within the Delta Channel using seining (the Delta Channel begins approximately one mile downstream of the southern-most population monitoring site). The Service's NM Fish and Wildlife Conservation Office also conducts monthly fish sampling surveys within the MRG at various locations to assess presence/absence of silvery minnow.

A gear evaluation study was conducted to examine the strengths and weaknesses of various sampling methodologies. Findings indicated that large numbers of samples are needed to detect small population changes with the current methodology (SWCA 2010a, Task 1), especially when population numbers are low. The study also showed that the mean size of silvery minnow captured by seining may be smaller than with fyke nets, especially during spring sampling in overbank habitats (SWCA 2011b). As far as community monitoring, seines captured the highest number of species when compared with fyke nets and electrofishing. As with all fish sampling techniques, this study indicated that gear suitability is dependent on study objectives, methods used, target species, and logistical and budgetary constraints (SWCA 2011, Gonzales et al. 2012).

#### *3.1.2.2 Population Estimation*

In addition to population monitoring, a population estimation effort was conducted in October annually from 2006 to 2011. The population estimate used a depletion method within an enclosure, utilizing cages and electrofishing within small mapped sections of the river. There appears to be a close relationship between the 2008–2010 population trends obtained from the population estimation program and population monitoring (Dudley et al. 2011); however, there is a divergence between the two datasets in 2011. There are currently not enough data points to establish if there is a relationship between the two studies that would allow for extrapolation from population density estimates to an estimate of riverwide minnow abundance. The riverwide population estimate has ranged from a high of 1.4 million in 2009 to a low of 267,000 in 2010.

#### *3.1.2.3 Spawning Monitoring and Entrainment*

Each spring, spawning effort in the main river channel and entrainment of silvery minnow eggs into the canal system are monitored during spring runoff. This monitoring is a requirement of the 2003 BO; it provides information on the timing and magnitude of spawning in the MRG, and documents spatial and temporal trends in reproductive effort annually and across years. The number of monitoring stations in the main river channel has varied among years, but has consisted of stations within the river at standard locations. Canal sites have varied among years as well, but have been consistently maintained at sites in the Isleta and San Acacia Reaches, with corresponding river sites for comparison in recent years. These stations are deployed within the river or canal, and the number of eggs per volume is calculated on a daily basis. Hourly catch rates also are recorded by crews collecting eggs for propagation purposes.

Project specific monitoring also occurs for habitat restoration and river maintenance projects. These will be discussed more specifically in Section 4.6.

#### *3.1.2.4 Status of Silvery Minnow in the MRG*

##### *3.1.2.4.1 Spawning*

Egg monitoring has shown a large variation in the number of eggs that are detected in the river on an annual basis. Timing of spawning appears to be related to a combination of discharge and water temperature conditions. Though the total numbers of eggs collected in low-flow years is generally higher than in high-flow years, when adjusted for total volume of water, the number of eggs transported in high-flow years is still substantial (several million eggs) (Dudley and Platania 2010). A small proportion of entrained eggs are sometimes salvaged from irrigation canals; however, improvements in the way diversions have been managed have minimized the number of eggs that are entrained. Temperature monitoring during egg monitoring indicates that, while mean daily temperatures across years are similar during spawning events, temperatures during high-flow years are more constant and experience less diel variation (Platania and Dudley 2006). It is unclear how this temperature fluctuation affects spawning or larval development.

Silvery minnow spawning has been detected each year that monitoring was conducted. As can be seen in Figure I-3, there is not a statistically significant correlation between the catch rate of eggs at the two monitoring sites and October CPUE ($R = 0.708$, $p = 0.352$). Silvery minnow have a possible reproductive output of > 2,000 eggs per female (Platania and Altenbach 1996). It is difficult to infer a measure of annual recruitment success from the number of eggs detected in the drift. Recruitment from egg to post-larval stages may be a more important dynamic and is dependent on habitat quantity and quality.

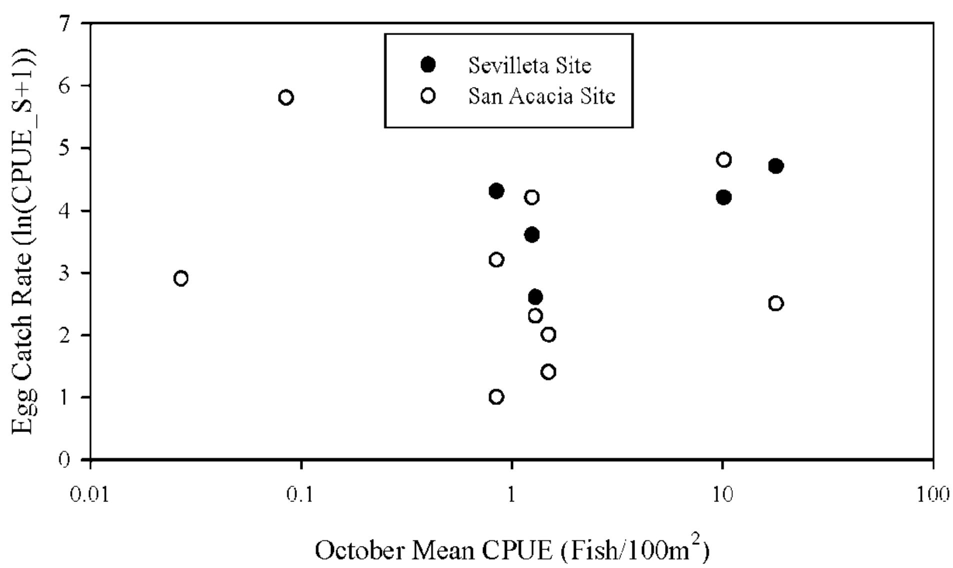


**Figure I-3. Scatter diagram of egg catch rate for Sevilleta (2006–2011) and San Acacia (2002–2004, 2006–2011) sites (Dudley and Platania 2011) with October CPUE data (population monitoring data)**

Since monitoring efforts began in 1993, the population dynamics of silvery minnow have been highly variable (Figure I-4). Silvery minnow catch rates declined an order of magnitude between 1993 and 2004, then increased to the highest density in 2005, and experienced a decline after 2009. Extremely low silvery minnow densities have been recorded since 2012, with an October census of 0.0 silvery minnow/100 $m^2$ in both 2012 and 2014, and only 0.029 silvery minnow/100 $m^2$ in 2013 (Dudley and Platania 2012, 2013, 2014). The October census is on 20 established sites; however, silvery minnow were captured at other locations.

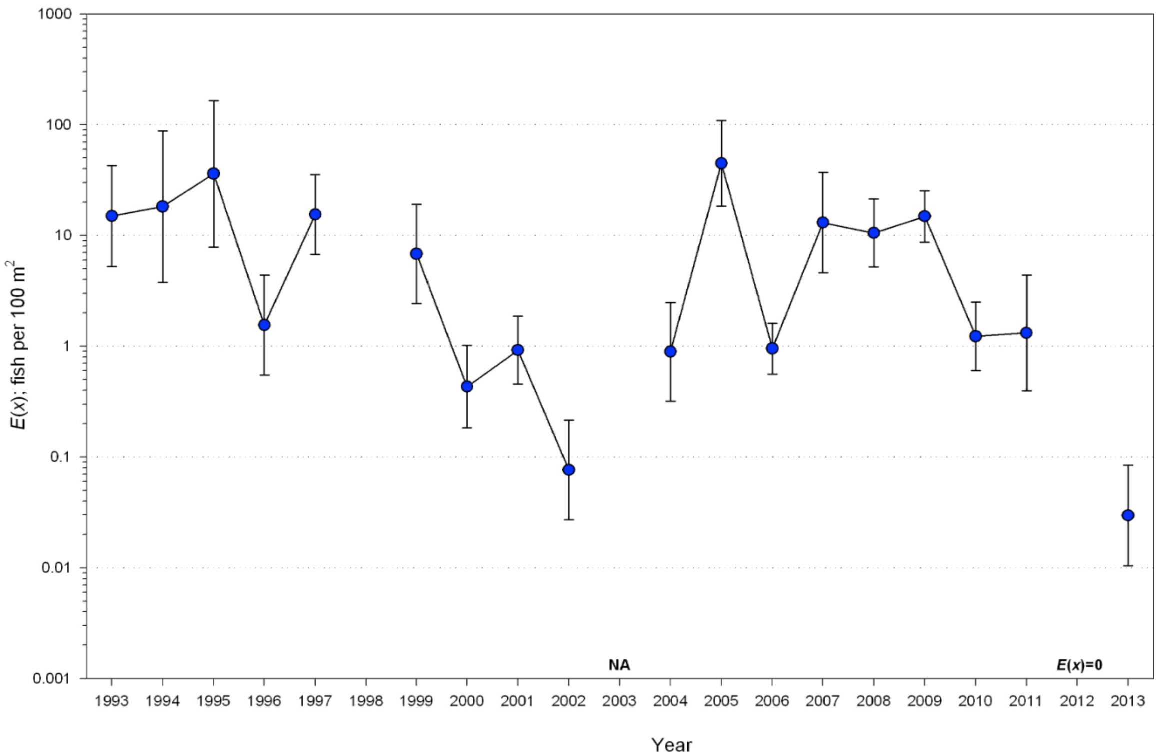


**Figure I-4. Rio Grande silvery minnow estimates of density (E(x)) using October sampling-site density data (CPUE; 1993-2013). Solid circles indicate modeled estimates and bars represent 95% confidence intervals. Dotted horizontal lines represent orders of magnitude (Dudley et al. 2014).**

The silvery minnow has not had strong recruitment (meaning the fall catch rates were less than the pre-spawn levels) (Figure I-5). In 2002, 2003, 2006, 2012, 2013, and 2014, there was little or no spring run-off. Population estimation modeling from 2008–2011 also shows a substantial decline in silvery minnow populations in 2010 in all reaches (Dudley et al. 2011). Estimates of the 2010 population were 67–90% lower than 2008 and 2009 estimates, depending on the reach and method used. It is uncertain what circumstances caused population decline in 2010.

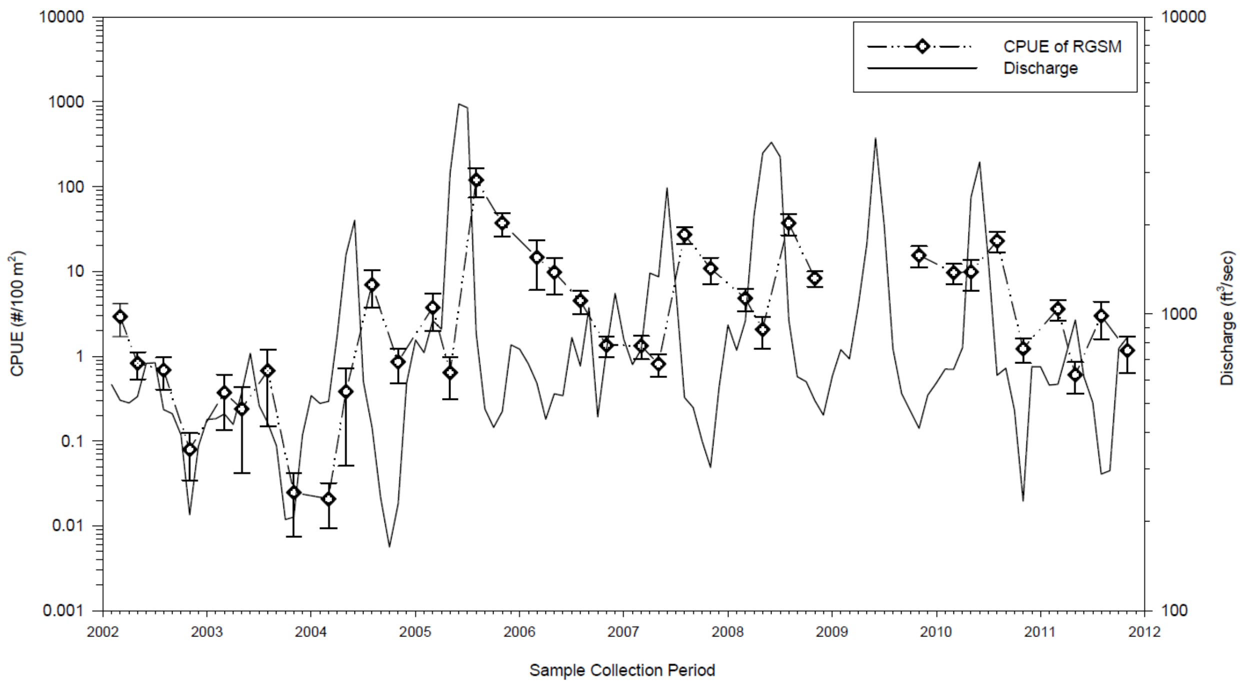


**Figure I-5. Time sequence of quarterly Rio Grande silvery minnow densities of the past decade (2001–2012) at population monitoring program collection sites and mean monthly discharge at USGS Gage #08330000 (Rio Grande at Albuquerque, New Mexico). Diamonds indicate sample means for each survey, and capped bars represent standard error (from Dudley and Platania, 2012).**

### *3.1.2.4.2 Population Dynamics*

Results from surveys conducted by Reclamation follow a similar pattern for the silvery minnow throughout the MRG due to drought and decreased spring runoff.

Analysis of the population monitoring data indicates a positive correlation between spring flow and mean October densities (Figure I-6) (Dudley and Platania 2011). This was confirmed through the analysis conducted in the PVA Ad-hoc Workgroup (PVA Workgroup, 2011)).

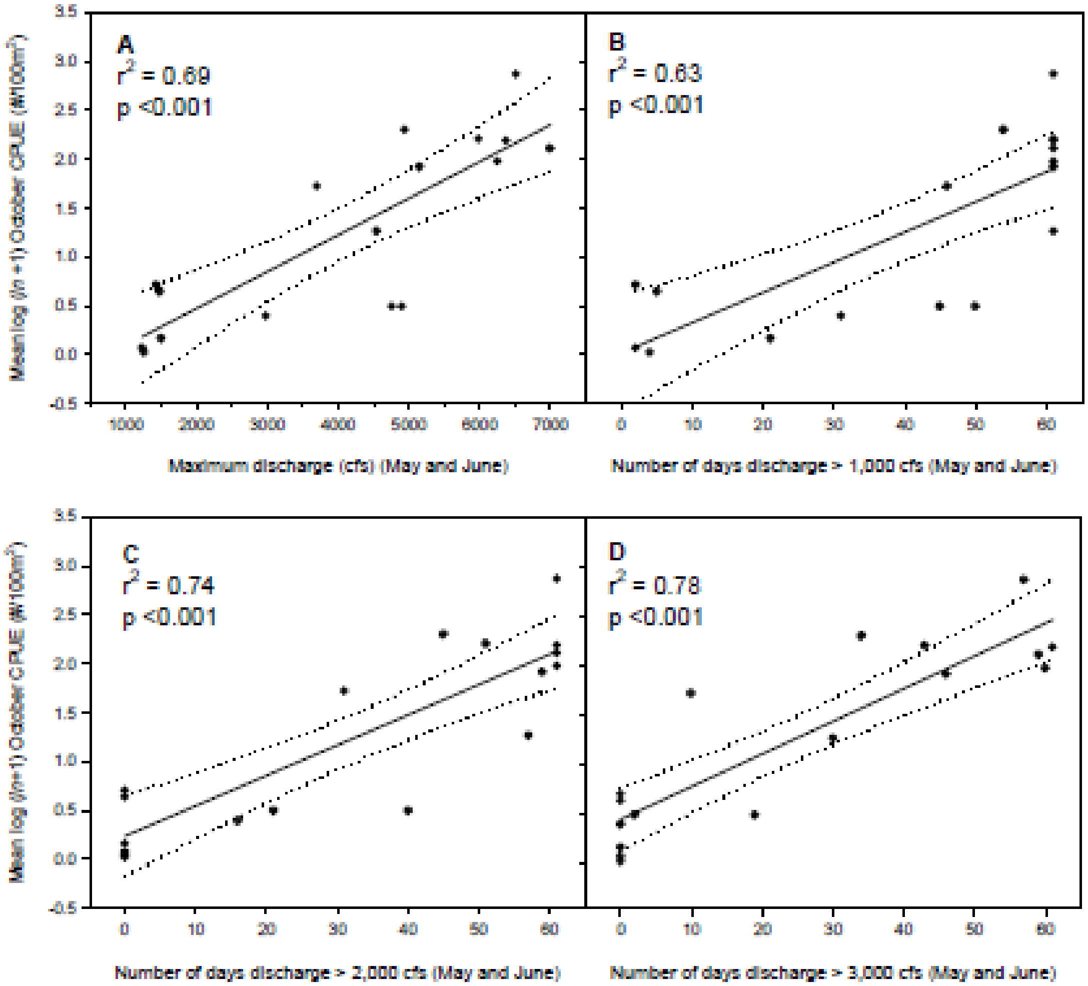


**Figure I-6. Regression analysis of Rio Grande silvery minnow log-transformed mean October densities (1993–1997,1999–2010) and select hydraulic variables (during May and June) for USGS Gage #08330000 (Rio Grande at Albuquerque, New Mexico). Graph shows regression line (solid) and 95% confidence intervals (dotted) (from Dudley and Platania 2010).**

Analysis did not indicate that summer flows enhance survival through the summer using mean summer CPUE (July–September). However, the regression analysis of October CPUE by Dudley and Platania indicated that silvery minnow CPUE increased significantly with delayed onset of low flows and increased mean daily discharge (as measured at the San Marcial gage) (Figure I-7). There were also significant negative correlation between October silvery minnow densities and number of days with discharge below threshold values (i.e., less than < 200 and < 100 cfs) (Dudley and Platania 2011).

The current silvery minnow population in the MRG has been annually augmented with hatchery-reared fish, including both wild caught eggs and larvae reared for eventual release back into the wild, as well as fish produced from captive broodstock. The program began stocking a few fish in 2001; large numbers of fish were stocked starting in 2003 (Remshardt 2010a) and to date, more than 2.3 million silvery minnow have been released into the MRG (Archdeacon et al. 2014).

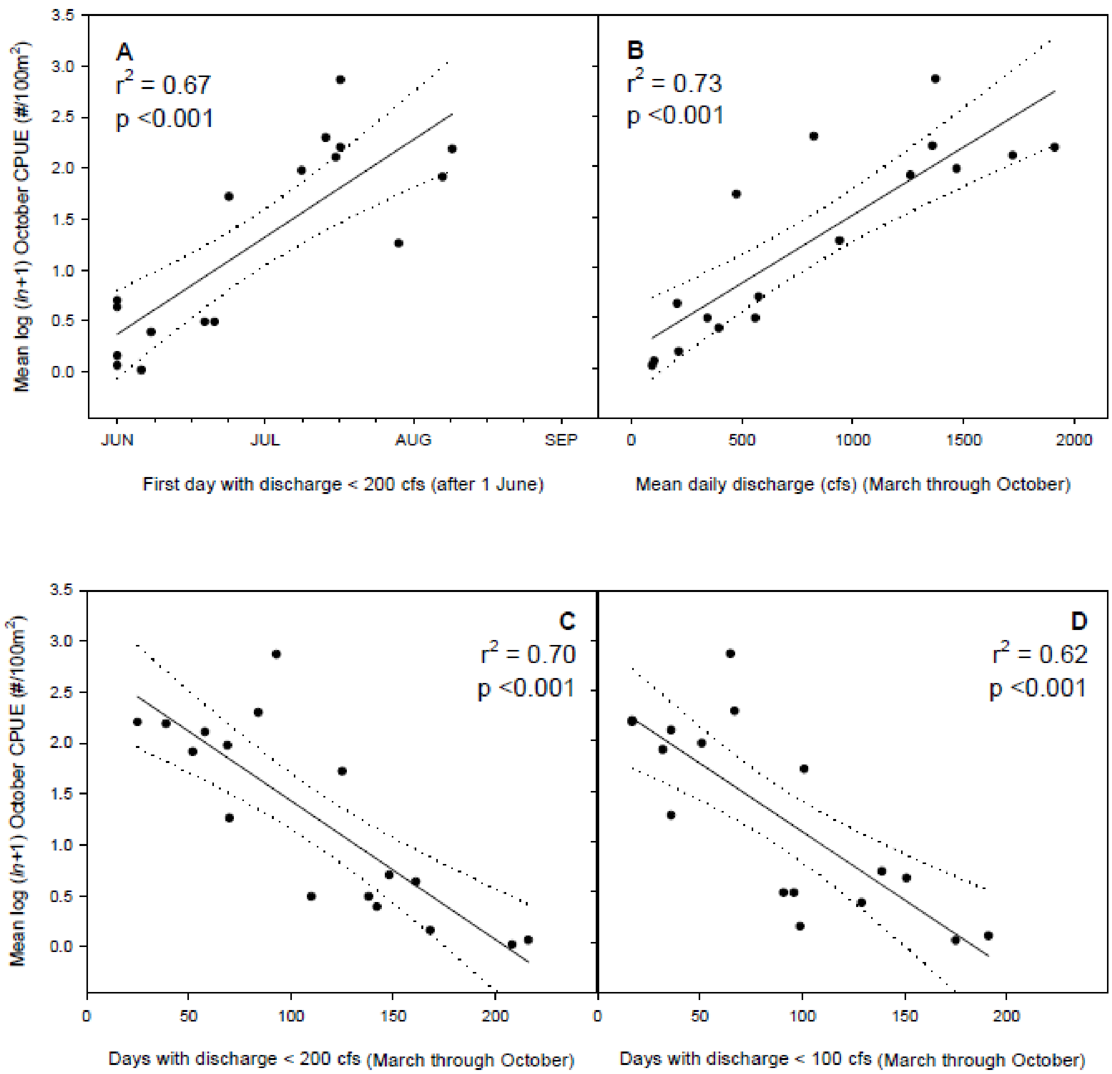


**Figure I-7. Regression analysis of Rio Grande silvery minnow log-transformed mean October densities (1993–1997, 1999–2010) and different hydraulic variables for USGS Gage #08358400 (Rio Grande Floodway at San Marcial, New Mexico). Graph shows regression line (solid) and 95% confidence intervals (dotted) (from Dudley and Platania, 2011).**

The numbers of fish stocked annually is based on a formula to achieve an overall density of 1.0 silvery minnow/100 $m^2$ as determined by September monitoring results (Remshardt 2012). All stocked silvery minnow are marked with visible implant elastomer tags. Initially, low numbers of hatchery minnow were captured in monitoring efforts (from <3% to 20% depending on the reach). Even in these earlier years with lower recapture rates for hatchery fish, it appeared the augmentation program had an effect on maintaining genetic diversity within the three reaches. In recent years, the majority of minnow captured during monitoring efforts have been hatchery-reared fish (e.g., Service monitoring from December 2013 to November 2014 found that 63 of 97 silvery minnows detected were hatchery-reared fish [Archdeacon 2015]). These results indicate that a high percentage of the existing silvery minnow population in recent years consists of augmented fish, suggesting a current dependence of the population on the captive rearing program. The propagation program provides security against catastrophic failure of the species within the MRG because it is currently the only established population of silvery minnow.

During river drying events, silvery minnow are rescued from isolated pools and relocated to wet portions of the river, generally within the same reach. The initial salvage program moved fish to upstream reaches; however, since 2007, salvaged silvery minnow are only moved to wetted areas within the same reach. Salvage and propagation activities are discussed more fully in Section 4.6.3.

From 2001–2010, there was variation in the community composition of fishes in the Rio Grande. Silvery minnow comprised a higher fraction of the total ichthyofaunal community from 2005–2009 than from 2000–2004 (Dudley and Platania 2011). The most common species in seining surveys were flathead chub, longnose dace, and white sucker in the Angostura Reach. Red shiner, common carp, silvery minnow, fathead minnow, river carpsucker, channel catfish, and western mosquitofish were most common in the Isleta Reach. Silvery minnow was more common in the Isleta and San Acacia Reaches compared to the Angostura Reach. Reclamation has annually electrofished portions of the river in February. These surveys most often captured channel catfish, common carp, and river carp sucker in the Angostura Reach, while silvery minnow were the most common species captured in the Isleta and San Acacia Reaches for the past 5 years (Reclamation 2010, 2012b).

The silvery minnow population has continued to decline in recent years (Dudley and Platania 2013, 2014; Dudley et al. 2014). The majority of fish that are collected during monitoring are hatchery-reared individuals, with a downward trend in the number of young-of-year observed. Hatchery-produced fish have been used to augment the wild population (e.g., 293,069 in 2013 and 268,318 in 2014) (Archdeacon et al. 2014, 2015); however, October population monitoring census indicates low recruitment and survival of silvery minnow in the past few years. Trends in the abundance of silvery minnow observed during rescue and salvage operations mirror those of population monitoring (Archdeacon et al. 2014). Several consecutive years of exceptional drought with limited spring runoff and silvery minnow recruitment are reflected in these recent population trends, resulting in dependence on augmentation to support the silvery minnow population. Current management practices are helping to prevent extinction but additional resources and efforts are required to work toward a self-sustaining population in the MRG and support species recovery (Dudley et al. 2015).

Additional information pertaining to the status of the silvery minnow can be found in the following documents:

Archdeacon, T.P., K.R. Henderson, R.L. Cook, and T.J. Austring. 2014. *Rio Grande Silvery Minnow Salvage and Rescue 2014 Annual Report*. Prepared for Middle Rio Grande Endangered Species Collaborative Program. Submitted to U.S. Bureau of Reclamation, Albuquerque, New Mexico. 23 p.

Dudley, R.K. and S.P. Platania. 2013. *Rio Grande Silvery Minnow Population Monitoring Program Results from December 2011 to October 2012*. Final report prepared for the Middle Rio Grande Endangered Species Collaborative Program by American Southwest Ichthyological Researchers, L.L.C., Albuquerque, New Mexico. 158 p.

Dudley, R.K. and S.P. Platania. 2014. *Summary of the Rio Grande Silvery Minnow population monitoring program results from October 2014*. Prepared for the Middle Rio Grande Endangered Species Collaborative Program by American Southwest Ichthyological Researchers, L.L.C., Albuquerque, New Mexico. 29 p.

Dudley, R.K., S.P. Platania, and G.C. White. 2014. *Rio Grande Silvery Minnow Population Monitoring Program Results from May to December 2013*. Final report prepared for the Middle Rio Grande Endangered Species Collaborative Program by American Southwest Ichthyological Researchers, L.L.C., Albuquerque, New Mexico. 137 p.

Dudley, R.K., S. P. Platania, and G.C. White. 2015. *Rio Grande Silvery Minnow Population Monitoring Program Results from February to December 2014*. Final report prepared for the Middle Rio Grande Endangered Species Collaborative Program by American Southwest Ichthyological Researchers, L.L.C., Albuquerque, New Mexico. 195 p.

##### *3.1.2.4.3 Genetic Monitoring*

Genetic monitoring of silvery minnow has been conducted since 1999. Historically, population bottlenecks have occurred that likely caused the loss of rare alleles and limited the allelic diversity of the population. Genetic variation and heterozygosity are often maintained unless the bottleneck is severe and lasts for several generations (Nei et al. 1975). Heterozygosity provides a good measure of the capability of a population to respond to selection immediately following a bottleneck. However, the number of alleles remaining is important for the long-term response to selection and survival of populations and species (Allendorf 1986). It is important to maintain a species genetic diversity for long-term population persistence to allow species the ability to adapt and respond to environmental changes.

The current genetic monitoring measures a variety of diversity metrics based on multiple microsatellite and mitochondrial DNA markers. Prior to the augmentation program for silvery minnow, there was considerable variation in diversity measures across reaches. Since the initiation of augmentation, diversity metrics have stabilized (Figure I-8), indicating that allele frequencies are being maintained within the population. Heterozygosity has continued to be variable (Osborne et al. 2012). In addition, a separate investigation of the genes of the immune response indicates that the silvery minnow shows similar variation to other cyprinid fishes studied (Osborne and Turner 2011a).

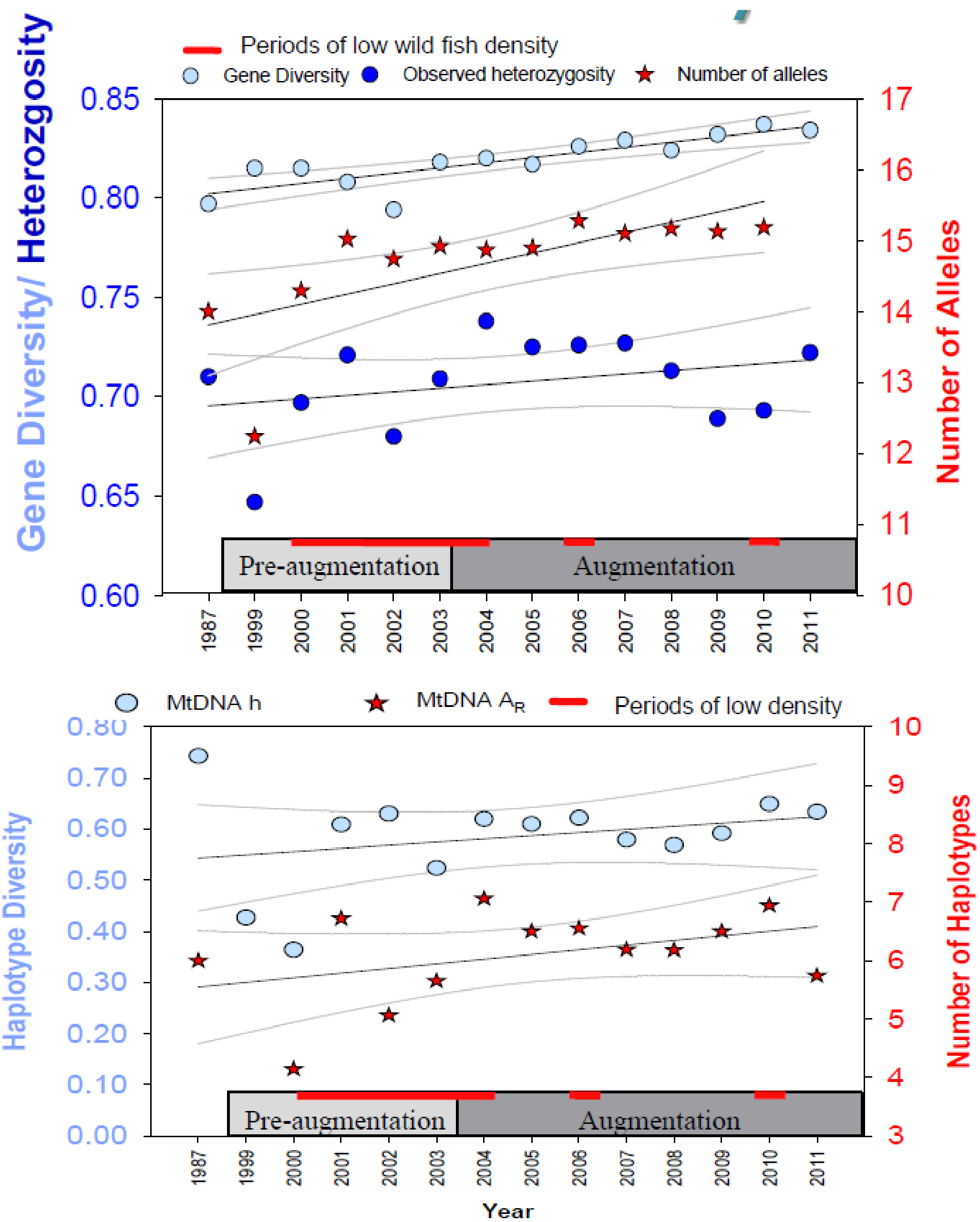


**Figure I-8. Diversity metrics of Rio Grande silvery minnow from genetic monitoring program from Osborne and Turner (2011b)**

Generally, recovery plans for rare species often reference a goal of attaining a minimum effective population size of 500 (Frankel and Soulé 1981). This number was derived using theoretical numbers based on calculations for "ideal" populations (i.e., one that meets all the Hardy-Weinberg assumptions) that would lose heterozygosity at a rate equal to that of the observed population; in other words, the minimum number of adults necessary to maintain genetic diversity and keep inbreeding at low levels. Temporal estimates of "genetic" effective population size ($N_e$) using various genetic methods have found that actual $N_e$ of most wild populations is much lower than would be calculated using population size estimates (Palsta and Ruzzante 2008). Many fish species with type III survivorship curves (such as the silvery minnow—e.g., high fecundity, high early mortality) show a very low ratio of $N_e/N$ (adult census size). Factors that contribute to this include fluctuating population size, biased sex ratios, variance in reproductive success between individuals, and metapopulation dynamics (Turner et al. 2002).

The revised recovery plan for the silvery minnow (Service 2010) states that the current measured effective population size of silvery minnow is estimated to be around 100 adults. There are several ways to estimate genetic effective size. Each type of estimator has biases associated with it. In variable populations, there is not generally correlation between variance effective size ($N_{eV}$) and inbreeding effective size ($N_{eI}$). $N_{eV}$ measures the variance in allele frequencies between two time points. $N_{eI}$ measures the probability of identity by descent. In a declining population, $N_{eI} > N_{eV}$. In a growing population, $N_{eI} < N_{eV}$. Depending on the method used, the variance effective size for silvery minnow has been in the range of 200–400 in the last decade (PBS&J 2011). Inbreeding effective size estimates are higher, ranging from 500 to infinity, but the variability is heavily influenced by sample size (Osborne and Turner 2011b). The estimates of variance effective size are small, but had stabilized and shown a slightly increasing trend until recently (Osborne et al. 2012). In 2014, however, mean estimates of variance effective size were not significantly different but were significantly smaller than observed in wild fish in most previous years (Carson et al. 2014).

The current silvery minnow population is confined to a limited area and does not have the possibility of occasional immigration from a disconnected population. In addition, gene flow between subsets of the population is limited to a downstream direction due to the presence of migration barriers. There is no correlation between CPUE levels and effective population size. For silvery minnow, there are likely several factors that influence genetic effective size beyond population size, including augmentation of the population by captive stocks. Generally, captive stocks from wild caught origins have higher variance effective size than those that are produced from hatchery broodstock. The availability of wild caught eggs for broodstock has been variable, and most recent stockings have been from captive spawning. Large numbers of eggs were collected in 2011, which should add to the genetic diversity of the hatchery stocks. Though low numbers of hatchery fish are generally captured in monitoring efforts, it appears that augmentation has positive effects for maintaining genetic diversity of the population, especially during low-population years.

##### *3.1.2.4.4 Water Quality and Fish Health Monitoring*

There are two general types of water quality concerns in the Rio Grande. Point source discharges generally occur near water treatment facilities or stormwater discharges that can cause fish kills. These have been documented occasionally within the Rio Grande within the Angostura Reach. NMDGF or the New Mexico Environment Department (NMED) investigate any reports of fish kills and try to determine a cause. There is not a coordinated effort for a long-term recordkeeping process for these fish kills. In the last few years, fish kills have been documented from various causes including ash flows from forest fire areas, low oxygen events from stormwater, and high chlorine levels in wastewater treatment effluent. In New Mexico, investigations of stormwater-related issues are led by the NMED and local governments. The City of Albuquerque currently has a program to improve the effectiveness of the storm drainage system within the City of Albuquerque and to safeguard the quality of the stormwater runoff discharging into the Rio Grande. Substances that enter the storm drain system currently flow directly to the Rio Grande, usually via neighborhood arroyos. New Mexico has not assumed the National Pollutant Discharge Elimination System (NPDES) stormwater program, and the U.S. Environmental Protection Agency (EPA) implements the NPDES program in New Mexico. The New Mexico Department of Transportation, the City of Albuquerque, the Albuquerque Metropolitan Arroyo Flood Control Authority (AMAFCA), and the Southern Sandoval County Arroyo Flood Control Authority produced the Storm Water Management Guidelines for Construction and Industrial Activities Manual in 2003.

In addition to these short-term issues, there is concern about long-term, chronic conditions that may affect fishes through long-term exposure and cause reproductive effects, health issues, or death. Sublethal impacts of various chemicals contribute to the overall conditions of environmental stress in the MRG, which could lead to declines in the population of silvery minnow and other aquatic life. A risk assessment was conducted using data available through 2003. This assessment's primary conclusion was that there is no clear "smoking gun" chemical that can be singled out as an agent likely to have produced significant riverwide historical impacts to silvery minnow. Nor can any chemical be specifically targeted as currently impairing the recovery of silvery minnow within the MRG (Tetra Tech 2005).

A study conducted by the NMED from 2006–2008 (NMED 2009) identified only a few water quality issues, notably elevated *E. coli*, one sample with an ammonia concentration of 9.12 milligrams per liter (mg/L) (five times the acute criteria), low dissolved oxygen (DO) during brief periods of time, and some samples elevated in metals such as aluminum, copper, and chromium. Temperature exceedances of their 32.2°C criterion were few, and the magnitude of exceedance was never greater than 3°C. For pH, no exceedances of the 6.6–9.9 standard units criterion were documented from deployed dataloggers at any locations except for one sample in 2007 at NM Highway 550 Bridge. Buhl (2008) established several preliminary parameters specific to silvery minnow: Water temps > 36°C acutely lethal, DO < 0.6 mg/L acutely lethal.

There were several instances of DO readings that were lower than the 5 mg/L standard within the Angostura Reach. NMED states in their report that these will be investigated more fully in the current monitoring period (2010–2012). In their draft 2006–2008 silvery minnow health study, the Service (2012) found that many of these low DO readings may be associated with storm events.

Fish tissue-based testing was conducted in 2007 within the Angostura Reach using a variety of species from the MRG. Sites were sampled, including (1) below North AMAFCA, and (2) Albuquerque South Side Water Reclamation Plant (which included the Rio Grande below South AMAFCA).

These fish showed levels of zinc and DDT higher than levels established by the United States Department of Agriculture Forest Service BEST Program as potentially having toxic effects on various fish species (NMED 2009). Fish collected in this survey contained several chemicals at concentrations above method detection limits but below toxic levels. The only contaminants not detected were lead and selenium for all samples and cadmium at two of the four sites. The sampling that took place near the Highway 550 site contained the highest concentration of cadmium and arsenic. Samples collected near the Rio Rancho Waste Water Treatment Plant (WWTP) contained the highest concentrations of mercury. The Albuquerque WWTP sample contained the highest concentrations of zinc.

The Service's fish health study of the wild silvery minnow population found no pathogenic viruses present in fish of the MRG. There was no obvious pattern of parasitic infections at various sites; however, bacterial infections were more prevalent during warm temperatures. Many species, including silvery minnow, exhibited shortened opercula. It is unknown if water quality issues influence this defect (Lusk et al. 2012).

Buhl (2011) conducted in situ experiments in the water from an irrigation wasteway drain to inform the feasibility of creating refugial habitat with this water during dry periods. There were no significant differences in survival, total length, weight, or condition factor of fish across sites, but absolute weight loss and relative reduction in condition factor were significantly greater in fish at the site just below the drain (wetted in stream habitat site) compared to those at a nearby river site. Some of these differences may have been related to the depth of the site and not directly attributable to the water quality.

A 2003 survey of various pharmaceutically active compounds did not detect estrogenic hormones within the Rio Grande. Antibiotic concentrations in the Rio Grande were minimal, with only sulfamethoxazole being detected (Brown et al. 2006). The USGS is currently conducting a study of estrogenic biomarkers and the effects of these compounds on the silvery minnow.

Water quality criteria were established for salvage of silvery minnow from isolated pools based on a series of survival tests (Caldwell et al. 2010). Fish in isolated pools are often very stressed from crowding, suboptimal water quality, and temperature fluctuations that cause them to be more susceptible to parasites and bacterial diseases. Thus, survival of these stressed fish is low. For a pool to be considered for salvage, a pool must meet the following conditions: (1) water temperature < 34 °C, (2) dissolved oxygen > 2.0 mg/L, (3) pH < 9.0 (4) no observable dead fish, (5) no moribund fish as indicated by lethargy, and (6) no fish exhibiting hemorrhagic lesions. If any of these secondary criteria are not met, the pool is not rescued.

### 3.1.3 Listing Status – Critical Habitat

The silvery minnow is currently listed as endangered on the New Mexico State list of endangered species, having first been listed May 25, 1979 as an endangered endemic population of the Mississippi silvery minnow (*Hybognathus nuchalis*). On July 20, 1994, the Service published a final rule to list the silvery minnow as an endangered species with proposed critical habitat (59 Fed Reg 36988). The Service initiated a 5-year review of the status of the species in 2010 (75 Fed Reg 15454). Additional information was submitted to the Service for consideration by many entities, including MRGCD and NMISC, but the review has not been published at this time.

Critical habitat was designated for the silvery minnow in 1999 (64 Fed Reg 36274), with revisions published February 19, 2003 (68 Fed Reg 8088). Designated critical habitat in the Rio Grande extends through Sandoval, Bernalillo, Valencia, and Socorro Counties, New Mexico, generally beginning at Cochiti Dam downstream to the utility line crossing the Rio Grande at the upstream end of the Elephant Butte Reservoir full pool (RM 62). The lateral extent of critical habitat includes those areas bounded by existing levees. In areas without levees, the lateral extent of critical habitat, as proposed, is defined as 300 feet (91.4 meters [m]) of riparian zone adjacent to each side of the river.

The critical habitat designation also includes a 5-mile segment of the Jemez River from Jemez Canyon Dam to the upstream boundary of Santa Ana Pueblo, Sandoval County. Pueblo lands in Santo Domingo, Santa Ana, Sandia, and Isleta Pueblos are excluded from critical habitat. The Service considered the Rio Grande around Big Bend National Park and the Pecos River between Ft. Sumner Dam and Brantley Reservoir as essential to conservation but did not designate them as critical habitat.

The Service identified four primary constituent elements (PCE) in the critical habitat designation (68 Fed.Reg 8114):

> "1. A hydrologic regime that provides sufficient flowing water with low to moderate currents capable of forming and maintaining a diversity of aquatic habitats, such as, but not limited to, the following: Backwaters (a body of water connected to the main channel, but with no appreciable flow), shallow side channels, pools (that portion of the river that is deep with relatively little velocity compared to the rest of the channel), eddies (a pool with water moving opposite to that in the river channel), and runs (flowing water in the river channel without obstructions) of varying depth and velocity—all of which are necessary for each of the particular silvery minnow life-history stages in appropriate seasons. The silvery minnow requires habitat with sufficient flows from early spring (March) to early summer (June) to trigger spawning, flows in the summer (June) through fall (October) that do not increase prolonged periods of low or no flow, and a relatively constant winter flow (November through February).
>
> 2. The presence of low-velocity habitat (including eddies created by debris piles, pools, or backwaters, or other refuge habitat (e.g., connected oxbows or braided channels) within unimpounded stretches of flowing water of sufficient length (i.e., river miles) that provide a variety of habitats with a wide range of depth and velocities.
>
> 3. Substrates of predominantly sand or silt.
>
> 4. Water of sufficient quality to maintain natural, daily, and seasonally variable water temperatures in the approximate range of greater than 1 degree Celsius (°C) (35 degrees Fahrenheit[°F]) and less than 30°C (85°F) and reduce degraded water quality conditions (decreased dissolved oxygen, increased pH, etc.)."

### 3.1.4 Life History and Ecology

Historically, the occupied range of silvery minnow included a broad range of presumed environmental parameters from those typical of the arid Southwest to the gulf coast of Texas. Current knowledge of silvery minnow life history and requirements are based on studies that have been conducted within the species' contemporary range, an environment that has been dramatically altered. It is unknown how the minnow's life history attributes may have differed in now unoccupied portions of its range.

In the MRG, silvery minnow generally spawn in the spring, from late April through June (Dudley and Platania 2014). Peak egg production typically occurs in mid- to late-May, coinciding with high spring discharge produced by snowmelt runoff. Spawning also is thought to be sometimes triggered by summer flow spikes in years with negligible snowmelt runoff. It is likely that several environmental variables influence the timing of silvery minnow spawning (e.g., photoperiod, temperature, and water turbidity).

Reproductively mature females are typically larger than males. Each female produces several clutches of eggs during spawning, ranging from 2,000–3,000 (Age 1) to 5,000+ eggs (Age 2) per female (Platania and Altenbach 1996). The majority of the population captured by population monitoring during prespawn seining surveys consists of Age 1 fish (1 year old), with older, larger fish (Age 2+) comprising less than 10% of the spawning population (Platania and Altenbach 1996, Horwitz et al. 2011). In paired sampling trials, the mean size of silvery minnow captured during spring sampling of inundated overbank habitats with fyke nets is slightly larger than the mean length of those collected with seines (SWCA 2011b, Gonzales et al. 2012). Studies on the age of wild silvery minnow using scale and otolith data are available, and there remain differing scientific interpretations (see Cowley et al. 2006, Horwitz et al. 2011).

Silvery minnow are generally found in schools, so sampling results and habitat studies are often affected by this grouping behavior. Dudley and Platania (1997) studied habitat preferences of the silvery minnow in the MRG at Rio Rancho and Socorro. Both juvenile and adult silvery minnow primarily used mesohabitats with moderate depths (15–40 centimeters [cm]), low water velocities (4–9 centimeters per second [cm/s]) and silt/sand substrates. Young-of-year silvery minnow are generally found in shallower and lower velocity habitats than adult individuals. During winter months, silvery minnow become less active and seek habitats with cover such as debris piles and low water velocities. During spring sampling, large concentrations of reproductively mature silvery minnow are often collected on inundated lateral overbank habitats (Hatch and Gonzales 2008). A Collaborative Program research study at the LLSMR also indicated that adjacent ponds and overbank habitat to the stream were used by spawning silvery minnow (Hutson 2013).

Adult silvery minnow are strong swimmers capable of moving upstream during high-flow events (Bestgen et al. 2010). However, studies conducted tracking hatchery fish indicate that there is not likely a population wide migration behavior for silvery minnow. It appears that movement is somewhat random with a net downstream trend for marked individuals though a few individuals moved upstream substantial distances (25 km). The distance traveled by recaptured fish ranged from 0.26 km (0.16 mile [mi]) to over 25 km (15.54 mi) (Platania et al. 2003). More recently, passive implant transponder (PIT) tags were implanted into hatchery fish to study the utilization of a fish passage structure built around the water treatment facility in Albuquerque (Archdeacon and Remshardt 2012). They found that the tagged silvery minnow moved through the facility from both upstream (19 km) and downstream (13 km) stocking locations.

Silvery minnow are thought to be omnivorous or herbivorous, consuming a variety of diatoms and algae. A study of historical (1874) and more recent (1978) preserved specimens revealed a variety of diatoms, as well as allochthonous organic matter, present in the gut contents (Shirey 2004, Cowley et al. 2006). Magana (2009) found that larval silvery minnow showed preference for certain species of diatoms that may be based on the growth form of the diatom. A study of silvery minnow in outdoor hatchery ponds found insects were present in 66% of fish, followed by formulated feed (60%), diatoms (40%), cladocerans (36%), rotifers (35%), filamentous algae (32%), bryozoan statoblasts (19%), copepods (11%), protozoa (9%), plant material (9%), ostracods (6%), detritus (5%), and sand (4%). Among size groups, small and medium fish consumed a greater variety of foods than large fish (Watson et al. 2009).

Silvery minnow produce numerous semi-buoyant non-adhesive eggs typical of the genus *Hybognathus*. Studies are available evaluating whether silvery minnow are pelagic or demersal spawners (Platania and Altenbach 1998, Platania 2000, Cowley et al. 2005, Gonzales and Hatch 2009, Medley and Shirey 2013). The specific gravity of silvery minnow eggs ranges from 1.012–1.00281 as a function of time post-fertilization (Cowley et al. 2005). Based on laboratory studies, egg hatching time is temperature-dependent, occurring in 24–48 hours at water temperatures of 20–30°C (Platania 2000). Newly hatched silvery minnow larvae are approximately 3.7 mm in length.

Eggs and larvae are vulnerable to downstream displacement by the current until larvae are able to actively seek out low-velocity habitats, which generally occurs within 3–5 days. Many eggs incubate as they drift downstream (Dudley and Platania 2007, SWCA 2011a). The distance that eggs and larvae may be displaced downstream is highly correlated with the level of discharge and habitat structure (Dudley and Platania 2007, Widmer et al. 2012). Habitat complexity is associated with discharge stage; at discharge levels that inundate the associated floodplain, there is a dramatic increase in available low-velocity habitats. Retention of gellan beads was higher in the Isleta Reach than the Angostura Reach, likely due to the greater habitat complexity and floodplain connectivity at the discharge tested (Widmer et al. 2012). The proximity of spawning to habitat also may determine how far eggs may disperse. Retention of propagules in upstream reaches is important to maintain the species within the upper portions of the range, especially in river systems that have been fragmented and where fish have reduced opportunity to move long distances.

The availability of nursery habitat varies spatially and temporally within the MRG. Spring runoff of above-average peak flows and extended durations provide much greater area, to a degree, of inundated riparian and terrestrial surfaces that may be used by silvery minnow larvae as nursery habitats (Porter and Massong 2004b). Overbank habitats often provide low to zero velocity, higher average temperatures, and higher primary production in comparison to the main channel, and such habitats provide a beneficial environment for larval fish development (Pease et al. 2006). Also, large numbers of gravid females have been documented in inundated overbank habitats (Gonzales and Hatch 2009, Gonzales et al. 2012). Greater recruitment of larval fish into the fall monitoring census generally occurs in years when spring runoff flows are sufficient to inundate overbank habitats, although other factors play into recruitment.

There also may be some negative implications with inundated floodplains, depending on the frequency and duration of flooding, such as low DO in areas that are infrequently flooded (Valett et al. 2005) and return flows of stagnant floodwaters that may temporarily decrease the DO in the main channel of the river (Abeyta and Lusk, 2004). Entrapment within the floodplain as flows recede can also occur. Whether larvae avoid areas of poor water quality has not been studied.

There are several studies supported by Reclamation and the Collaborative Program that have been (or are currently) conducted to inform future management. Bixby and Burdett (2011) investigated the correlation of nutrient availability and periphyton growth in the MRG from 2007–2010. They found that periphyton distribution is highly influenced by variation in turbidity and nutrients. In the summer months, high turbidity from tributaries creates a light-limited environment where primary production is limited to a littoral zone “bathtub ring.” Additionally, there is a gradient of nutrient inputs as the river flows through urban landscapes as concentrations of phosphate and nitrates vary.

There were similar findings of Valdez et al. (in review), who studied food availability within the MRG in 2005 and 2006. In addition to the large allochthonous load of organic matter, there was also significant autochthonous production along shallow shorelines where there was sufficient light penetration for photosynthesis and where velocity was low with little scour so that macroinvertebrate and aufwuchs communities could establish. Mesohabitats that support autochthonous production and the greatest food sources for fish comprise relatively small wetted areas of the channel, which coincide with low-velocity mesohabitats used by silvery minnow. They concluded that the abundance and diversity of food resources available during their study did not suggest a food limitation for Rio Grande silvery minnow.

Additional information pertaining to life history and habitat needs of the silvery minnow can be found in the following documents:

Dudley, R.K. and S.P. Platania. 1997. *Habitat use of the Rio Grande silvery minnow*. Report to the U.S. Bureau of Reclamation, Albuquerque, NM. 88 pp.

Dudley, R.K. and S.P. Platania. 2011a. Summary of the Rio Grande silvery minnow population monitoring program results from December 2010. American Southwest Ichthyological Researchers, L.L.C, Albuquerque, New Mexico. Available online at <http://www.asirllc.com/rgsm/rgsm2010/pdf/RGSM_December2010.pdf>.

Dudley, R.K. and S.P. Platania. 2011b. *Draft Rio Grande silvery minnow population monitoring program results from September 2009 to October 2010*. A Middle Rio Grande Endangered Species Act Collaborative Program Funded Research Project. American Southwest Ichthyological Researchers, L.L.C., Albuquerque, New Mexico. 187 pp.

Dudley, R.K. and S.P. Platania. 2011c. Summary of the Rio Grande silvery minnow population monitoring program results from October 2011. American Southwest Ichthyological

Researchers, LLC, Albuquerque, New Mexico. Available online at <http://www.asirllc.com/rgsm/rgsm2011/pdf/RGSM_October2011.pdf>.

Gonzales, E.J., G.M. Haggerty, and A. Lundahl. 2012. Using fyke-net capture data to assess daily trends in abundance of spawning Rio Grande silvery minnow. *North American Journal of Fisheries Management* 32(3): 544-547.

Massong, T.M. 2004. *Rio Grande river maintenance priority sites on the Pueblo of Cochiti*. U.S. Department of the Interior, Bureau of Reclamation, Albuquerque Area Office, 10 p.

Medley, C.N. and P.D. Shirey. 2013. Review and reinterpretation of Rio Grande silvery minnow reproductive ecology using egg biology, life history, hydrology, and geomorphology information. *Ecohydrology* (wileyonlinelibrary.com) DOI: 10.1002/eco.1373.

U.S. Fish and Wildlife Service. 1994. Endangered and threatened wildlife and plants: Final rule to list the Rio Grande silvery minnow as an endangered species. Federal Register 59: 36988-36995.

U.S. Fish and Wildlife Service. 2003. Endangered and threatened wildlife and plants: Designation of critical habitat for the Rio Grande silvery minnow, Final rule. Federal Register 68: 8087-8135.

U.S. Fish and Wildlife Service. 2010. *Rio Grande Silvery Minnow (Hybognathus amarus) Recovery Plan, First Revision*. Albuquerque, NM. viii + 210 p.

### 3.1.5 Reasons for Decline

The silvery minnow is presumed to have historically been one of the most abundant and widespread fishes in the Rio Grande Basin including the Pecos River. Similar to many fish species in the western portions of North America, silvery minnow likely started to decline concurrent with human encroachment and development along the Rio Grande and its tributaries. Though small-scale water development was present in the drainage for more than 500 years, major water development projects and flow modifications began in the late 1800s in the San Luis Valley, Colorado, and in 1913 with the completion of Elephant Butte Reservoir (Service 2003a). By 1993, when the silvery minnow was proposed for listing, there were more than 20 large dams and irrigation structures along the Rio Grande and its major tributaries (i.e., such as the Pecos River, Rio Chama, and Jemez River). Additionally, demands for water increased greatly in the 20$^{th}$ and 21$^{st}$ centuries, and water supply has been exacerbated by ongoing drought. A detailed description of threats by listing factor was presented with the Final Rule to list the Rio Grande silvery minnow in 1994 (58 Fed Reg 11823).

Trevino-Robinson (1959) documented the early 1950s "cosmopolitan" occurrence of silvery minnow in the Rio Grande downstream from its confluence with the Pecos River. Historical drying of the Rio Grande is noted by several authors (e.g., Trevino-Robinson 1959, Chernoff et al. 1982). Increased agricultural and municipal water demands have increased the magnitude and duration of low-flow conditions. In addition to low water conditions, poor water quality conditions were noted in the lower portions of the Rio Grande, including increased salinity and the presence of agricultural chemicals in fish tissues (White et al. 1983, Andreasen 1985). Silvery minnow have not been documented below Elephant Butte Dam on the Rio Grande since the mid-1950s (Hubbs et al. 1977, Sublette et al. 1990, Edwards and Contreras-Balderas 1991), until the recent stocking in Big Bend National Park. Silvery minnow were last sampled above Cochiti Dam near Velarde five years after the closing of Cochiti Dam in 1973 (Bestgen and Platania 1991).

Hybridization and/or competition with nonnative congener species operated to displace the silvery minnow from its former range in the Pecos River. The silvery minnow was displaced in the Pecos River by its congener *H. placitus* (plains minnow), which was probably introduced during 1968 into the Pecos drainage from the Canadian drainage (Cowley 1979). The displacement that ensued was complete in less than one decade (Hoagstrom et al. 2010). Initial studies to investigate hybridization of plains minnow and silvery minnow did not produce viable offspring (Caldwell 2003), but the results did not conclusively demonstrate whether these species could produce viable offspring. The study did demonstrate that, under hatchery conditions, the species would behaviorally interbreed. Further research is warranted to determine if some type of competitive reproductive interference may have occurred. Heterospecific matings and hybridization are types of reproductive interference that can lead to fitness losses for species due to wasted reproductive effort and nonviable offspring (Groning and Hochkirch 2008).

Predation and competition with other fish species have also been cited as factors possibly contributing to the decline of the species (Service 1999, 2003a). A wide range of fish species coevolved with the silvery minnow and are native to the Rio Grande and Pecos River. Accidental or intentional releases of fishes outside of their native ranges have enabled numerous exotic fish to become established populations in the Rio Grande Basin (Sublette et al. 1990). These fish represent additional potential competitors or predators of the silvery minnow. Lotic conditions, created by dams and diversions, often favor large predatory species such as various species of sunfishes and catfishes. Avian predation is also a factor for survival of the silvery minnow, especially during periods of low or no flow. Few studies have been conducted to determine the effect of predation or interspecific competition on silvery minnow by the various species that now exist within the Rio Grande.

The entrainment of silvery minnow (primarily eggs and larvae) in the infrastructure of irrigation systems that derive water directly from the Rio Grande has been cited as a factor contributing to the decline of silvery minnow (Service 1999). Egg entrainment into MRG irrigation canals has been monitored since 2001. Low numbers of eggs have been found in the sampling. Management strategies at MRG diversions have likely minimized the number of eggs that are currently entrained. Low densities of silvery minnow may persist within the permanently watered channels such as the LFCC and the MRGCD drains (Cowley et al. 2007, Lang and Altenbach 1994, Reclamation 2010). These channels may provide some refuge for silvery minnow during extreme dry periods, although it is unlikely that they can complete their life cycle within canals due to limited habitat, high numbers of nonnative fish species, and variable possibility of returning to the river.

Historically, river engineering projects to manage geomorphic processes had variable effects on silvery minnow habitat quality and area depending on how they were implemented. Traditional river engineering activities within the Rio Grande in combination with regulated flows have confined the Rio Grande to a narrower channel and reduced the connectivity with overbank habitat to reduce depletions of water. Upstream reservoirs also stop sediment transport that often results in channel incision, further reducing floodplain connectivity. Contemporary river engineering projects now incorporate features that enhance silvery minnow habitat, such as point bars, side channels, and islands.

Since 2003, coordinated water management actions, habitat restoration, fish salvage, and augmentation with hatchery stocks have been implemented in the MRG by the Collaborative Program and its members. However, several prolonged drought periods have occurred (2000–2003, 2011–2014) that have limited the ability of MRG water managers to implement actions to conserve the silvery minnow and improve critical habitat. For example, many of the habitat restoration sites have not been inundated over the past four years (2011–2014) due to very low spring runoff. With only a few years of average or above-average flows, limited monitoring, and low fish densities, it is difficult to determine yet what the impacts are of these projects.

Primarily due to the prolonged regional drought, the silvery minnow population census has shown very low numbers of wild fish in recent years. There remains a good deal of uncertainty over how to best improve potential recruitment, especially during and after consecutive dry years. The long-term survival and recovery of the fish will be dependent on how well they can rebound after years of poor recruitment.

## 3.2 Southwestern Willow Flycatcher

### 3.2.1 Species Description

The southwestern willow flycatcher (*Empidonax traillii extimus)* (flycatcher) is a small passerine bird, approximately 15 cm (5.75 inches) in length. Phillips (1948) described the southwestern subspecies as *E. t. extimus*. The flycatcher is one of four subspecies of the willow flycatcher currently recognized (Hubbard 1987, Unitt 1987), though Browning (1993) suggests a possible fifth subspecies (*E. t. campestris*) in the central and midwestern United States (Figure I-9). The willow flycatcher subspecies are distinguished primarily by subtle differences in color and morphology and by habitat use. Recent research (Paxton 2000) concluded that *E. t. extimus* is genetically distinct from the other willow flycatcher subspecies. More recent morphologic and genetic analysis, which remains unresolved, suggests that the willow flycatchers of the Southwest represent peripheral populations of an otherwise widespread species (Zink 2015).

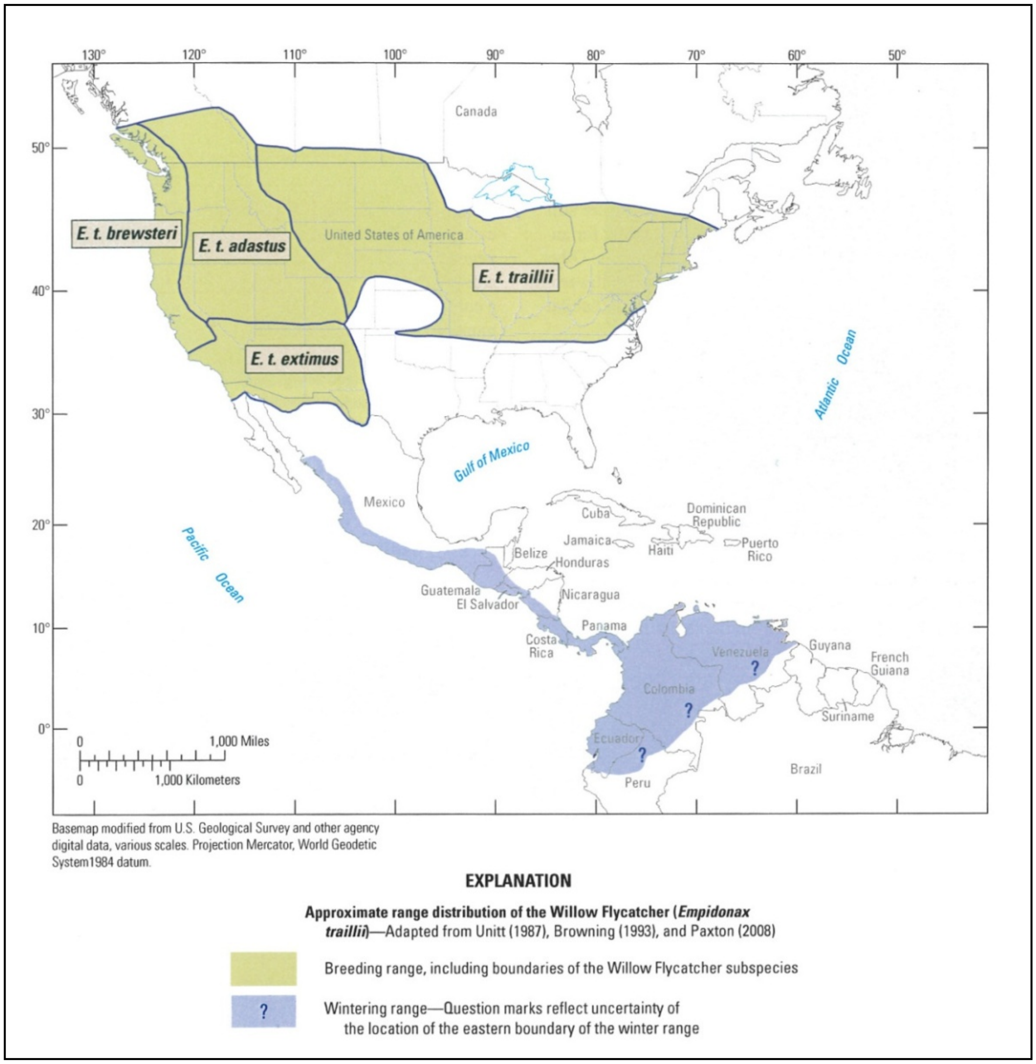


**Figure I-9. Breeding ranges of the willow flycatcher subspecies (from Sogge et al. 2010)**

### 3.2.2 Distribution and Abundance

The species occurs in southern California, Arizona, New Mexico, southern portions of Nevada and Utah, and possibly southwestern Colorado (60 Fed Reg 10694). Reclamation has received no reporting from standardized surveys from the state of Texas. In 2007, the population along the Gila River drainage was the largest with 30.1% of all territories rangewide, followed by the population along the Rio Grande drainage with 23.3% (Durst et al. 2008). Estimates of overall territory numbers rangewide in 1993 were approximately 140 distributed among 41 known sites (Durst et al. 2008).

As of 2007, the population of flycatchers rangewide increased to approximately 1,299 territories distributed among 288 sites (Durst et al. 2008) (Figure I-10). Large populations are located along the Gila River and Rio Grande in New Mexico; the Kern, Owens, San Luis Rey, Santa

Ana, and Santa Margarita Rivers in California; and the Gila, San Pedro, and Salt River drainages in Arizona (Durst et al. 2008). In New Mexico, the flycatcher has been observed in the Rio Grande, Rio Chama, Zuni, San Francisco, Pecos, Canadian, and Gila River drainages. Flycatchers were first reported at Elephant Butte State Park in the 1970s, although the exact locations of the sightings were not documented (Hubbard 1987). Because surveys were not consistent or extensive prior to the listing of this species, a comparison of historical numbers to current status is not possible; however, the available native riparian habitat overall along the Rio Grande has declined.

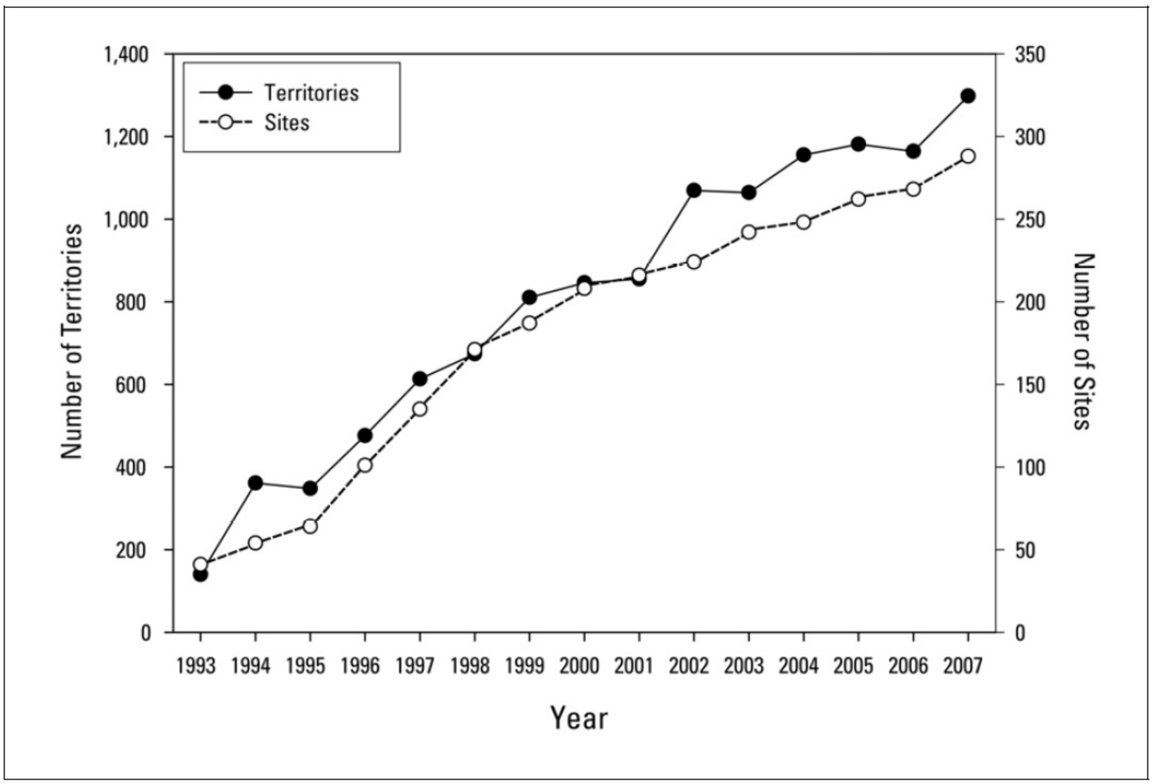


**Figure I-10. Estimated number of flycatcher territories and sites rangewide from 1993–2007 (from Durst et al. 2008)**

A standardized survey protocol and consistent reporting system have been followed since 1994 using guidelines provided by the Service. The fundamental principles of the standardized methodology for presence/absence surveys have remained the same since the original protocol development and have proven to be an effective tool for locating flycatchers rangewide (Sogge et al. 2010).

In the MRG, surveys for flycatchers in selected areas occurred because of environmental compliance activities for various projects. Although a systematic survey effort throughout the entire riparian corridor of the MRG has not occurred, reaches of the river with the most suitable habitat for flycatchers have been surveyed. Presence/absence surveys and nest monitoring along selected areas of the Rio Grande have been conducted since 1993. With expanded or increased survey efforts during this period, several sites have been located where flycatcher territories have consistently been established. Once located, most of these core breeding areas have been monitored annually.

Since the initial surveys of the Rio Grande Valley in the 1990s, breeding pairs have been found within the MRG Project area from Elephant Butte Reservoir upstream to the vicinity of Taos. Several locations along the Rio Grande have consistently held breeding flycatchers. These areas have one or more flycatcher pairs that have established a territory in an attempt to breed, with most birds returning annually. In some locations, these local populations appear to be expanding with an increased number of territories being detected. Some local populations have remained small (10–15 territories, or fewer) but stable; other sites have been abandoned and no longer contain territorial flycatchers. As of 2014, the population in the San Marcial Reach (San Marcial railroad trestle to the Elephant Butte Reservoir delta) is the largest breeding population within New Mexico and the breeding population within BDA is the second largest along the Rio Grande (Moore and Ahlers 2015).

Five general locations of flycatcher populations have been established throughout the MRG (Figure I-11). These areas consistently have held several territories; however, the numbers of territories, pairs, nest attempts, and successful nests have varied through the years.

Since 1993, flycatchers have been reported from 19 sites within the Rio Grande Basin; however, several of these sites no longer support flycatchers. The majority of currently occupied sites within the entire Rio Grande Basin support isolated populations of fewer than six territories. Sites such as Tierra Azul, Ohkay Owingeh, and Selden Canyon/Radium Springs have been fairly consistent in territory numbers since 1993, which is indicative of somewhat stable populations within these sites.

A total of approximately 383 flycatcher territories were found within the entire Rio Grande Basin of New Mexico during the 2013 breeding season (Service 2014b). Occupied sites were scattered from just upstream of Cochiti Reservoir, downstream to Radium Springs near Las Cruces. During the 2013 breeding season, most suitable habitat within the main stem of the Rio Grande was surveyed, and it is highly unlikely that any large populations of flycatchers have gone undetected; however, sites supporting a few undetected territories may exist in some isolated patches of habitat throughout the Rio Grande Basin.


**Figure I-11. Five general locations of flycatcher populations within the MRG**

A total of 112 flycatcher territories were detected during the 2013 survey season along the MRG from the state line to RM 62. Territory numbers generally have increased since surveys began in 1993 (Table I-1).

The San Acacia Diversion Dam to BDA Reach experienced flycatcher population growth in the early 2010s in the area around the wildlife refuge. Other increases in territory numbers have occurred more recently in the area near Belen in the Isleta Diversion Dam to San Acacia Diversion Dam Reach.

**Table I-1. Flycatcher territories since 1995 by river reach**

| Reach | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| State line to Angostura Diversion Dam | 11 | 20 | 17 | 2 | 2 | 18 | 1 | 0 | 1 | 12 | 12 | 13 | 12 | 19 | 35 | 21 | 25 | 1 | 1 |
| Angostura Diversion Dam to Isleta Diversion Dam | 4 | 3 | NS | NS | NS | 14 | NS | NS | 4 | 7 | 6 | 9 | 12 | 16 | 0 | 0 | 0 | 0 | 0 |
| Isleta Diversion Dam to San Acacia Diversion Dam | NS | NS | NS | NS | 4 | 7 | 11 | 13 | 17 | 17 | 22 | 22 | 22 | 32 | 21 | 19 | 19 | 20 | 27 |
| San Acacia Diversion Dam to BDA | 2 | 4 | 3 | 3 | 2 | 1 | 1 | 9 | 1 | 2 | 0 | 6 | 6 | 8 | 21 | 38 | 58 | 80 | 47 |
| BDA to RM 62 | 0 | 0 | 1 | 0 | 12 | 6 | 3 | 8 | 3 | 16 | 3 | 15 | 10 | 13 | 15 | 13 | 16 | 17 | 37 |
| **Total** | **19** | **27** | **21** | **5** | **20** | **46** | **16** | **30** | **26** | **54** | **43** | **65** | **62** | **88** | **92** | **91** | **118** | **118** | **112** |

NS = No surveys were completed for this reach in the given year.
Please note that surveying effort may vary from year to year in any given reach depending on project needs or funding availability. Though all permitted surveyor is required to submit results to the FWS, this does not happen in all cases and survey results may be unknown in some sites within river reaches.
Territories consist of either an unpaired male that defended an area during the course of a breeding season, or a pair, or a pair with a nest.

The Elephant Butte Reservoir population was first recorded in 1993 when four flycatcher territories were found. The population steadily increased up until 2009–2011 with approximately 300 territories. In 2012 the population decreased by approximately 50 territories. In 2013, a total of 233 territories were found within the conservation pool of Elephant Butte Reservoir (Moore and Ahlers 2014). Approximately 61% of the total known territories found within the Rio Grande Basin during the 2013 season were within the conservation pool of Elephant Butte Reservoir, which is located south of the project action area (aside from the Delta Channel boundaries).

### 3.2.3 Listing Status and Critical Habitat

A final rule was published in the February 27, 1995 Federal Register to list the Southwestern United States population of the flycatcher as an endangered species under the ESA with proposed critical habitat (60 Fed Reg 10694). However, the final rule of July 22, 1997 designating critical habitat for the species rangewide did not include the Rio Grande (62 Fed Reg 39129). Critical habitat was redesignated through a final rule published October 19, 2005 (70 Fed Reg 60886).

The Service released a new proposal for critical habitat in August 2011 (76 Fed Reg 50542) as a result of a lawsuit by the Center of Biological Diversity over the 2005 critical habitat designation. On January 3, 2013, a final designation for critical habitat was again published (78 Fed Reg 344).

The 2013 final designation of critical habitat defines two units located along the Rio Grande in the state of New Mexico: the Upper Rio Grande Management Unit that includes approximately 789 hectares (ha) (1,951 acres), and the Middle Rio Grande Management Unit that designates 21,957 ha (54,259 acres), based on geographic information system (GIS) calculations using the critical habitat shapefile provided by the Service.

The segments mentioned above are characterized as follows (Figure I-12):

Upper Rio Grande Management Unit: *"…a 46.8-km (29.1-mi) Rio Grande segment that extends from the Taos Junction Bridge (State Route 520) downstream to the northern boundary of the San Juan (Ohkay Ohwingeh) Pueblo, and a 1.1 km (0.4 mi) segment of the Rio Grande between the San Juan (Ohkay Ohwingeh) and Santa Clara Pueblos. We are also designating as flycatcher critical habitat an 11.9-km (7.4-mi) segment of the Rio Grande del Rancho from Sarco Canyon downstream to the Arroyo Miranda confluence, and a 10.7-km (6.6-mi) segment of Coyote Creek from above Coyote Creek State Park downstream to the second bridge on State Route 518, upstream from Los Cocas. Additionally, we are designating a 0.4-km (0.2-mi) segment of the Rio Fernando that is located about 3.2 km (2.0 mi) upstream from the Rio Lucero confluence."*

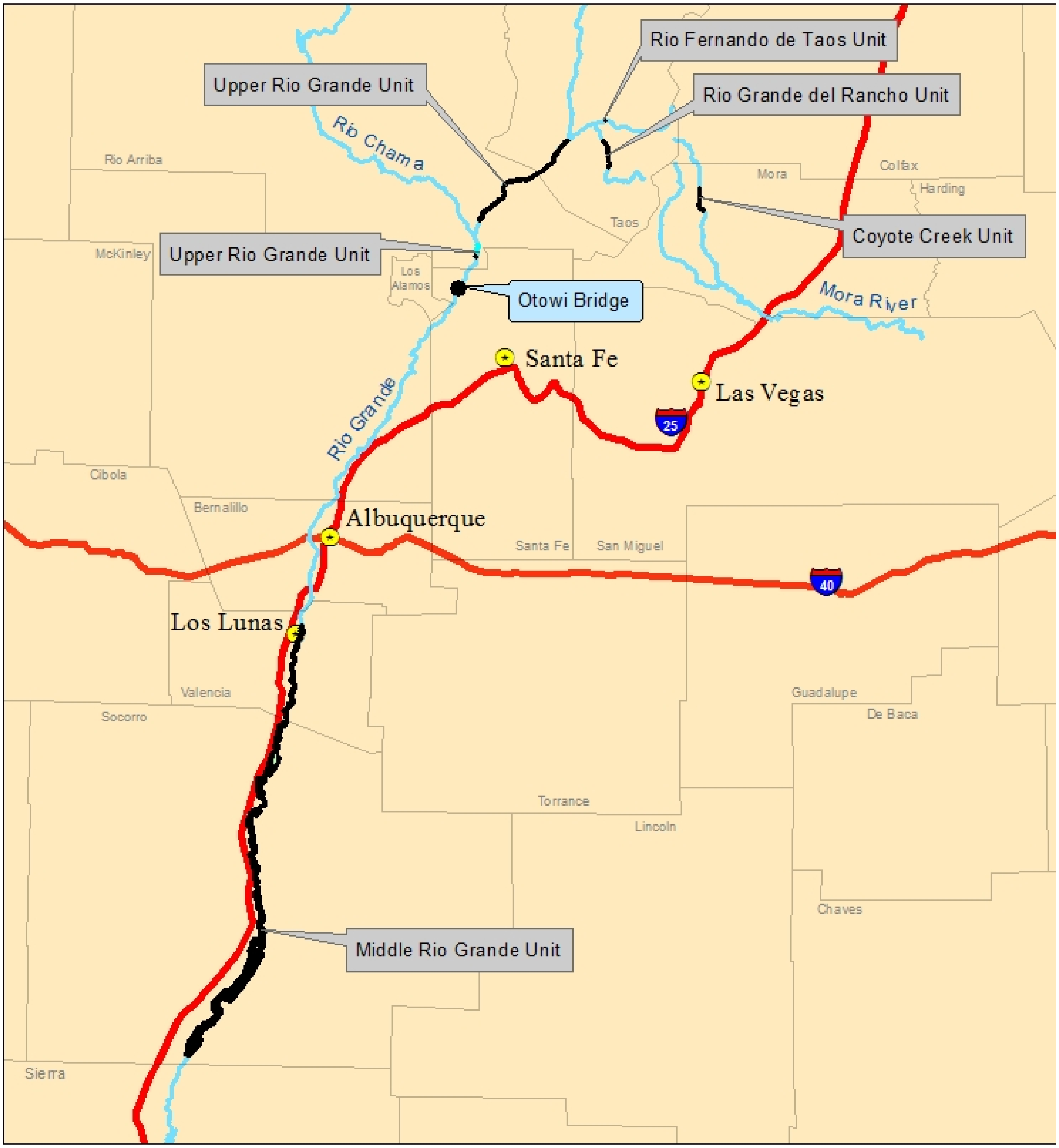


**Figure I-12. 2013 final critical habitat designations**

- The Upper Rio Grande New Mexico Segment is considered the area from the Taos Junction Bridge to the upstream boundary of Ohkay Owingeh Pueblo, as well as a segment between the southern boundary of Ohkay Owingeh Pueblo to the northern boundary of Santa Clara Pueblo.

- The Rio Grande del Rancho Segment is considered the area from Sarco Canyon downstream to the Arroyo Miranda confluence.
- The Coyote Creek Segment is considered the area from 2 km (1.2 miles) above Coyote Creek State Park to the second bridge on State Route 518, upstream from Los Cocas.
- The Rio Fernando de Taos is a 0.2 mile segment located approximately 2 miles upstream from the Rio Lucero confluence.

Middle Rio Grande Management Unit: *"…a 180.4-km (112.1-mi) segment of the Rio Grande that extends from below Isleta Pueblo and the Bernalillo and Valencia County line downstream past Bosque del Apache and Sevilleta NWRs and into the upper part of Elephant Butte Reservoir ending in Socorro County about 3.2 km (2.0 mi) north of the Sierra County line, New Mexico (about 14.4 km, 9.0 mi of the upper part of Elephant Butte Reservoir, downstream of the power-line crossing is included within the designation)."*

In both the 2005 critical habitat designation (70 CFR 60886) and the most current final designated critical habitat from 2013 (50 Fed Reg 344), the Service identified two PCEs that were recognized as the physical or biological features essential to the conservation of the flycatcher. Those PCEs are as follows:

- PCE 1—Riparian Vegetation

"Riparian habitat in a dynamic river or lakeside, natural or manmade successional environment (for nesting, foraging, migration, dispersal, and shelter) that is comprised of trees and shrubs (that can include Gooddings willow, coyote willow, Geyers willow, arroyo willow, red willow, yewleaf willow, Pacific willow, boxelder, tamarisk, Russian olive, buttonbush, cottonwood, stinging nettle, alder, velvet ash, poison hemlock, blackberry, seep willow, oak, rose, sycamore, false indigo, Pacific poison ivy, grape, Virginia creeper, Siberian elm, and walnut) and some combination of:

a. Dense riparian vegetation with thickets of trees and shrubs that can range in height from about 2–30 m (about 6–98 ft). Lower-stature thickets (2–4 m or 6–13 ft tall) are found at higher elevation riparian forests, and tall-stature thickets are found at middle and lower-elevation riparian forests,

b. Areas of dense riparian foliage at least from the ground level up to approximately 4 m (13 ft) above ground or dense foliage only at the shrub or tree level as a low, dense canopy.

c. Sites for nesting that contain a dense (about 50–100%) tree or shrub (or both) canopy (the amount of cover provided by tree and shrub branches measured from the ground).

d. Dense patches of riparian forests that are interspersed with small openings of open water or marsh or areas with shorter and sparser vegetation that creates a variety of habitat that is not uniformly dense. Patch size may be as small as 0.1 ha (0.25 acre) or as large as 70 ha (175 acre)."

- PCE 2—Insect Prey Populations

> "A variety of insect prey populations found within or adjacent to riparian flood plains or moist environments, which can include: flying ants, wasps, and bees (Hymenoptera); dragonflies (Odonata); flies (Diptera); true bugs (Hemiptera); beetles (Coleoptera); butterflies, moths, and caterpillars (Lepidoptera); and spittlebugs (Homoptera)."

### 3.2.4 Life History and Ecology

Flycatchers are neotropical migrant birds that overwinter in such places as southern Mexico, Central America, and likely South America for about 8 months before migrating back to the Southwestern United States (78 Fed Reg 344). Unfortunately, little is known about the ecology and distribution of flycatcher populations during migration. However, it appears flycatchers use a wide range of habitat types in their wintering grounds (Schuetz et al. 2007). In general, winter habitat is a combination of four main habitat components including standing or slow-moving water and/or saturated soils, patches or stringers of trees, woody shrubs, and open areas (Schuetz et al. 2007, Koronkiewicz and Sogge 2000). The main body of knowledge of flycatchers surrounds breeding and nesting success in its summer range.

Flycatcher breeding chronology is presented in Figure I-13 and falls within the generalized breeding chronology expected of Southwestern willow flycatchers (based on Unitt 1987, Brown 1988, Whitfield 1990, Skaggs 1996, Sogge et al. 1995, Maynard 1995, Sferra et al. 1997, Sogge et al. 2010, Service 2002a).

Each stage of the breeding cycle represents a greater energy investment in the nesting effort by the flycatcher pair and may influence their fidelity to the nest site or their susceptibility to abandon the nest if the conditions in the selected breeding habitat become adverse.

Extreme dates for any given stage of the breeding cycle may vary as much as a week from the dates presented. Egg laying begins as early as late-May but more often starts in early- to mid-June. Chicks can be present in nests from mid-June through early-August. Young typically fledge from nests from late-June through mid-August but remain in the natal area 14–15 days. Adults depart from breeding territories as early as mid-August but may stay until mid-September in later nesting efforts. Fledglings likely leave the breeding areas 1-2 weeks after adults. Most flycatchers only live 1 or 2 years as adults, but there have been rare occurrences of flycatchers living at least 9 years (Paxton et al. 2007).

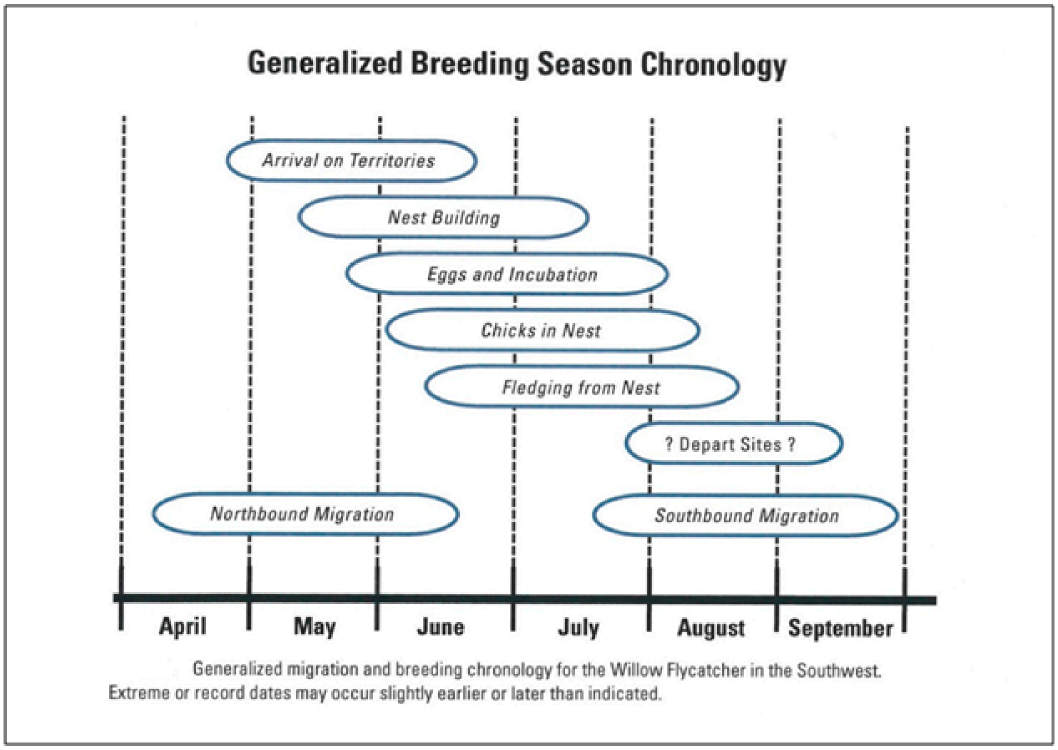


**Figure I-13. Generalized breeding chronology of the Southwestern willow flycatcher (from Sogge et al. 2010)**

The flycatcher is an obligate riparian species occurring in habitats adjacent to rivers, streams or other wetlands characterized by dense growths of willows (*Salix* spp.), seepwillow (*Baccharis* spp.), arrowweed (*Pluchea* spp.), saltcedar (*Tamarix* spp.), or other species (50 CFR 10693). Species composition, however, appears less important than plant and twig structure (Moore and Ahlers 2011a). Slender stems and twigs are important for nest attachment. Nest placement is highly variable, as nests have been observed at heights ranging from 0.6–20 m and generally occur adjacent to or over water (Sogge et al. 2010). Along the MRG, breeding territories have been found in young and mid-age riparian vegetation dominated by dense growths of willows at least 15 feet high, as well as in mixed native and exotic stands dominated by Russian olive and saltcedar (Moore and Ahlers 2009).

A majority of the birds within the MRG select habitat patches dominated by native species, usually dense willows, for nesting. Within these willow patches, nests have been found on individual saltcedar plants, especially in older, taller willow patches where an understory of saltcedar provides suitable nesting substrate. It appears that the tree species with the vertical structure of more slender stems and twigs on younger plants in the understory vegetation is selected for nest placement (Moore and Ahlers 2011a). Most recently, nests located at the Sevilleta NWR and La Joya State Wildlife Management Area (WMA) have been established in areas adjacent to the river dominated by saltcedar and Russian olive; however, the overall vegetation type of most of the flycatcher territories established in the MRG is dominated by native species and not saltcedar. From 2010 to 2014 (drought years), vegetation shifts have been observed where native stands are now transitioning to mixed or exotic-dominated stands (Moore and Ahlers 2015).

A critical component for suitable nesting conditions is the presence of water, usually provided by overbank flooding or some other hydrologic source. Reclamation has found that 92% of all flycatcher nests in the Reclamation-surveyed areas of the MRG from 2004–2013 (n = 2,152), occur within 100 m of surface water, and 84% occur within 50 m (Moore and Ahlers 2014). The presence of surface water at the onset of nest site selection and nest initiation is likely critical, though not absolutely necessary. For example and particularly observed in reservoir sites, a flycatcher territory may have vegetation completely immersed in water during a wet year or thoroughly dry and hundreds of meters away from surface water in drought years (78 Fed Reg 344).

Flycatchers and many other species of neotropical migrant land birds also use the Rio Grande riparian corridor as stopover habitat during migration. Studies have shown that, during the spring and fall migration, flycatchers are more commonly found in willow habitats than in other riparian vegetation types (Finch and Yong 1997). During presence/absence surveys in May and early June, migrating flycatchers are frequently observed throughout the project area. These birds use a variety of vegetation types during migration, many of which are classified as “low suitability” for breeding habitat (Ahlers and White 1997).

Evidence gathered during multiyear studies of color-banded flycatcher populations show that, although most male flycatchers return to former breeding areas, flycatchers regularly move among sites within and between years (Ellis et al. 2008). Between 1997 and 2005, of the 1,012 relocated banded flycatchers rangewide, 595 (59%) banded flycatchers in Arizona returned to the breeding site of the previous year, while 398 (39%) moved to other breeding areas within the same major drainage, and 19 (2%) moved to a completely different drainage (Paxton et al. 2007). Overall distance moved among adults and returning nestlings ranged from 0.03–444 km with mean distance moved by adults (9.5 km) much less than the mean fledgling dispersal distance (20.5 km) (Paxton et al. 2007). Although most returning flycatchers showed site fidelity to breeding territories, a significant number move within and among sites. Movement patterns are strongly influenced by reproductive success. The age class of habitat patches also may be of consideration (Paxton et al. 2007).

Flycatcher prey base is relatively understudied, but it does appear that flycatcher food availability may be largely influenced by density and species of vegetation, proximity to and type of water, saturated soils, and temperature and humidity (78 Fed Reg 344). The flycatcher is an insect generalist and can feed on a variety of different prey. In a comparison between native, exotic, or mixed habitat types, it appears that the arthropod community is statistically indistinguishable among habitats (Durst 2004). The difference in relative quality among the habitat types also was indistinguishable (Durst 2004). In the same study and between years (drier in 2002 versus wetter year in 2003), prey base was believed to be driven by differences in relative insect abundances (2003 yielded a five-fold increase in total arthropod biomass). In the drier year with less relative humidity, greater distance to water, and less food availability, flycatcher nest success in this area of the study decreased substantially (Smith et al. 2003).

#### *3.2.4.1 Flycatcher Breeding Habitat Characteristics*

Many flycatcher breeding sites are composed of spatially complex habitat mosaics, often including both exotic and native vegetation. Within a site, flycatchers often use only a part of the patch, with territories frequently clumped or distributed near the patch edge. Therefore, the vegetation composition of individual territories may differ from the overall composition of the patch (Sogge et al. 2002).

Generally, four broad categories have been developed to describe species composition at breeding sites and include the following:

- Native: > 90% native vegetation
- Mixed: > 50% native (50–90% native vegetation)
- Mixed: > 50% exotic (50–90% exotic vegetation)
- Exotic: > 90% exotic vegetation

Habitat patches composed of native vegetation account for approximately half (44%) of the known flycatcher territories in the Southwest. As of the 2007 breeding season, rangewide, 50% of breeding territories occurred in mixed patches and 4% in patches > 90% exotic (Durst et al. 2008). In many cases, exotics are contributing significantly to the habitat structure by providing the dense lower-strata vegetation that flycatchers prefer (Sogge et al. 2002).

Data collected and analyzed on nest substrate and surrounding habitat patch communities in the MRG (from Reclamation nest monitoring activities from Velarde to Elephant Butte, primarily nests from the following areas: Sevilleta/La Joya, BDA, and San Marcial) indicate that flycatchers may key in on areas dominated by native vegetation but often select exotic vegetation, particularly saltcedar as a nest substrate. Saltcedar actually may be the flycatchers' substrate of choice due to its dense and vertical twig structure. From 1999–2013, approximately 46% of 2,413 nests located in these river reaches were physically constructed on exotic plants (Russian olive [*Elaeagnus angustifolia*] 2% and saltcedar [*Tamarix* spp.] 40.0%) (Moore and Ahlers 2014). This degree of nesting on exotic plants represents a very large percentage given that, in the MRG between 1999–2014, 267 nests (10%) with known outcomes were in saltcedar-dominated territories, 1,736 (65%) were in willow (Salix)-dominated territories, and 641 (24%) were in mixed-dominance territories . This shift from mainly native-dominated territories to more of a mixed or exotic habitat occupied territory became increasingly evident from 2010–2014 (Moore and Ahlers 2015).

The saltcedar leaf beetle (*Diorhabda* spp.) (beetle) was released in field cages in six states (California, Nevada, Utah, Texas, Colorado, and Wyoming) in 1999 and field released in 2001 (DeLoach et al. 2003). The beetles defoliate saltcedar during the growing season, which corresponds to the flycatcher breeding season, and take multiple years of continuous defoliation to eventually kill saltcedar (Paxton et al. 2011). The abundance of beetles may provide a temporary food source for flycatchers; however, once defoliation takes place, it is likely that other foliage feeding insects would disperse (Paxton et al. 2011). With reduced canopy cover as well as food source, flycatchers occupying habitat composed of mainly saltcedar would be at a disadvantage.

At this time, the northern beetle subspecies has been moving from north to south along the Rio Grande and is as far south as the Rio Puerco and Rio Grande confluence. The southern beetle subspecies is moving from south to north and has been located as far north as approximately Rincon, New Mexico. Within the MRG, flycatchers use saltcedar as a nesting substrate at a disproportionate rate, which is a concern due to the inevitable expansion of the beetle. However, the vast majority of flycatcher territories are in native-dominated stands, and the defoliation or mortality of a few saltcedar trees within those stands likely will not reduce overall habitat quality (Moore and Ahlers 2011a).

#### *3.2.4.2 General Habitat Description/Condition*

Suitable and flycatcher occupied riparian habitat within the MRG from the state line to RM 62 include dense stands of willows and other woody riparian plants adjacent to or near the river. Some areas along that same stretch of the MRG support local areas of suitable willow flycatcher habitat (using Hink and Ohmart vegetation classification); however, no birds have been observed establishing territories, thus indicating that suitable habitat is not a limiting factor.

For the purposes of this flycatcher baseline, the area from the state line to RM 62 has been divided into reaches as follows: (1) state line to Angostura Diversion Dam, (2) Angostura Diversion Dam to Isleta Diversion Dam, (3) Isleta Diversion Dam to San Acacia Diversion Dam, (4) San Acacia Diversion Dam to the southern boundary of BDA, and (5) the southern boundary of BDA to RM 62.

In general, the bosque from the state line to San Acacia Reach contains mainly single-aged stands of older cottonwoods (*Populus* spp.) and lacks the diversity of a healthy, multiaged riparian forest. Exotic vegetation such as Russian olive and Siberian elm also has become established. In many areas, significant channel narrowing and degradation have significantly limited overbank flooding and reduced the potential for recruitment of native riparian vegetation, especially cottonwoods and willows. There are some areas within this stretch that currently do have suitable habitat in the form of lower terraces with backchannels, dense canopy cover by exotic Russian olives, native willows, and marshlike conditions.

Known flycatcher habitat in the Rio Puerco area (in the Isleta Diversion Dam to San Acacia Diversion Dam Reach) occurs adjacent to the river and is dominated by coyote willow (*Salix exigua*), saltcedar, and Russian olive. The trend of channel narrowing and degradation reduces the amount of overbank flooding and the potential to enhance existing sites or establish new native vegetation.

From San Acacia Diversion Dam to BDA, habitat varies greatly from deep, incised channels with dry, high terraces consisting of mainly saltcedar vegetation to areas that experience overbank flooding in high-flow events with cottonwood galleries and young native patches of vegetation. The vegetation is very mixed in this large area that typically is not occupied by flycatchers (with the exception of the area within BDA) and also consists of mesquite, Russian olive, saltbush, quailbush, New Mexico olive, and a variety of other species.

Within BDA, habitat varies from dense monotypic saltcedar to mature cottonwood galleries. Mature coyote willow and Russian olive also typically line the banks, which is where large populations of flycatchers have established territories within the past couple of breeding seasons.

South of BDA to RM 62 consists of mainly saltcedar and Russian olive with mature cottonwoods interspersed. In areas south of the railroad trestle, habitat contains less saltcedar and Russian olive and contains larger quantities of mature cottonwood and willows. However, in recent years, these areas have become very dry, and the mature cottonwoods have been very susceptible to mistletoe (*Viscum album)*. Foliage in the canopy is now very sparse.

#### *3.2.4.3 Suitable Habitat Classification*

Development of a GIS-based flycatcher habitat suitability model was initiated in 1998 for the MRG Basin and continues to be refined based on changes in hydrology and updated vegetation maps. Riparian vegetation in the MRG Basin between San Acacia Diversion Dam and Elephant Butte Reservoir had been classified using the Hink and Ohmart (1984) classification system through a cooperative effort with the U.S. Forest Service. This system identifies vegetation polygons based on dominant species and structure. Plant community types are classified according to the dominant and/or co-dominant species in the canopy and shrub layers.

During the summer and fall of 2002, as part of the Collaborative Program, Reclamation personnel updated vegetation maps from Belen to San Marcial using a combination of ground-truthing and aerial photograph analysis. During the summer of 2004, the conservation pool of Elephant Butte Reservoir was again aerially photographed (true color), and vegetation heights were remotely sensed using light detection and ranging (LIDAR) methods. The area was ground truthed again during the summer of 2005. In 2008, the conservation pool of Elephant Butte

Reservoir again was reviewed, and habitat mapping was updated based on ground-truthing and aerial photography flown in late summer of 2007. The last round of updates to the vegetation mapping was completed in 2012 with 2011 aerial imagery. These areas are continually being reviewed as vegetation matures and develops in new areas so that components of the flycatcher habitat suitability model remain current. The next round of updates to the vegetation mapping is scheduled for 2016.

In 2008 and 2012, breeding habitat suitability was refined by identifying all areas that were within 50 meters of existing watercourses, ponded water, or in the zone of peak inundation. Using the vegetation maps and the flycatcher territories detected from 2006–2009, guidelines for categorizing each vegetation type into habitat suitability classes were established based on structure and density of vegetation. In 2012, territories detected from 2010–2012 were overlaid onto the vegetation maps to apply the flycatcher habitat model and ensure that the suitability factors used from the 2008 dataset were still relevant. Factors used in making these determinations are explained below.

**Suitable –** Suitable habitat included vegetation in which a high percentage of flycatcher territories was detected. Areas with a significant structural component—primarily intermediate-sized trees (15–40 ft) with or without understory or stands with dense shrubby growth (5–15 ft)—also were considered suitable if a high percentage of territories occurred within the vegetation type. Other qualifying vegetation types were those that included a combination of important plant species, especially tree willows, coyote willows (particularly in the canopy layer), Russian olive, and saltcedar (however, not monotypic saltcedar) and also vegetation classes with a "d" qualifier, which indicated > 50% aerial vegetation cover.

**Moderately Suitable –** Moderately suitable habitat included vegetation in which a fairly high percentage of territories occurred from 2006–2009. Areas that provided a good structural component (primarily the same community types as described in suitable habitat) and occasionally community type 1, which consisted of tall/mature trees with well-developed canopy (> 40 ft), also could be considered moderately suitable. This category required an adequate combination of vegetation species with at least 50% of the species composition made up of the more desirable plant species (those listed under "Suitable" habitat).

**Unsuitable –** Unsuitable habitat included vegetation in community types with tall/mature trees with or without understory (> 40 ft) or communities with very young and low growth. These were habitats in which vegetation was either too sparse or too mature, or the majority of the polygon consisted of the lower priority plant species. If fourwing saltbush (*Atriplex canescens*), honey mesquite (*Prosopis glandulosa*), screwbean mesquite (*Prosopis pubescens*), creosote (*Larrea tridentata*), or New Mexico olive (*Forestiera pubescens*) were a component of the classification, then the vegetation type was determined to be unsuitable.

**Nonhabitat –** Nonhabitat for flycatchers consists of five classifications, which include open areas with no woody overstory (e.g., open water or marsh) and human developments (e.g., roads and railroads).

Results from Ahlers et al. (2010) indicated that 78% of flycatcher territories detected from 2006–2009 were in vegetation classifications with a tree willow component. However, results revealed a large increase in the occurrence of saltcedar within occupied habitats. Although saltcedar is invasive and often considered an undesirable plant species, it does provide suitable habitat for flycatchers in the study area. Of all the territories, 62% had a saltcedar component, and saltcedar was the dominant species within 15% of the territories.

Although not within the action area and not included in this consultation, the vast majority of suitable habitat and flycatcher territories were found within the conservation pool of Elephant Butte Reservoir, which was a vital component in determining habitat suitability composition. There were 4,512 acres of suitable and moderately suitable flycatcher habitat mapped within this area, far beyond any of the other reaches. Areas near BDA provided the next highest amount of suitable and moderately suitable habitat with 917 acres. The development of such high quality habitat in the conservation pool of Elephant Butte Reservoir can be attributed to a decline in the reservoir levels, which exposed soils and provided moist sites for willows to establish. The suitability of this habitat for flycatchers was substantiated by the occurrence of an average of 289 territories per year documented from 2010–2012, again far more than in any of the other reaches in the study area. The BDA area had an average of 45 flycatcher territories per year from 2010–2012. Ultimately, the structure and density of flycatcher habitat are likely what are most attractive, rather than the plant species composition (Moore and Ahlers 2008, 2009)

Flycatchers (and many other species of neotropical migrant landbirds) use the Rio Grande riparian corridor as stopover habitat during migration. Studies have shown that, during the spring and fall migration, flycatchers more commonly are found in willow habitats than in other riparian vegetation types, including the narrow band of coyote willows that line the LFCC (Finch and Yong 1997). Presence/absence surveys during May have detected migrating flycatchers throughout the project area in vegetation types that would be classified as “unsuitable” for breeding habitat (Ahlers and White 1997).

#### *3.2.4.4 Development and Status of Suitable Southwestern Willow Flycatcher Breeding Habitat Within the MRG*

It is commonly recognized that one of the primary causes for the decline of neotropical migrants, along with numerous other terrestrial species, is the decrease in the abundance of riparian vegetation over the past hundred years. The removal of the dynamic components of river systems is a main reason for this decline in riparian vegetation.

The Rio Grande and associated riparian areas historically have been a very dynamic system in constant change; without this change, the diversity and productivity decrease. Sediment deposition, scouring flows, inundation, and irregular flows are natural dynamic processes that historically occurred frequently enough in concert to shape the characteristics of the Rio Grande channel and floodplain. Flycatcher habitat historically has developed in conjunction with this hydrologically dynamic system where habitat was created and destroyed in a relatively short period of time. It is this type of dynamic, successional system that flycatchers depend on for the establishment and development of their breeding habitat. Through the development of dams, irrigation systems, and controlled flows, the dynamics of the river system have been eliminated except for localized areas such as within reservoirs, where water storage levels frequently change with releases and inflows. It is no coincidence that flycatchers have expanded and dispersed within the delta of the Elephant Butte Reservoir. In previous years, this has been the only large-scale area with this dynamic process in favor of flycatcher habitat expansion in the form of changing reservoir elevations. Cottonwoods and willows are aggressive colonizers of disturbed sites in a variety of ecological situations (Reichenbacher 1984).

The interaction of river discharge (timing and magnitude), river channel morphology, and floodplain characteristics are vital components that can favor the establishment of native vegetation and enhance the development of suitable willow flycatcher breeding habitat within the MRG. Manmade procedures have been developed and implemented such as mechanical disturbance, herbicide treatments, prescribed fire, channel realignment, operational flows, avulsions, and river realignment. These processes manipulate the river and floodplain in an attempt to support the diversity of a healthy river system.

Successful cottonwood and willow recruitment has been shown to coincide with the descending limb of the spring runoff hydrograph. The timing and rate of decline of receding flood flows such as those that occur at the conservation pool of Elephant Butte have been documented as important factors affecting seedling survival (Sprenger et al. 2002). Newly scoured area of the river channel or floodplain and areas where sediment has been deposited also provide conditions for regeneration of native species and can stimulate vegetation health. An example of this was the sediment plug in BDA in 2008 and the response to that event by the large increase in suitable habitat and flycatcher territories.

Habitat modeling throughout the MRG (including areas south of the action area) has shown that there currently is suitable unoccupied habitat, thus indicating that habitat availability is presently not a limiting factor to this population. The reason that flycatchers do not expand into all areas of suitable habitat is possibly a result of their relatively strong site fidelity. However, the availability of suitable habitat is likely to decline over the next few years, particularly within the conservation pool of Elephant Butte Reservoir due to natural succession, extended flooding from the LFCC in some areas quickly replaced with extended drought, channel degradation in the Rio Grande, and saltcedar encroachment that inevitably will be impacted by the saltcedar leaf beetle.

The distribution of flycatcher territories within the MRG has shifted and will continue to shift in response to these habitat changes.

### 3.2.5 Reasons for Decline

A complete description of threats by listing factor and reasons for decline is provided in the Final Rule listing the flycatcher as an endangered species (60 Fed Reg 10695). During the last two centuries, human-induced hydrological and ecological changes have heavily influenced the composition and extent of floodplain riparian vegetation along the MRG (Bullard and Wells 1992, Dick-Peddie 1993). Introduction of exotic species, such as saltcedar, has decreased the availability of dense willow and associated desirable vegetation and habitat important to flycatchers. The destruction and fragmentation of forested breeding habitat also may play a role in population reduction of migratory birds (Lynch and Whigham 1984, Wilcove 1988). In addition, the rapid rate of deforestation in tropical areas has been cited as a possible reason for population declines in forest-dwelling migrant land birds (Lovejoy 1983, Rappole and McDonald 1994, Robbins et al. 1989).

Brood parasitism by brown-headed cowbirds (*Molothrus ater*) (cowbird), has been implicated in the decline of songbirds, including those found in the Western riparian habitats (Gaines 1974, Goldwasser et al. 1980, Laymon and Halterman 1987). Cowbirds have increased their range with the clearing of forests and the spread of intensive grazing and agriculture. Flycatchers are more susceptible to cowbird nest parasitism because of the ease of egg laying in the flycatcher's open cup nest design. Habitat fragmentation and forest openings allow cowbirds easy access to host nests located near these edges. Grazing cattle often are associated with cowbird activity; however, in a recent report (Brodhead et al. 2007), brood parasitism by cowbirds was more closely associated with habitat types, particularly vegetation, patch size, and edge effect. Nest parasitism and predation, combined with declining populations and habitat loss or modification via dams and reservoirs, diversions and groundwater pumping, channelization and bank stabilization, phreatophyte control, livestock grazing, recreation, fire, agricultural development, and/or urbanization (Service 2002a), have placed this species in a precarious situation (Mayfield 1977, Rothstein et al. 1988, Brittingham and Temple 1983, Laymon and Halterman 1987). Predation rates are also high for flycatcher nests, up to 50 percent in recent years in the southern reaches of the MRG.

## 3.3 Yellow-Billed Cuckoo

### 3.3.1 Species Description

The yellow-billed cuckoo (cuckoo) is a neotropical migratory bird about 12 inches long. They are slender, long-tailed birds with white spots on the underside of their tail feathers, a white breast, brown backs, and a long, curved, mainly yellow bill.

It has been debated whether the western yellow-billed cuckoo (*Coccyzus americanus occidentalis*) is a true subspecies of the yellow-billed cuckoo. In 2001, the Service determined that the western population is a Distinct Population Segment (DPS) (66 Fed Reg 38611) from the eastern population (*C. a. americanus*), with the division being the continental divide from Montana to central Colorado, the eastern boundary of the Rio Grande drainage from central Colorado to Texas, and the mountain ranges that form a southeastern extension of the Rocky Mountains to the Big Bend area in west Texas.

### 3.3.2 Distribution and Abundance

The decline of the western yellow-billed cuckoo is primarily the result of riparian habitat loss and degradation, with past riparian habitat losses estimated at about 90 percent in New Mexico (79 Fed Reg 59992). Other threats include loss of habitat to agricultural and other land uses, overgrazing, exposure to pesticides, wildfire, and conversion of habitat to monotypic stands of nonnative vegetation (79 Fed Reg 59992). Figure I-14 illustrates the historical and current breeding range of the cuckoo.

Estimating cuckoo breeding territories is quite complicated due to large and overlapping territories, the employment of a ‘helper male’ (juvenile male that assists a pair with nest building, foraging, etc.) in some cases, and the general elusive nature of the cuckoo. A rangewide protocol for survey methodology and territory estimation is currently being developed with the assistance of biologists from multiple agencies. It is estimated that rangewide (including Mexico) there are a total of 680 to 1,025 breeding pairs (79 Fed Reg 59992).


**Figure I-14. Historical breeding range and current populations of the western yellow-billed cuckoo (adapted from Laymon and Halterman 1987)**

Formal surveys for cuckoos along the MRG began in 2006 with a total of 105 detections or 44 estimated total territories from the south boundary of BDA to Elephant Butte Reservoir (Johanson et al. 2006). In 2013, Reclamation conducted continuous surveys from the south boundary of Isleta Pueblo to Elephant Butte Reservoir resulting in 391 detections or an estimated 119 total territories (Ahlers and Moore 2014). This area has one of the largest concentrations of the cuckoo in New Mexico (79 Fed Reg 59992), which is largely concentrated south of the action area within areas historically inundated by Elephant Butte Reservoir with an estimated 60 territories south of RM 62 (about 3 miles upstream of the Power Line at the Elephant Butte inflow) (Ahlers and Moore 2014). It is believed that this population has increased slightly since formal surveys began; however, the data are not directly comparable over time because of differences in the amount of area surveyed, number of surveys within breeding season, and the different processes for estimating territories (see Table I-2 adapted from Ahlers and Moore 2014).

**Table I-2. Yellow-billed cuckoo detections and territories in the MRG from 2006 through 2013 (adapted from Ahlers and Moore 2014)**

| River Reach | Cuckoo Detections/Territories Delineated | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **2006** | **2007** | **2008** | **2009** | **2010** | **2011** | **2012** | **2013** |
| Belen (S. Boundary Isleta Pueblo to Rio Puerco) | n/s | n/s | n/s | 1/0 | 3/0 | 16/4 | 44/15 | 20/6 |
| Sevilleta NWR/ La Joya (Rio Puerco to San Acacia Diversion Dam) | n/s | n/s | n/s | 4/2 | 1/0 | 6/2 | 36/12 | 19/6 |
| San Acacia (San Acacia Diversion Dam to Escondida Bridge) | n/s | n/s | n/s | 8/1 | 3/0 | 6/1 | 19/4 | 20/5 |
| Escondida (Escondida Bridge to N. Boundary BDA) | n/s | 3/2 | 19/10 | 29/9 | 6/2 | 15/3 | 68/21 | 80/23 |
| BDA | n/s | 22/13 | 35/14 | 47/11 | 14/3 | 17/4 | 36/10 | 29/8 |
| Tiffany (S. Boundary BDA to RR Trestle at Black Mesa) | 10/6 | 12/4 | 7/3 | 10/3 | 2/0 | 4/1 | 10/2 | 4/1 |
| San Marcial (RR Trestle at Black Mesa to RM 62) | 30/10 | 40/16 | 47/15 | 46/13 | 27/6 | 43/12 | 25/8 | 30/10 |
| **Total** | **40/16** | **77/35** | **108/42** | **145/39** | **56/11** | **107/27** | **238/72** | **202/59** |

n/s = Not surveyed

Historically, cuckoos were also documented in areas farther north along the Rio Grande and in portions of the Gila, San Francisco, and San Juan Rivers (78 Fed Reg 61622). Although systematic surveys have not been conducted on these rivers in western New Mexico, the extent of cuckoo habitat in these areas is limited, discontinuous and fragmented (78 Fed Reg 61622). Based on available habitat, a maximum of 55 cuckoo pairs could breed on these other rivers in western New Mexico (78 Fed Reg 61622).

### 3.3.3 Listing Status and Critical Habitat

The western DPS of the cuckoo was listed as a threatened species under the ESA in October 2014 (79 Fed Reg 59992). The Western DPS of the cuckoo includes the U.S. states of Arizona, California, western Colorado, Idaho, western Montana, western New Mexico, Nevada, Oregon, western Texas, Utah, Washington, western Wyoming; Canadian province of southwestern British Columbia; and the Mexican states of Baja California, Baja California Sur, Chihuahua, western Durango, Sinaloa, and Sonora (Figure I-15). In New Mexico, the Western DPS includes the Rio Grande.

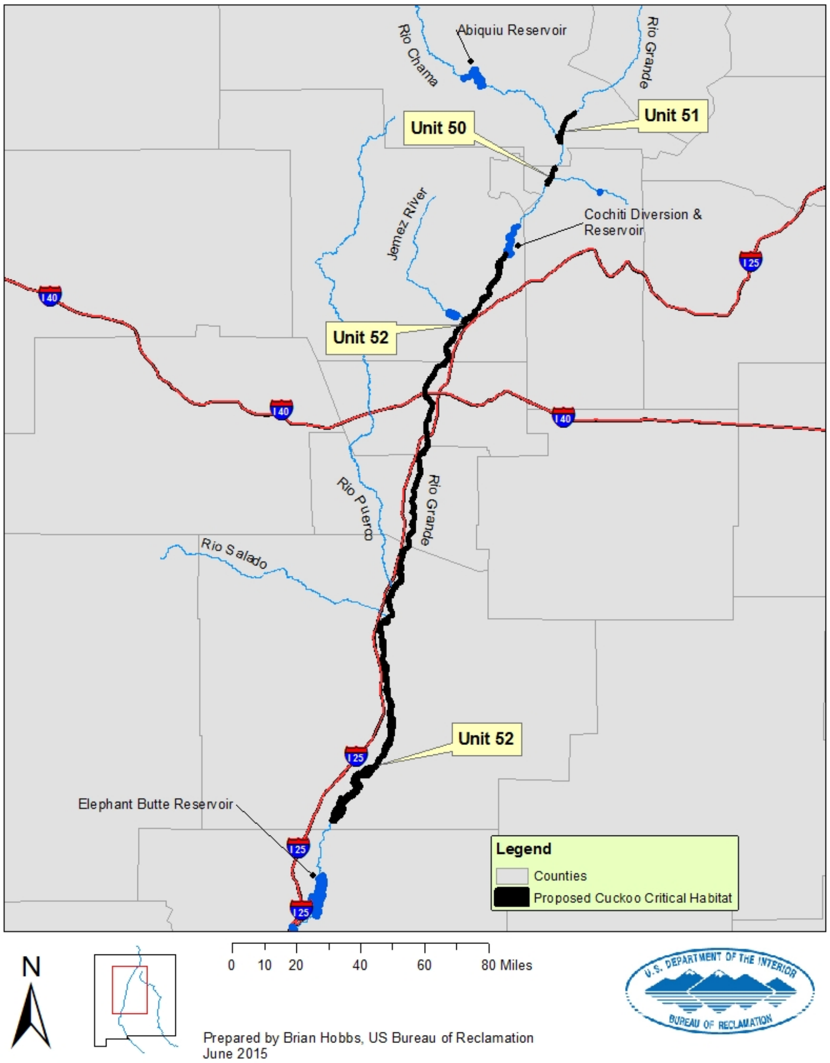


**Figure I-15. Areas of proposed cuckoo critical habitat along the Rio Grande in New Mexico (Units 50-52)**

Proposed critical habitat announced in the Federal Register in August of 2014 (79 Fed Reg 48548) includes 8 units in New Mexico. Along the MRG, this proposed area includes the following:

- Unit 50: NM-6 Upper Rio Grande. Includes 1,830 acres in extent and is a 10-mile-long continuous segment of the upper Rio Grande from Ohkay Owingeh to near Alcalde in Rio Arriba County.

- Unit 51: NM-7 Upper Rio Grande 2. Includes 1,173 acres in extent and is a 6-mile-long continuous segment of the MRG starting from the Highway 502 Bridge at the south end of the San Ildefonso Pueblo upstream to a point on the river in Rio Arriba County south of La Mesilla.

- Unit 52: NM-8 Middle Rio Grande 1. Includes 61,959 acres in extent and is a continuous 170 miles long from RM 54 at Elephant Butte Reservoir upstream to just below Cochiti Dam. The population in this unit is believed to be the largest breeding population of cuckoos north of Mexico.

The Service identified 3 PCEs of proposed critical habitat for the cuckoo as follows:

- PCE 1 - Riparian Woodlands

"Riparian woodlands with mixed willow cottonwood vegetation, mesquite-thorn forest vegetation, or a combination of these that contain habitat for nesting and foraging in contiguous or nearly contiguous patches that are greater than 325 ft (100 m) in width and 200 acres (81 ha) or more in extent. These habitat patches contain one or more nesting groves, which are generally willow dominated, have above average canopy closure (greater than 70 percent), and have a cooler, more humid environment than the surrounding riparian and upland habitats."

- PCE 2 - Adequate Prey Base

"Presence of a prey base consisting of large insect fauna (for example, cicadas, caterpillars, katydids, grasshoppers, large beetles, dragonflies) and tree frogs for adults and young in breeding areas during the nesting season and in post-breeding dispersal areas."

- PCE 3 - Dynamic Riverine Processes

"River systems that are dynamic and provide hydrologic processes that encourage sediment movement and deposits that allow seedling germination and promote plant growth, maintenance, health, and vigor (e.g. lower gradient streams and broad floodplains, elevated subsurface groundwater table, and perennial rivers and streams). This allows habitat to regenerate at regular intervals, leading to riparian vegetation with variously aged patches from young to old."

### 3.3.4 Life History and Ecology

Cuckoos are neotropical migrant birds that arrive in the western United States in June and depart for their winter range towards the end of August. Cuckoos nest in large, dense patches of riparian vegetation, particularly with a cottonwood and/or Goodding's willow overstory (Ehrlich et al. 1988). A dense understory consisting of exotic saltcedar, Russian olive (*Elaeagnus angustifolia*), or native vegetation (e.g. *Salix* spp.) also appears to be an important component for territory establishment (Sechrist et al. 2009). In New Mexico, home range estimates for cuckoos within portions of the Rio Grande varied from 5–282 ha, and averaged 82 ha based on their minimum convex polygon (MCP) (Sechrist et al. 2009).

Nest heights range from 1.3–13 meters and are made up of loose twigs arranged in a shallow saucer shape. Clutch sizes vary depending on food supply, and contain 2–5 eggs of a light blue-green color. Both the male and female incubate the eggs, and both male and female (and sometimes a 'helper juvenile male') will tend to the young. The incubation and nestling periods are very short, with the eggs hatching in 11–12 days and young fledging in only 5–7 days (79 Fed Reg 59991). Incubation begins when the first egg is laid and the young hatch asynchronously, with the oldest near fledging while the youngest has just hatched within the same nest (Hughes 1999). Evidence of breeding site fidelity varies. It is likely that cuckoos return to sites of previous successful breeding, but if conditions are not suitable in a given year, they may move to other locations (79 Fed Reg 59991).

Not much is known about the winter range of the cuckoo. Based on the single cuckoo that was affixed with a geolocator (e.g., satellite-linked tag) and recaptured on the Rio Grande, it appears that it overwintered in eastern Bolivia, southwestern Brazil, Paraguay, and northeastern Argentina (Sechrist et al. 2012).

#### *3.3.4.1 Cuckoo Breeding Habitat Characteristics*

The cuckoo breeding sites are typically located in riparian woodlands that cover 50 acres or more (79 Fed Reg 59991). On the Rio Grande, based on the telemetry results from 10 tracked cuckoos from 2007–2008, home range estimates varied from 5–282 ha with an average of 81.6 ha based on their MCP (Sechrist et al. 2009). In addition to large expanses of riparian vegetation, cuckoos also require adequate hydrology. Biologists have hypothesized that cuckoos are restricted to large and moist patches of vegetation due to humidity requirements for successful hatching and rearing of young (Hamilton et al. 1965).

The type of vegetation occupied during the breeding season varies by location within the range. The majority of all detections from 2009-2013 on the Rio Grande (21%) have been located in vegetation patches consisting of a native canopy (e.g., Goodding's willow and/or cottonwood) and mixed understory (e.g., coyote or Goodding's willow and saltcedar) (Figure I-16) (Ahlers and Moore 2014). These data are consistent with telemetry results from 2007–2008 where preference within the 50% kernel home range was also documented as native canopy and mixed understory.

Although it appears that cuckoos have a preference for breeding within native stands of vegetation, more than 10% of detections from 2009-2013 were located in 'exotic understory' type vegetation communities (Figure I-16) (Ahlers and Moore 2014). It is hypothesized that saltcedar is not in fact a suitable breeding habitat component, but rather a location used for foraging or stopping over due to the vast expanses of the saltcedar patches present on the landscape (Ahlers and Moore 2014). It can also be hypothesized that due to the vast expanses of saltcedar present, if it was all defoliated in a given year, the microclimate and/or humidity levels would likely change due to the absence of foliage cover.

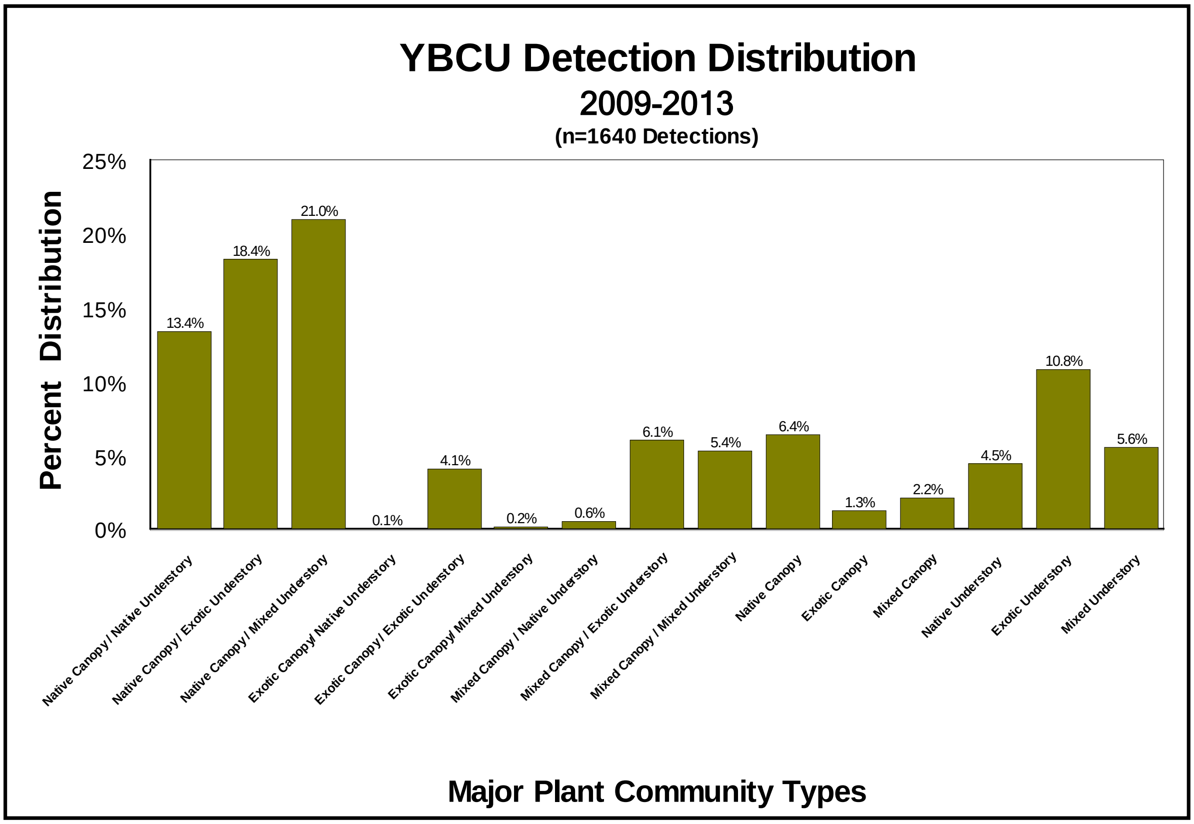


**Figure I-16. Percentage of yellow-billed cuckoo detections within various major habitat types, 2009–2013**

As mentioned in Section 3.2.4.1, the anticipated future presence of the saltcedar leaf beetle may provide a temporary food source for insectivorous birds, but once the beetle defoliates the vegetation, other foliage feeding insects would likely disperse (Paxton et al. 2011).

#### *3.3.4.2 General Habitat Description/Condition*

Territories for cuckoos are concentrated south of the project area near the Narrows area of Elephant Butte Reservoir. The habitat in this area consists of multiple age classes of Goodding's and coyote willow that colonized as the reservoir receded during the late 1990s to early 2000s (Ahlers and Moore 2014). The second largest cluster of territories (roughly 20% of all detections) is located between Socorro and Highway 380 in habitat mainly consisting of dense coyote and Goodding's willow, cottonwood, and Russian olive. This area also has low-lying river bars and terraces that are subject to periodic overbank flooding.

Refer to the habitat description from Section 3.2.4.2 for further vegetation details by reach.

#### *3.3.4.3 Suitable Habitat Classification*

There are currently no habitat suitability models specific to the cuckoo. The Reclamation GIS-based habitat suitability model used for flycatchers (Section 3.2.4.3) will likely be adapted for the cuckoo within the next several years. USGS has also been working on the initial stages to modify their landscape-level flycatcher habitat model using Landsat imagery (Hatten and Sogge 2007) to accommodate characteristics specific to the cuckoo.

In the interim, it is anticipated that habitat suitability GIS layers from the 2012 flycatcher habitat suitability study will likely be similar to habitat suitability for the cuckoos, as their territories overlap to a certain extent. It is hypothesized that for the cuckoo there would actually be more acreage of suitable habitat available compared to the flycatcher suitable habitat results due to the cuckoo having an affinity to not just the Goodding's willow canopy component, but also cottonwood.

#### *3.3.4.4 Development and Status of Suitable Yellow-Billed Cuckoo Breeding Habitat Within the MRG*

Refer to the narrative provided regarding the flycatcher in Section 3.2.4.4, as it also pertains to the cuckoo.

### 3.3.5 Reasons for Decline

A description of threats to the species under each of the five listing factors is provided in the final rule to list the species (79 Fed Reg 59992). Threats to the species include

> ". . . habitat loss associated with manmade features that alter watercourse hydrology so that the natural processes that sustained riparian habitat in western North America are greatly diminished. Loss and degradation of habitat has also occurred as a result of livestock overgrazing and encroachment from agriculture. These losses are exacerbated by the conversion of native habitat to predominantly nonnative vegetation. Habitat loss results in the additional effects associated with small and widely separated habitat patches such as increased predation and reduced dispersal potential. This threat is particularly persistent where small habitat patches are in proximity to human-altered landscapes, especially agricultural fields, resulting in the potential for pesticides to poison individual western yellow-billed cuckoos and reduce their prey base." (79 Fed Reg 48548)

When proposing to list the cuckoo as threatened, the Service identified two primary categories for threats to the species being (1) the present or threatened destruction, modification, or curtailment of its habitat or range, and (2) other natural or manmade factors affecting its continued existence (78 Fed Reg 61622).

The first threat includes habitat destruction, modification, and degradation as a result of dam construction and operations, water diversions, river flow management, stream channelization and stabilization, conversion to agricultural uses, such as crops and livestock grazing, urban and transportation infrastructure, and increased incidence of wildfire (78 Fed Reg 61622). These actions have the potential to fragment the landscape and/or encourage exotic vegetation species to outcompete native vegetation species.

The second threat includes the fact that habitat patches are rare and populations are typically small and isolated. This combination makes the species susceptible to further declines in population through lack of immigration, chance weather events, fluctuating availability of prey populations, pesticides, collisions with tall vertical structures during migration, spread of the introduced tamarisk leaf beetle as a biocontrol agent in the Southwest, and climate change (78 Fed Reg 61622).

## 3.4 New Mexico Meadow Jumping Mouse

### 3.4.1 Species Description

The New Mexico meadow jumping mouse (*Zapus hudsonius luteus*) (jumping mouse) is a small rodent endemic to New Mexico, Arizona, and a small area of southern Colorado (Hafner et al. 1981, Jones 1999). It is dark yellowish brown, dark brown, and grayish brown on the back, yellowish brown on the sides, and white underneath (Van Pelt 1993), and is approximately 7.4–10 inches (187 to 255 mm) in total length, with elongated feet (1.2 inches [30.6 mm]) and an extremely long, bicolored tail (5.1 inches [130.6 mm]) (Van Pelt 1993, Hafner et al. 1981).

Two additional subspecies of meadow jumping mice (*Zapus hudsonius*)—Bear Lodge meadow jumping mouse (*Z. h. campestris*) and Preble's meadow jumping mouse (*Z. h. preblei*)—occur in northeastern Wyoming, western South Dakota, and southwestern Montana and northern Colorado and southern Wyoming, respectively (Figure I-17). Genetic and morphological studies have shown differentiation between the subspecies (King et al. 2006, Vignieri et al. 2006, Frey 2008, Malaney et al. 2012).

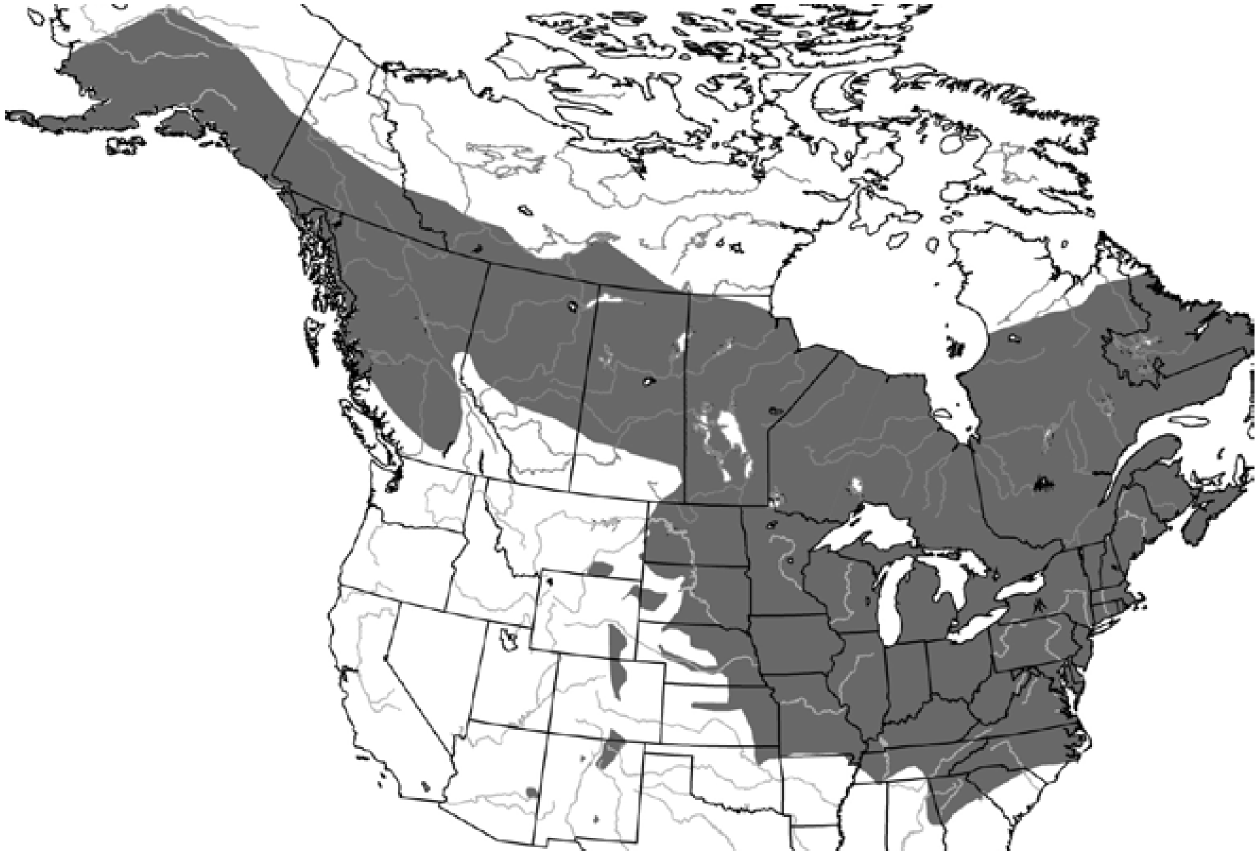

**Figure I-17. Distribution of *Zapus hudsonius* species (gray shading) (modified from Frey and Malaney 2009). *Z. h. luteus* occurs along the MRG at the BDA Refuge, but is not shown on this map.**

### 3.4.2 Distribution and Abundance

With the exception of BDA, systematic surveys of jumping mice and their habitat have not been conducted throughout the entire riparian corridor of the MRG. Since its listing, surveys for jumping mice and suitable jumping mouse habitat have occurred in selected areas as part of environmental compliance activities for various projects, such as the Delta Channel river maintenance project (Reclamation 2014a). The Delta Channel is located on the fringe of the geographic area within the Rio Grande watershed where jumping mice could potentially occur (Frey 2013); however, a habitat assessment determined that this area does not represent suitable habitat based on the herbaceous vegetation composition and structure, a lack of soil moisture, a high frequency and long history of disturbance, and a lack of regular inundation (Reclamation 2014a). Based on the habitat assessments within the Delta Channel and available information on vegetation in the area, it is unlikely that occupied or suitable jumping mouse habitat exists south of BDA.

The historical distribution of the jumping mouse likely included riparian areas and wetlands along streams in the Sangre de Cristo and San Juan Mountains from southern Colorado to central

New Mexico, including the Jemez and Sacramento Mountains and the Rio Grande Valley from Española to BDA, and into parts of the White Mountains in eastern Arizona (79 Fed Reg 33119).

Eight geographic management areas with 29 populations have been documented since 2005 (2 in Colorado, 15 in New Mexico, and 12 in Arizona). Four of the eight geographic management areas have two or more locations, each known to be occupied by the jumping mouse, and the other four have one location each. Most of the current populations are isolated and widely separated, and all locations are insufficient in size to support resilient populations. In addition, 11 of the 29 documented populations have been compromised since 2011 due to water shortages, excessive grazing, or wildfire and post-fire flooding, and these populations could already be extirpated (Service 2014c).

In the MRG Valley, jumping mice are known to use both natural wetlands and riparian habitats associated with irrigation channels (Frey and Wright 2012). Current distribution of jumping mice within the MRG is uncertain, but the species was confirmed to persist at Ohkay Owingeh Pueblo and the adjacent Rio Chama (Rio Arriba County), Isleta Pueblo (Bernalillo County), near Casa Colorada Wildlife Area (Valencia County), and BDA (Socorro County) as of the late 1980s (Morrison 1988, Frey 2006a). The largest known population in New Mexico occurs along the Rio Grande in BDA. This population is found along the Riverside Canal with an area of suitable habitat estimated to be 10.12 acres. The population is estimated to range from 5–6.6 mice per acre along 2.7 km (1.7 miles) of canal (Service 2014c). Surveys at BDA in 2014 resulted in the capture of 19 mice (Service 2014d). Historically the jumping mouse was also found at Isleta and Ohkay Owingeh Pueblos. The Isleta Pueblo location has not been surveyed since 1987 and no jumping mice were found during surveys performed in 2012 at Ohkay Owingeh Pueblo (Service 2014e).

Additional information pertaining to the distribution of the jumping mouse can be found in the following documents:

Frey, J.K. and D.A. Kopp. 2014. *Final Report: Preliminary Assessment of Jumping mouse Habitat Associated with Middle Rio Grande Project*. U.S. Department of the Interior, Bureau of Reclamation, Albuquerque Area Office, 18 pp.

U.S. Fish and Wildlife Service. 2013. Endangered and Threatened Wildlife and Plants, Proposed Designation of Critical Habitat for the New Mexico Meadow Jumping Mouse: Listing Determination for the New Mexico Meadow Jumping Mouse; Proposed Rules. Federal Register 78: 37328-37363.

U.S. Fish and Wildlife Service. 2014c. Endangered and Threatened Wildlife and Plants, Determination of Endangered Status for the New Mexico Jumping Mouse Through Its Range; Final Rule. Federal Register 79: 33119-33137.

U.S. Fish and Wildlife Service. 2014d. New Mexico meadow jumping mouse (*Zapus hudsonius luteus*) Survey Results at Bosque del Apache National Wildlife Refuge. United States Government Memorandum. 12 pp.

U.S. Fish and Wildlife Service. 2014e. Species Status Assessment Report, New Mexico meadow jumping mouse (*Zapus hudsonius luteus*). Albuquerque, New Mexico. 149 pp.

### 3.4.3 Listing Status and Critical Habitat

A final rule was published in the June 10, 2014 Federal Register (effective July 10, 2014) (79 Fed Reg 33119) to list the New Mexico meadow jumping mouse as an endangered species under the ESA with proposed critical habitat. The final designation for critical habitat for the species is still being determined.

Proposed critical habitat units have been identified for Bernalillo, Colfax, Mora, Otero, Rio Arriba, Sandoval, and Socorro Counties in New Mexico, Las Animas, Archuleta, and La Plata Counties in Colorado, and Greenlee and Apache Counties in Arizona. Four PCEs of the physical or biological features essential to the conservation of the jumping mouse consist of the following within these areas, as proposed (78 Fed Reg 37328).

- PCE 1—Riparian Communities

"Riparian communities along rivers and streams, springs and wetlands, or canals and ditches characterized by one of two wetland vegetation community types;

a. Persistent emergent herbaceous wetlands dominated by beaked sedge (*Carex rostrata*) or reed canarygrass (*Phalaris arundinacea*) alliances

b. Scrub-shrub riparian areas that are dominated by willows (*Salix* spp.) or alders (*Alnus* spp.)"

- PCE 2—Flowing Water

"Flowing water that provides saturated soils throughout the jumping mouse's active season that supports tall (average stubble height of herbaceous vegetation of at least 69 cm (27 inches) and dense herbaceous riparian vegetation (cover averaging at least 61 vertical cm (24 inches)) composed primarily of sedges (*Carex* spp. or *Schoenoplectus pungens*) and forbs, including, but not limited to one or more of the following associated species: spikerush (*Eleocharis macrostachya*), beaked sedge (*Carex rostrata*), reed canarygrass (*Phalaris arundinacea*), rushes (*Juncus* spp. and *Scirpus* spp.), and numerous species of grasses such as bluegrass (*Poa* spp.), slender wheatgrass (*Elymus trachycaulus*), brome (*Bromus* spp.), foxtail barley (*Hordeum jubatum*), or Japanese brome (*Bromus japonicas*), and forbs such as water hemlock (*Circuta douglasii*), field mint (*Mentha arvense*), asters (*Aster* spp.), or cutleaf coneflower (*Rudbeckia laciniata*)."

- PCE 3—Sufficient Areas

> "Sufficient areas of 9 to 24 km (5.6 to 15 mi) along a stream, ditch, or canal that contain suitable or restorable habitat to support movements of individual jumping mice."

- PCE 4—Adjacent areas

> "Include adjacent floodplain and upland areas extending approximately 100 m (330 ft) outward from the water's edge (as defined by the bankfull stage of streams)."

Additional information pertaining to the listing status and critical habitat of the jumping mouse can be found in the following documents:

Frey, J.K. 2013. *Draft survey protocol for the New Mexico meadow jumping mouse (Zapus hudsonius luteus)*. Final report submitted to Non-game and T&E Mammal Program, New Mexico Department of Game and Fish. June 28, 2013. 53 pp.

Frey, J.K. and D.A. Kopp. 2014. *Final Report: Preliminary Assessment of Jumping mouse Habitat Associated with Middle Rio Grande Project*. U.S. Department of the Interior, Bureau of Reclamation, Albuquerque Area Office. 18 pp.

U.S. Fish and Wildlife Service. 2013. Endangered and Threatened Wildlife and Plants, Proposed Designation of Critical Habitat for the New Mexico Meadow Jumping Mouse: Listing Determination for the New Mexico Meadow Jumping Mouse; Proposed Rules. Federal Register 78: 37328-37363.

U.S. Fish and Wildlife Service. 2014c. Endangered and Threatened Wildlife and Plants, Determination of Endangered Status for the New Mexico Jumping Mouse Through Its Range; Final Rule. Federal Register 79: 33119-33137.

U.S. Fish and Wildlife Service. 2014d. New Mexico meadow jumping mouse (*Zapus hudsonius luteus*) Survey Results at Bosque del Apache National Wildlife Refuge. United States Government Memorandum. 12 pp.

U.S. Fish and Wildlife Service. 2014e. *Species Status Assessment Report, New Mexico meadow jumping mouse* (*Zapus hudsonius luteus*). Albuquerque, NM. 149 pp.

### 3.4.4 Life History and Ecology

The jumping mouse is a habitat specialist associated with herbaceous riparian wetland habitats. Its habitat is characterized by tall dense riparian herbaceous vegetation at least 61 cm (24 in) in average stubble height. Vegetation is important in providing food and cover for nesting, nesting materials, movement, and to avoid predation. The herbaceous vegetation is described above under PCE 2. Seasonally or perennial flowing waters are needed to support the vegetation growth.

Jumping mice occur in habitat that is near water, contains moist soils, and has dense herbaceous canopy cover that in BDA is typically composed of dogbane (*Apocynum cannabinum*), foxtail barley (*Hordeum jubatum*), and common threesquare (*Schoenoplectus pungens*) (Frey and Wright 2012). During past jumping mouse surveys, soils were saturated at the capture sites, and vegetation was generally composed of forbs, grasses, and rushes (Frey and Wright 2012). Most jumping mice were located within stands of young coyote willows (*Salix exigua*), characterized by sapling (< 3 years old) willows, mixed with herbaceous plants along the shores of canals and bordering temporarily flooded, managed wetlands (Frey and Wright 2012). Jumping mice were rarely found in association with older, woody willows.

Although the jumping mouse commonly uses riparian vegetation immediately adjacent to a perennial stream, it may also utilize seasonal streams, wetland, or marshes that contain areas of saturated soils, agricultural ditches, and canals, and wet meadows or seeps. Historically, these wetland habitats would have been in large patches (movements of 200 to 700 m [656 to 2,297 ft]) to disperse to other habitat patches within stream segments) located intermittently along long stretches of streams.

A draft survey protocol that outlines trapping parameters has been developed by Jennifer K. Frey, PhD (Frey 2013). The draft protocol is under review to determine feasibility as a monitoring tool. There are currently no habitat suitability models for the MRG specific to the jumping mouse. Where the data were available, the Reclamation GIS-based flycatcher habitat suitability model and vegetation mapping were utilized for identifying potential jumping mouse habitat in the MRG (Frey and Kopp 2014). However, the vegetation mapping for flycatchers was not at a fine enough scale to determine suitable jumping mouse habitat without field checks.

BDA has conducted the most detailed study available of habitat use in the MRG by jumping mice. Jumping mice only occurred where there was an overlap of required habitats at three scales: landscape, macrohabitat, and microhabitat (Frey and Wright 2012). At the landscape scale, jumping mice selected canals with water, foxtail barley (*Hordeum jubatum*) herbaceous temporarily flooded association, and narrowleaf willow (coyote willow) / mesic graminoids shrubland association. Only canals reaches with low banks and composed of soils that were capable of developing a moist soil herbaceous vegetation zone were utilized. Jumping mice only used regenerating stands of willow that had sparse enough canopy to develop diverse herbaceous ground cover. Mature stands of willow typically lack a dense herbaceous layer and are not utilized by jumping mice (Service 2014e).

Jumping mice at the macrohabitat scale selected only canals and the foxtail barley (*Hordeum jubatum*) herbaceous temporarily flooded association. Drier vegetation associations, including

*Prosopis glandulosa - Atriplex canescens* shrubland, *Tamarix ramosissima* monotype, *Tamarix ramosissima/Populus deltoides, Populus deltoides* woodland, *Salix exigua/Baccharis salicifolia* shrubland, and *Salix exigua*/mesic forb shrubland, were avoided completely. Associations consisting of narrowleaf willow and grasses (i.e., *Salix exigua*/mesic graminoid shrubland, *Salix exigua*/mixed grass shrubland) were used in proportion to their availability (Service 2014c).

Jumping mice microhabitat selection included areas near water with high soil moisture and dense herbaceous canopy cover, and was significantly more likely to be associated with common threesquare (*Schoenoplectus pungens*), dogbane (*Apocynum cannabinum*), and foxtail barley (*Hordeum jubatum*). Habitats represented by Rio Grande cottonwood (*Populus deltoides wislizeni*), plains bristlegrass (*Setaria vulpiseta*), saltgrass (*Distichlis spicata*), mule-fat (*Baccharis salicifolia),* spikerush (*Eleocharis* spp.), and two exotic invasive species, kochia (*Bassia scoparia*) and saltcedar (*Tamarix ramosissima*), were avoided (Service 2014c)

The jumping mouse is a profound hibernator with the maximum extent of aboveground activity for populations in the MRG limited to mid-May to late-October (Frey and Kopp 2014). Higher elevation montane jumping mouse populations have a shorter active period from early June to September. During this short timeframe, it must have access to high quality food in order to breed, birth and raise young, and store up sufficient fat reserves to survive the next year's hibernation period. There is a correlation between jumping mouse activity and the growing season of the grasses and forbs on which the jumping mouse depends.

The jumping mouse occurs from elevations ranging from about 1,371 m (4,500 ft) in the middle Rio Grande to about 2,438 m (8,000 ft) in montane populations. They are generally nocturnal, solitary, and not antagonistic toward one another. Little is known about the reproductive needs of the jumping mouse, but the breeding season probably begins in July or August, with one litter of 2–7 young produced each year.

Jumping mice utilize different types of nests in different habitat types. For hibernation and rearing of young, the jumping mouse nests in dry soils but otherwise exclusively uses moist, streamside, dense riparian or wetland herbaceous vegetation (Service 2014c). Day nests are structures that are used during the day for protection from predation and resting and are constructed of available plant material, such as grasses, forbs, sedges, and rushes. Females will use maternal nests in areas outside the moist riparian areas for giving birth and rearing young. The maternal nests used by female jumping mice located in drier riparian habitats are dominated by riparian shrubs or trees and are usually below ground (though they may also be found above ground) under fallen sticks and limbs from willow (*Salix* spp.), cottonwood (*Populus deltoides*), and mesquite (*Prosopis* spp.) trees (Frey and Wright, 2012). These nests provide shelter for the females and their young to avoid predation (Service 2014c).

Jumping mice are prey for many other species, and predation is likely a significant source of mortality. Known predators of jumping mice include garter snakes (*Thamnophis* spp.), rattlesnakes (*Crotalus* spp.), bullfrogs (*Lithobates catesbianus*), foxes (*Vulpes vulpes* and/or *Urocyon cinereoargenteus*), house cats (*Felis catus*), long-tailed weasels (*Mustela frenata*), and red-tailed hawks (*Buteo jamaicensis*) (Shenk and Sivert 1999, Schorr 2001). Other potential predators of jumping mice include coyotes (*Canis latrans*), barn owls (*Tyto alba*), great horned owls (*Bubo virginianus*), western screech owls (*Otus kennicottii*), long-eared owls (*Asio otus*), and northern harriers (*Circus cyaneus*) (Quimby 1951, Whitaker 1963). Additional mortality factors for jumping mice include drowning and losses associated with starvation, exposure, disease, cannibalism, and insufficient fat stores for hibernation (Sheldon 1934, Whitaker 1963, Schorr 2001).

Additional information pertaining to life history and habitat needs of the jumping mouse can be found in the following documents:

Frey, J.K. 2013. *Draft survey protocol for the New Mexico meadow jumping mouse (Zapus hudsonius luteus)*. Final report submitted to Non-game and T& E Mammal Program, New Mexico Department of Game and Fish. June 28, 2013. 53 pp.

Frey, J.K. and D.A. Kopp. 2014. *Final Report: Preliminary Assessment of Jumping mouse Habitat Associated with Middle Rio Grande Project*. U.S. Department of the Interior, Bureau of Reclamation, Albuquerque Area Office. 18 pp.

Frey, J.K. and G.D. Wright. 2012. *Multiple-scale habitat selection by a small mammal habitat specialist (Zapus hudsonius luteus) in a managed floodplain landscape*. Department of Fish Wildlife and Conservation Ecology, New Mexico State University, Las Cruces, New Mexico, 152 pp.

U.S. Fish and Wildlife Service. 2013. Endangered and Threatened Wildlife and Plants, Proposed Designation of Critical Habitat for the New Mexico Meadow Jumping Mouse: Listing Determination for the New Mexico Meadow Jumping Mouse; Proposed Rules. Federal Register 78: 37328-37363.

U.S. Fish and Wildlife Service. 2014c. Endangered and Threatened Wildlife and Plants, Determination of Endangered Status for the New Mexico Jumping Mouse Through Its Range; Final Rule. Federal Register 79: 33119-33137.

U.S. Fish and Wildlife Service. 2014d. New Mexico meadow jumping mouse (*Zapus hudsonius luteus*) Survey Results at Bosque del Apache National Wildlife Refuge. United States Government Memorandum. 12 pp.

U.S. Fish and Wildlife Service. 2014e. *Species Status Assessment Report New Mexico meadow jumping mouse (Zapus hudsonius luteus).* Albuquerque, NM. 149 p.

### 3.4.5 Reasons for Decline

A complete description of threats by listing factor and reasons for decline is provided in the Final Rule listing the New Mexico meadow jumping mouse as an endangered species (79 Fed Reg 33119). The loss of dense riparian herbaceous vegetation that serves as suitable habitat for the jumping mouse has already resulted in the loss of many local populations of the subspecies and is the most important stressor to jumping mouse viability. Without sufficiently sized connected areas of suitable habitat, the New Mexico meadow jumping mouse has been unable to respond to the modification of habitats and is likely to continue to lose populations due to ongoing and future habitat loss (Service 2014c).

The primary sources of past and future habitat losses are from livestock grazing, water management and use, lack of water due to drought, and wildfires. Additional sources of habitat loss are likely to occur from floods, loss of beaver ponds, highway reconstruction, residential and commercial development, coalbed methane development, and recreation. Historically larger connected populations of jumping mice would have been able to withstand or recover from local stressors, but the current condition of small populations makes local extirpations more common. In addition, the isolated state of existing populations makes natural recolonization of impacted areas highly unlikely in most areas.

While suitable habitat exists within the MRG, these areas lack sufficient patch size and habitat connectivity needed to allow for dispersal of individual mice to new areas. As a result, the jumping mice now exist in isolated populations. Historically the MRG likely had a widespread distribution associated with marshes and wet meadows. Expansion of the jumping mouse population of BDA and reestablishment of additional populations would provide added redundancy and representation within the MRG. In addition, areas outside of BDA could be utilized to reestablish populations representative of the historical, geographical, and ecological distribution, such as on Ohkay Owingeh and Isleta Pueblos (Service 2014c).

Additional information pertaining to reasons for decline of the jumping mouse can be found in the following documents:

Frey, J.K. 2013. *Draft survey protocol for the New Mexico meadow jumping mouse (Zapus hudsonius luteus)*. Final report submitted to Non-game and T& E Mammal Program, New Mexico Department of Game and Fish. June 28, 2013. 53 pp.

Frey, J.K. and D.A. Kopp. 2014. *Final Report: Preliminary Assessment of Jumping mouse Habitat Associated with Middle Rio Grande Project*. U.S. Department of the Interior, Bureau of Reclamation, Albuquerque Area Office. 18 pp.

Hafner, D.J., K.E. Peterson, and T.L. Yates. 1981. Evolutionary relationships of jumping mice (Genus Zapus) of the Southwestern United States. *Journal of Mammalogy* 62:501–512.

Jones, C.A. 1999. *Zapus hudsonius* in southern Colorado. Occasional paper: Museum of Texas Tech University 191:1–7.

U.S. Fish and Wildlife Service. 2013. Endangered and Threatened Wildlife and Plants, Proposed Designation of Critical Habitat for the New Mexico Meadow Jumping Mouse: Listing Determination for the New Mexico Meadow Jumping Mouse; Proposed Rules. Federal Register 78: 37328-37363.

U.S. Fish and Wildlife Service. 2014c. Endangered and Threatened Wildlife and Plants, Determination of Endangered Status for the New Mexico Jumping Mouse Through Its Range; Final Rule. Federal Register 79: 33119-33137.

U.S. Fish and Wildlife Service. 2014d. New Mexico meadow jumping mouse (*Zapus hudsonius luteus*) Survey Results at Bosque del Apache National Wildlife Refuge. United States Government Memorandum. 12 pp.

U.S. Fish and Wildlife Service. 2014e. *Species Status Assessment Report, New Mexico meadow jumping mouse (Zapus hudsonius luteus)*. Albuquerque, NM. 149 p.

Van Pelt, W.E. 1993. Nongame field notes: Meadow jumping mouse. *Arizona Wildlife News.* 1 p.

## 3.5 Pecos Sunflower

### 3.5.1 Species Description

Pecos sunflower (*Helianthus paradoxus Heiser*) is an annual, herbaceous plant. It grows 1–3 m (3.3–9.9 ft) tall and is branched at the top. The leaves are opposite on the lower part of the stem and alternate at the top, lance-shaped with three prominent veins, and up to 17.5 cm (6.9 inches) long by 8.5 cm (3.3 inches) wide. The stem and leaf surfaces have a few short, stiff hairs. Flower heads are 5–7 cm (2.0–2.8 inches) in diameter with bright yellow rays around a dark purplish brown center (the disc flowers). Pecos sunflower looks much like the common sunflower (*Helianthus annuus*) seen along roadsides throughout the West, but differs from the common sunflower by having narrower leaves, fewer hairs on the stems and leaves, smaller flower heads, and narrower bracts (phyllaries) around the bases of the heads. The prairie sunflower (*Helianthus petiolaris*) also has narrow leaves and phyllaries, but is distinguished from Pecos sunflower by having white cilia in the dark center of the flower head and a branching pattern from the base of the plant that imparts a bushy appearance. Common sunflower and prairie sunflower usually bloom earlier in the season (May–August depending on location) than

Pecos sunflower (September and October), and neither occupies the wet, saline soils that are typical of Pecos sunflower habitats. Pecos sunflower has a highly disjunctive distribution, yet there appears to be very little phenotypic variation between populations.

### 3.5.2 Status and Distribution

Pecos sunflower was known only from a single population near Fort Stockton, Pecos County, Texas when it was proposed as a candidate for listing as endangered under the ESA on December 15, 1980 (45 Fed Reg 82480). Subsequent field surveys for this plant found additional populations in New Mexico and Texas on a variety of state and federal lands and several private land holdings.

The species faces a moderate degree of threat. The plant is associated with spring seeps and desert wet meadows (cienegas) habitats, which are very rare in the dry regions of New Mexico and Texas. Little is known about the historical distribution of the Pecos sunflower, but there is evidence these habitats have historically been, and are presently being, reduced or eliminated by aquifer depletion or severely impacted by agricultural activities and encroachment by alien plants (Poole 1992, Sivinski 1996).

Pecos sunflower is presently known from only seven populations—two in west Texas and five in New Mexico (Figure I-18). The type of locality (location from which the species was first described) is near Fort Stockton in Pecos County, Texas. Near Fort Stockton, a large population with several hundred thousand plants currently exists at The Nature Conservancy's (TNC's) Diamond Y Spring Preserve, with a smaller group of plants downstream at a nearby highway right-of-way. A second Texas population occurs at Sandia Spring Preserve (TNC) in the Balmorhea area of Reeves County, Texas.

Most Pecos sunflower habitats are limited to less than 2 hectares (5 acres) of wetland. Some are only a small fraction of a hectare; however, one near Fort Stockton and another near Roswell are more extensive. The number of sunflowers per site varies from less than 100 to several hundred thousand. Because Pecos sunflower is an annual, the number of plants per site can fluctuate greatly from year to year with changes in precipitation and depth to groundwater. Stands of Pecos sunflower can change location within the habitat as well (Sivinski 1992). If a wetland habitat dries out permanently, even a large population of Pecos sunflower would disappear (Service 2005b).


**Figure I-18. Distribution of Pecos sunflower**

In New Mexico, the five Pecos sunflower populations are located in the Roswell/Dexter region, Santa Rosa, two locations in the Rio San Jose Valley, and on the MRG. In the Roswell/Dexter region of the Pecos River valley in Chaves County, Pecos sunflower occurs at 11 spring seeps and cienegas. Three of these wetlands support many thousands of Pecos sunflowers, but the remainder represent smaller, isolated occurrences. Springs and cienegas within and near the town of Santa Rosa in Guadalupe County have eight wetlands with Pecos sunflower—one of which consists of a few hundred thousand plants in good years. Two widely separated areas of spring seeps and cienegas in the Rio San Jose valley of western New Mexico each support a population of Pecos sunflower. One occurs on the lower Rio San Jose in Valencia County and the other is in Cibola County in the vicinity of Grants. Neither is an especially large population. Another larger population on the Rio Grande at La Joya Waterfowl Management Area in Socorro County occurs near the confluence of the Rio Puerco, which has the Rio San Jose as a tributary stream. This large population is managed by the NMDGF and is the only population within the MRG water management action area.

Additionally in 2008, a cooperative effort established a reintroduced population on private property in Socorro County. This population has expanded its range in the short time since establishment, but no population estimates are available. Additionally this population currently has not been proposed as critical habitat.

### 3.5.3 Listing Status and Critical Habitat

Pecos sunflower was listed as a threatened species by the Service on October 20, 1999 (64 Fed Reg 56582-56590). Critical habitat for the species was designated effective May 8, 2008 (73 Fed Reg 17762-17807), with PCEs for the species identified as desert wetland or riparian habitat components that provide:

1. Silty clay or fine sand soils that contain high organic content, are saline or alkaline, are permanently saturated within the root zone (top 50 cm of the soil profile), and have salinity levels ranging from 10 to 40 parts per thousand.

2. Low proportion (less than 10%) of woody shrub or canopy cover directly around the plant.

The State lists Pecos sunflower as endangered under the regulations of the New Mexico Endangered Plant Species Act (19 New Mexico Administrative Code 21.2). This species is also listed as threatened by the State of Texas (31 Texas Administrative Code 2.69(A)).

The population of Pecos sunflower on the Rio Grande (Valencia County, La Joya Waterfowl Management Area [WMA]) contains all of the PCEs in the appropriate spatial arrangement and quantity, and is threatened by encroachment of nonnative vegetation. The site was determined to be essential to the conservation of the species because it is occupied by a very large (estimated between 100,000 and 1,000,000 individuals) stable population and is sufficiently distant (over 40 mi [64 km]) from other populations to serve as an additional locality that contributes to the conservation of genetic variation (Service 2005b). This population was excluded from critical habitat designation because the NMDGF (2007) has developed a habitat management plan for the Pecos sunflower. The management plan was developed to support conservation of the species on the La Joya WMA by (1) controlling invasive species, (2) protecting the natural spring in Unit 5 from motorized vehicles and heavy equipment, (3) monitoring core populations by digitizing these areas annually, and (4) restoring native habitat through revegetation.

The Service concluded that the plan was complete and provided for the conservation and protection of the physical and biological features essential to the conservation of the species (73 Fed Reg 17762-17807).

### 3.5.4 Life History and Ecology

Pecos sunflower grows in areas with permanently saturated soils in the root zone. These are most commonly desert springs and seeps that form wet meadows called cienegas, which are rare wetland habitats in the arid Southwest region (Hendrickson and Minckley 1984). Pecos sunflower also can occur around the margins of lakes, impoundments, and creeks. When Pecos sunflowers grow around lakes or ponds, these are usually impoundments or subsidence areas within natural cienega habitats. The soils of these desert wetlands are typically saline or alkaline because the waters are high in dissolved solids, and high rates of evaporation leave deposits of salts, including carbonates, at the soil surface. Soils in these habitats are predominantly silty clays or fine sands with high organic matter content. Studies by Van Auken and Bush (1995) and Van Auken (2001) showed that Pecos sunflower grows in saline soils, but seeds germinate and establish best when precipitation and high water tables reduce salinity near the soil's surface. Like all sunflowers, this species requires open areas that are not shaded by taller vegetation.

Plants commonly associated with Pecos sunflower include *Distichlis spicata* (saltgrass), *Sporobolus airoides* (alkali sacaton), *Phragmites australis* (common reed), *Schoenoplectus americanus* (chairmaker's bulrush), *Juncus balticus* (Baltic rush), *Muhlenbergia asperifolia* (alkali muhly), *Limonium limbatum* (southwestern sea lavender), *Flaveria chloraefolia* (clasping yellowtops), *Cirsium wrightii* (Wright's marsh thistle), *Tamarix* sp. (saltcedar), and *Elaeagnus angustifolia* (Russian olive) (Poole 1992, Sivinski 1996). All of these species are indicators of wet, saline, or alkaline soils. Pecos sunflower often occurs with saltgrass between the saturated soils occupied by bulrush and the relatively drier soils with alkali sacaton (Van Auken and Bush 1998).

### 3.5.5 Reasons for Decline

Spring seeps or cienega habitats are very rare in the dry regions of New Mexico and Texas. There is evidence that these habitats have historically been, and are presently being, reduced or eliminated by aquifer depletion or severely impacted by agricultural activities and encroachment by alien plants (Poole 1992, Sivinski 1996). The Southwestern United States is currently experiencing a period of prolonged drought that is exacerbating this habitat degradation. The trend of decreasing habitat availability and suitability justified listing Pecos sunflower as a threatened species. Recovery actions to reverse or stabilize this trend and ensure the long-term sustainability of this species include identifying the ecological parameters of Pecos sunflower habitat and enlisting the cooperation of the various habitat owners in the long-term conservation of the species (Service 2005b).

# 3.6 Interior Least Tern

## 3.6.1 Status and Distribution

The interior least tern (S*ternula antillarum athalassos*) (tern) was listed as endangered by the Service in 1985 (50 CFR 21784). This subspecies historically bred along the Colorado (in Texas), Red, Rio Grande (in Texas), Arkansas, Missouri, Ohio, and Mississippi River systems and has been found on braided rivers of southwestern Kansas, northwestern Oklahoma, and southeastern New Mexico (American Ornithologists' Union 1957). In New Mexico, the tern was first recorded (including nesting) at Bitter Lake NWR in 1949; since then, it remained present essentially annually (Marlatt 1984, NMDGF 2008). The species also occurs as an occasional breeder in Eddy County, New Mexico (Moore 2011). The tern has been observed as a 'vagrant' or 'highly unusual' species among the 377 avian species detected on the BDA since 1940 (Service 1995). In 2005, a rangewide survey of terns was completed, and the Rio Grande/Pecos River systems collectively made up 0.8% of the population (Lott 2006). Historically, tern nesting has been confirmed on six reservoirs along the Rio Grande/Pecos Reach at Bitter Lake NWR, Brantley Lake, and Imperial Reservoir on the Pecos; and Lake Casa Blanca, Amistad Reservoir, and Falcon Reservoir on the Rio Grande in Texas (Lott 2006) (Figure I-19).

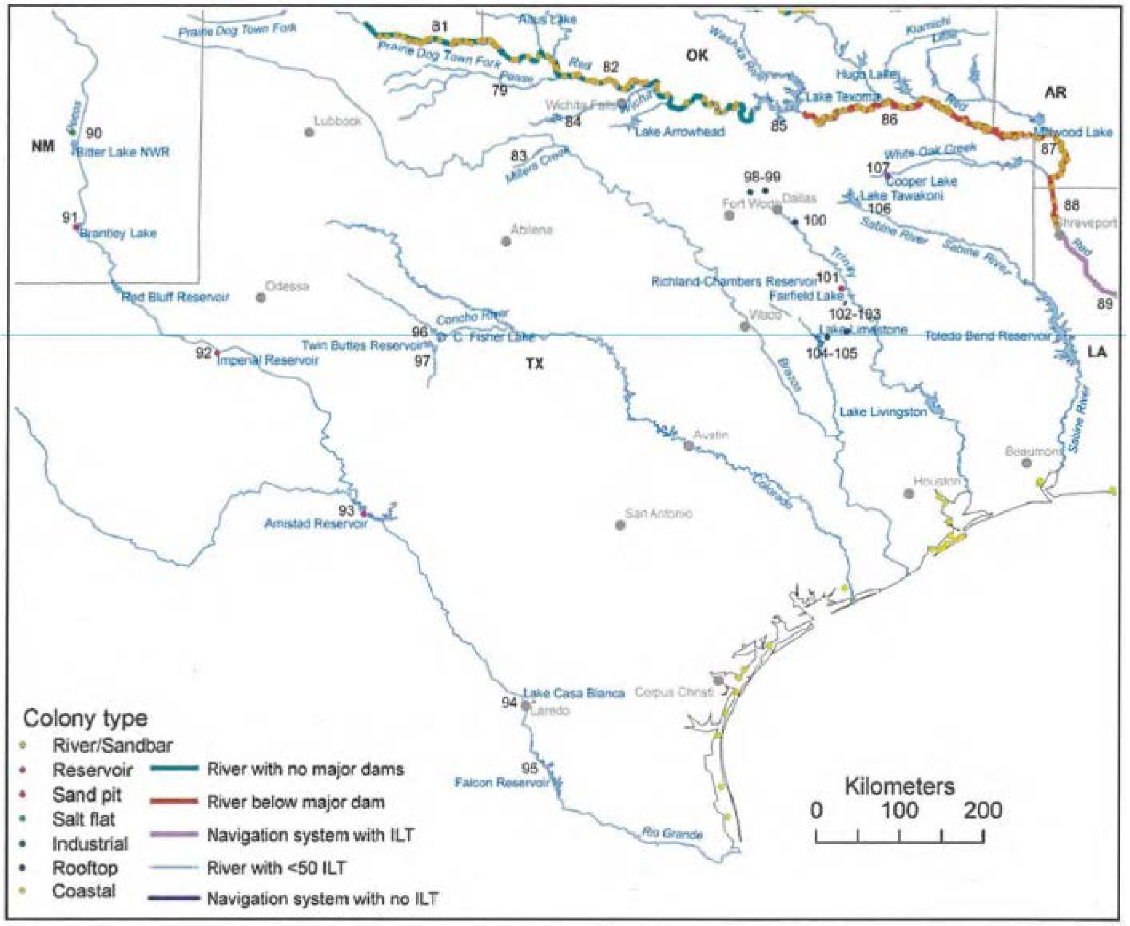


**Figure I-19. Distribution of the 2005 tern (ILT in figure) breeding colonies within New Mexico and Texas (Lott 2006)**

## 3.6.2 Life History and Ecology

Breeding habitat requirements for this species include the presence of bare or nearly bare ground on alluvial islands, shorelines, or sandbars for nesting, the availability of food (primarily small fish), and the existence of favorable water levels during the nesting season so nests remain above water (Ducey 1981). Breeding colonies contain from 5–75 nests. Although most nesting occurs along river banks and reservoirs, the tern also nests on barren flats of saline lakes and ponds. Nests are constructed by scraping a depression within the sand.

Eggs are typically a pale to olive beige color and specked with chocolate marks, blending in with the sand or mudflat habitat. Little is known about the wintering areas occupied by the tern, but it is believed that they can be found along the Central American coast and the northern coast of South America from Venezuela to northeastern Brazil (Service 1990).

### 3.6.3 Reasons for Decline

Loss of nesting areas through permanent inundation or destruction by reservoir and channelization projects was identified as the major threat to the species (Service 1995). Alteration of natural river or lake dynamics has caused unfavorable vegetation succession on many remaining islands, curtailing their use as nesting sites by terns. Recreational use of sandbars, releases of water from upstream reservoirs, and annual spring floods often inundate nests.

# 4. Environmental Baseline

## 4.1 Introduction

Under section 7(a)(2) of the ESA, when considering the effects of the action on federally listed species, agencies are required to consider the environmental baseline. Regulations implementing the ESA (50 Fed Reg 402.02) define the environmental baseline as the past and present impacts of all federal, state, or private actions and other human activities in the action area; the anticipated impacts of all proposed federal actions in the action area that have undergone formal or early section 7 consultation[17]; and the impacts of state and private actions that are contemporaneous with the consultation in progress. The environmental baseline defines the current status of the species and its habitat in the action area as a point of comparison to assess the effects of the action now under consultation. The environmental baseline describes a "snapshot in time" that includes the effects of all past and present federal and non-federal human activities. All existing facilities and all previous and current effects of operation and maintenance of the Project, as well as all ongoing, non-federal irrigation activities and existing physical features such as diversion dams, storage dams, and flood control levees are part of the environmental baseline.

## 4.2 Historical Perspective

### 4.2.1 Water Operations

Largely due to the limited water supply and the highly variable streamflows in the Rio Grande, humans have modified the Rio Grande system over time to protect themselves from floods and to maximize their beneficial use of water. Human activities, taking advantage of flows in the Rio Grande system, extend back to the agricultural traditions of pueblo peoples since time immemorial. Pueblo oral histories convey, and the early Spanish accounts of the Rio Grande confirm, that pueblo peoples developed advanced systems of irrigated agriculture long before the arrival of Europeans. Beginning with the arrival of Spanish settlers in the late 16th century, irrigation activities expanded and impacted the flows in the Rio Grande system. The subsequent agricultural practices and administration of the river, as well as the intensive use of nonirrigated lands within the Rio Grande Basin, under the Spanish, Mexican, and American periods brought about changes to the shape and behavior of the river, the distribution of flows in time through that river, and the habitat of the species that depend on that river for life. The greatest of these changes, by far, have been made over the past century.

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[17] In addition to content in this chapter, see *Appendix 6 Reclamation and Corps Completed Consultations* from the 2013 BA for a description of actions that have already undergone section 7 consultation within the action area.

Modifications leading to current conditions include dam and levee construction, irrigation/drain system development, land use, and channelization activities, which took place from the 1930s to the 1970s, as well as groundwater pumping, which has expanded greatly from the 1940s to the present, especially in the Angostura Reach. Operation of the flood control and water storage dams alters the shape of the hydrograph, as well as the amount of water that is conveyed through the river. The alteration of the hydrograph and highly variable streamflows that have resulted in cycles of drought on the MRG also have influenced vegetation changes on the MRG. Figure I-20 illustrates the major events over the past century that have affected the hydrology and geomorphology, and therefore the habitat for listed species in the MRG.

Eight major dams (El Vado, Abiquiu, Nambe Falls, Cochiti, Galisteo, Jemez Canyon, Elephant Butte, and Caballo) plus three cross-river diversion structures and minor diversions between Embudo and Española have been constructed on the MRG or its tributaries over the past century by the Corps, Reclamation, the MRGCD, and in cooperation with other non-federal partners. These dams and diversion structures affect the flow and sediment distribution in the MRG. They alter flows by storing and releasing water in a manner that generally decreases flood peaks and alters the distribution in time of the flows in the annual hydrograph. The major dams also trap significant amounts of sediment, causing buildup and increases in channel elevation upstream, and riverbed degradation and coarsening in the reaches below the dams.

Groundwater use has exceeded 170,000 AFY in the Albuquerque Basin and has caused groundwater level declines of up to 160 feet (McAda and Barroll, 2002). Ultimately, the water pumped is replaced by seepage from the river into the groundwater system.

The historical development of the MRG has ongoing impacts on listed species. Silvery minnow use a diversity of wetted habitats throughout the year; low-velocity habitats are important for all life stages, and egg and larval development are strongly tied to the magnitude and duration of runoff that inundates overbank habitats. Overbank flooding is needed to create shallow, low-velocity backwaters that are used by silvery minnow larvae, and to maintain and restore native riparian vegetation for flycatcher habitat. Also, summertime river flows that supported both species were historically dependent on groundwater inflows; today, losses from the river to the groundwater system increase the chances of river drying, and decrease the longevity of isolated pools for minnow to use as refuges during periods of drying. Water and sediment management have resulted in a large reduction of suitable habitat for the flycatcher, as a result of the reduction of high-flow frequency, duration, and magnitude that helped to create and maintain habitat for this species. Habitat elements for the flycatcher are provided by thickets of riparian shrubs and small trees and adjacent surface water, or areas where such suitable vegetation may become established (Service 2005a).

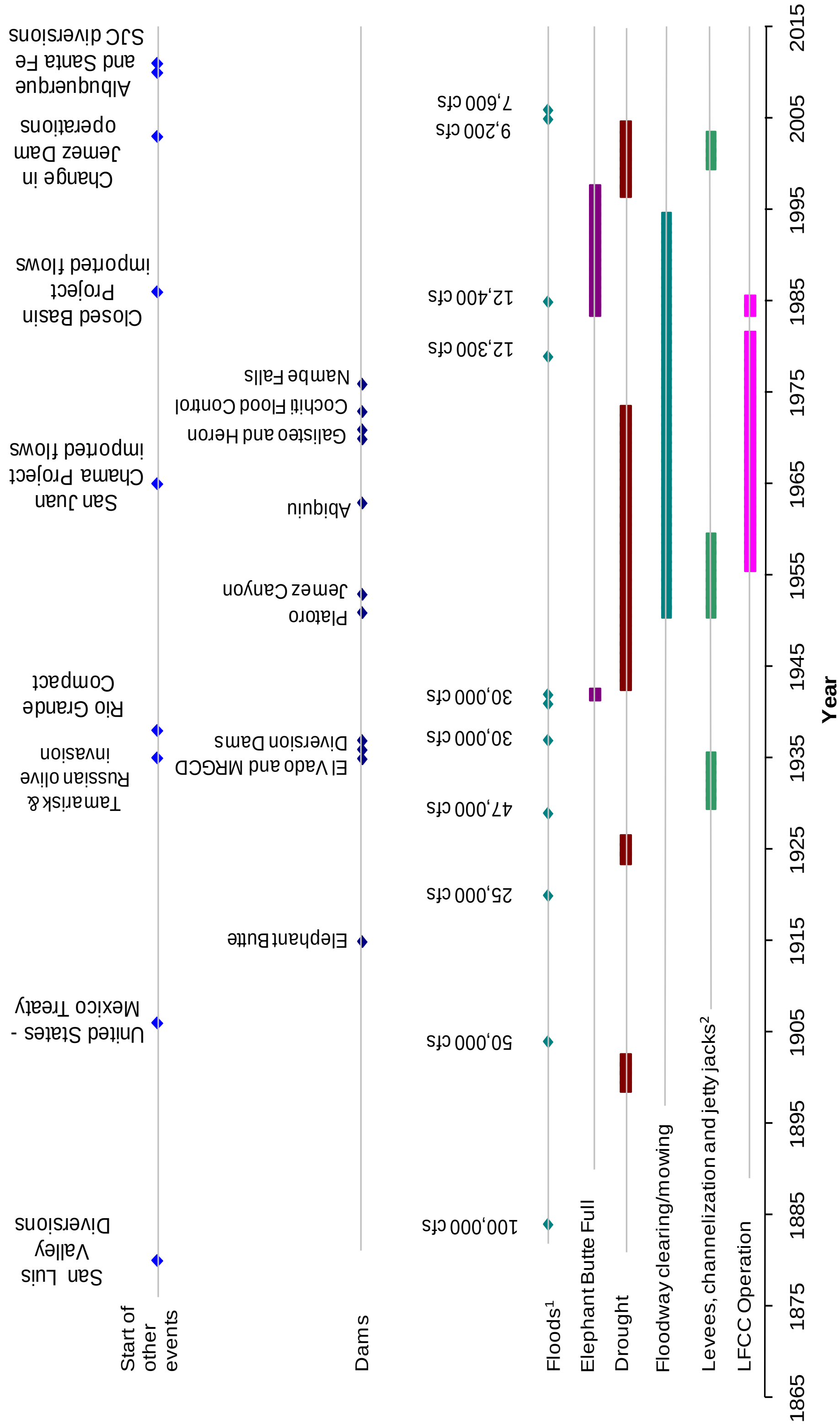



**Figure I-20. Timeline of significant events influencing the hydrology and geomorphology of the MRG. Flood events listed are measured at various locations between Otowi and San Marcial.**

Prior to documented development of water resources, the MRG had a high sediment load and an active, braided river channel with a mobile sand bed. The river's active watercourse was up to a half-mile wide, and included numerous braids. Over time, the active watercourses filled with sediment, then broke out into the floodplain and possibly avulsed to create new active watercourses. This process caused aggradation across the floodplain. During periods in which peak flows were low for several years in a row, as well as periods of sustained low flows, the active channel narrowed through vegetation encroachment along and within the active channel. Sediment stored during these low-flow times was remobilized during subsequent large floods, which reestablished a wider active channel. This process caused sediment to build up fairly uniformly across the floodplain. This active channel and floodplain connection provided habitat for all life stages of the silvery minnow and various successional stages of vegetation along the riparian corridor, used as breeding habitat by flycatchers.

Today, the river through much of the MRG is a single-thread channel, as a result of both anthropogenic and natural changes throughout the system, that is now confined into a narrow corridor between levees. Between Cochiti Dam and Elephant Butte Reservoir headwaters, there are 235 miles (378 km) of levees (includes distances on both sides of the river) (Service 2005a). Changes on the MRG in the last century have increased the channel uniformity, eliminating thousands of acres of the shallow, low-velocity habitats required by both silvery minnow and flycatchers. The loss of habitat complexity may cause eggs and larvae of the silvery minnow to drift downstream longer distances than in more complex channels (Widmer et al. 2012). A comparison of river habitat changes between 1935 and 1989 shows a 49% reduction of river channel habitat from 22,023 acres (8,916 ha) to 10,736 acres (4,347 ha) (Crawford et al. 1993). The MRG also has been fragmented by cross-channel diversion structures, which silvery minnow can pass in a downstream direction but not in an upstream direction. In some years, eggs and larvae that drift downstream of these diversions are unable to return to upstream natal reaches.

The channel in the upstream portion of the MRG is deeper and swifter and more isolated from the surrounding floodplain, which is now the bosque. The disconnection from the floodplain in these reaches and the establishment of exotic species, such as Russian olive and saltcedar, have made overbank habitat inaccessible to the silvery minnow and decreased the availability of dense willow and associated native vegetation and habitat important to flycatchers.

The lower portion of the MRG, below San Acacia Diversion Dam, is currently a combination of an upstream incised channel isolated from the historical floodplain and a downstream perched river, for much of which the LFCC (which currently functions like a riverside drain) serves as the low point in the valley in many areas. River flow is lost to the surrounding floodplain, drains, and groundwater system. The perched river system, in turn, makes the river channel more prone to drying under low-flow conditions. Overbank inundation also occurs more often in the downstream portions of this reach; however, there is not always a direct path back from the overbank areas to the river, which may cause fish to become stranded as the flows drop. Today, this reach generally is aggrading with some channel degradation occurring when the Elephant Butte Reservoir pool is low, as is currently the case.

These changes in hydrology and construction of major features along the river also have modified the river in ways that directly affect the habitat of listed species. Historically, the silvery minnow is thought to have occupied the Rio Grande from approximately Española, New Mexico to the gulf coast of Texas, and is also thought to have occupied some of the larger tributaries. Today, silvery minnow are restricted to a reach of the Rio Grande in New Mexico, from the vicinity of Bernalillo downstream to the headwaters of Elephant Butte Reservoir, approximately 150 river miles.

The channel narrowing trend in the Rio Grande and the resulting degradation of aquatic habitat will continue under the current river management regime. Returning the river to its earlier state—wide, braided, and sandy—would require recurring major flow events, which would exceed the safe channel capacity below Cochiti Dam. As this is impracticable, Collaborative Program participants have undertaken efforts to mechanically construct features that provide more favorable habitat conditions for aquatic species under the available hydrologic conditions. Generally, these efforts attempt either to modify the banks of the Rio Grande to encourage overbanking or to expand lower elevation channel capacity to create springtime habitat more suitable for silvery minnow spawning and riparian conditions more suitable for the growth of native vegetation. In most years, native flows cause inundation of these "habitat restoration sites;" however, in some low-water years, releases of additional pulses of water are needed to inundate the modified areas. While these habitat restoration projects generally are unable to shift the broader geomorphic trends, they have created localized enhancements to aquatic habitat to facilitate increased availability of overbank habitat during certain spring snowmelt runoff periods.

The Rio Grande is and will continue to be a highly managed system. Similarly, silvery minnow populations have been managed by a variety of activities ranging from the habitat restoration projects described above to population augmentation with fish reared in hatcheries. Unlike the silvery minnow, which currently only exists in,[18] and must complete its entire life cycle within, the MRG, the flycatcher is mainly dependent on the project area and other similar areas in the Southwest for breeding and rearing of young and completes other portions of its life cycle elsewhere. Flycatcher populations are dependent on riparian conditions within their breeding area. Within the United States, the species occurs in southern California, Arizona, New Mexico, southern portions of Nevada and Utah, and possibly southwestern Colorado. The species is likely extirpated from west Texas. Rangewide, changes in hydrology and active management of

[18] Viability of the reintroduced population in the Big Bend Reach is currently not established.

and development in river corridors have reduced the availability of suitable habitat for the flycatcher and contributed to population decline.

Because of the above factors, active management and persistence of habitat for both species is important for maintaining viable populations.

### 4.2.2 River Maintenance

This section describes the river maintenance environmental baseline. Additional geomorphic and background supporting information also may be found in the *Middle Rio Grande River Maintenance Plan, Part 1* (Reclamation 2007), the *Middle Rio Grande River Maintenance Program Comprehensive Plan and Guide* (Reclamation 2012a), and the report titled *Channel Conditions and Dynamics of the Middle Rio Grande* by Makar and AuBuchon (2012).

This river maintenance baseline includes additional baseline information on river maintenance work between 2001 and 2012 (Section 4.2.2.2). This section was added to provide baseline information on the historical MRG work that has been done through river maintenance. This historical perspective provides a picture of the current river maintenance practice that considers environmental resources, along with the more traditional river maintenance concerns of channel sustainability, protection of riverside infrastructure and resources, and effective water delivery. Some of the methods that have been used for river maintenance projects are similar to those used for habitat restoration work on the MRG (Section 4.6.2.2). While the purposes for the work may have been different, these methods have a similar effect on the surrounding local morphology.

#### *4.2.2.1 MRG River Maintenance Priority Site Criteria*

The decision process for identifying individual river maintenance projects and actions follows criteria developed to prioritize river maintenance needs (Smith 2005). A river maintenance priority site is defined as a site at which one or more of the following exist and could be addressed by river maintenance activities:

- The continuation of current trends of channel migration or morphology likely will result in damage to riverside infrastructure within the foreseeable future.
- Similar conditions have historically resulted in failures or near failures at flows less than the 2-year flood.
- Existing conditions cause significant economic loss, danger to public health and safety, or loss of effective water delivery.

Monitored sites are locations that have the potential to become future priority sites based on the above criteria. The river maintenance program has established a methodology for assessing existing sites and identifying new site locations. This methodology involves ongoing aerial monitoring and field reviews of river channel conditions. Factors incorporated into the priority site review methodology process include engineering analysis and judgments, river geomorphic considerations, environmental considerations, public involvement, political considerations, and economic considerations (i.e., the value of riverside infrastructure). The fundamental activities that support decision making on channel maintenance needs are monitoring changes in the river channel morphology, evaluating channel stability, and modeling channel and levee capacity (Smith 2005). The priority site review methodology rates sites for maintenance implementation to determine their relative priority to each other as well as to document decisions that are made to undertake river maintenance activities for each site. Additional information about the decision process for determining river maintenance activities at priority and monitored sites can be found in the report *Middle Rio Grande River Maintenance Plan, Part 1* (Reclamation 2007).

#### *4.2.2.2 MRG River Maintenance Sites: 2001–2012*

A summary of acreage impacts and project durations for river maintenance projects during 2001–2012 is shown in Table I-3. The information in Table I-3 represents statistical river maintenance project information on a per project basis. These are projects that have been implemented or are in the process of being implemented. Information on the type and amount of river maintenance projects completed during 2001–2012 is shown in Table I-4. An illustration of the impact acreage (wet and dry) for river maintenance projects completed during 2001–2012 is shown in Figure I-21 as a percent exceedance curve. The projects are a combination of new project sites, completed sites where adaptive management was needed, and interim/unanticipated work.

**Table I-3. 2001–2012 River maintenance acreage impacts and project durations**

| | Access Roads (acres) | Project Impact Area in the Dry (acres) | Project Impact Area in the Wet (acres) | Total Project Impact Area (acres) | Project Duration (months) |
|---|---|---|---|---|---|
| Maximum | 18 | 68 [1] | 62 [2] | 88 | 16 |
| Minimum | 0 | 0 | 0 | 1 | 1 |
| Average | 3 | 7 | 5 | 12 | 6 |

[1] See Table I-11 for information on the BDA Channel Widening river maintenance project.
[2] See Table I-8 for information on the Santa Ana Restoration Phase 1 river maintenance project.

**Table I-4. River Maintenance Projects by Year**

| Year | Adaptive Management Sites | New Project Sites | Interim or Emergency Work | Total |
|---|---|---|---|---|
| 2000 | | | | 0 |
| 2001 | | 1 | | 1 |
| 2002 | | 2 | 1 | 3 |
| 2003 | | 1 | | 1 |
| 2004 | | 1 | | 1 |
| 2005 | 1 | 4 | 3 | 8 |
| 2006 | | | 1 | 1 |
| 2007 | 3 | 3 | 1 | 7 |
| 2008 | | 4 | | 4 |
| 2009 | 1 | 2 | | 3 |
| 2010 | 1 | | 1 | 2 |
| 2011 | | 2 | 1 | 3 |
| 2012 | 1 | 2 | 1 | 4 |
| **Total** | **7** | **22** | **9** | **38** |
| **Average per year** | **1** | **2** | **1** | **4** |

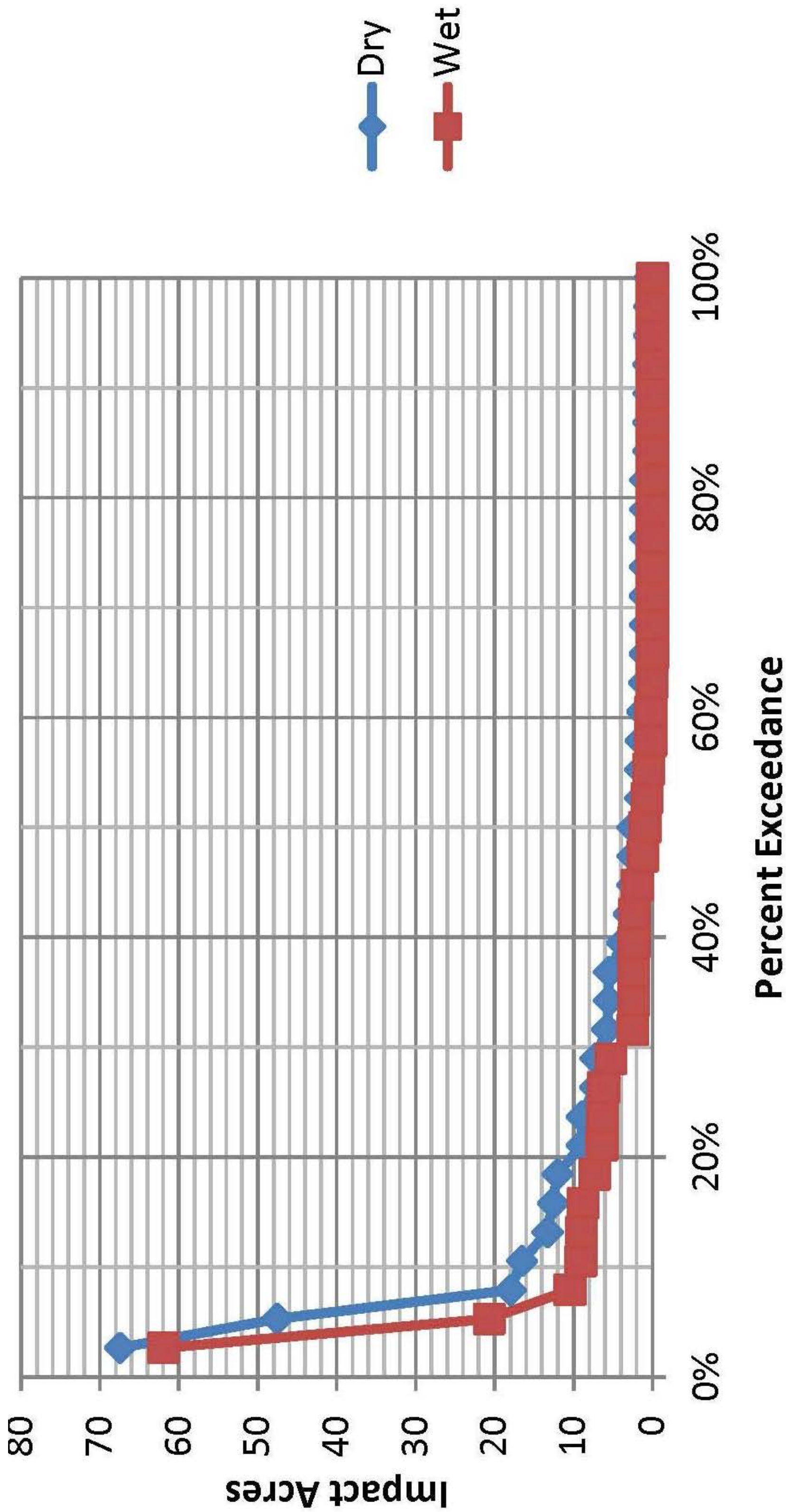



**Figure I-21. Percent exceedance curves for river maintenance project footprint impacts (2001–2012).**

Tables I-5 through I-12 provide an overview of river maintenance work during 2001–2012 separated by geomorphic reach. The tables include the type of project (new, adaptive management, or interim/unanticipated), a brief description of the project purpose, the types of river maintenance methods used for the project, implementation techniques employed on the project, access road acreage, project impact acres in the wet and dry, project duration, habitat features created because of the project, and general observations about the project's success or failure.

Acreage for access roads describes the use area for new or minimally used access roads. Existing maintained roads that were used for access are not included in this total. The acres listed for wet and dry impact areas are the footprint or planview impact areas for the projects at low flows. The acreage listed was calculated by delineating the project footprints in GIS using aerial photography during low-flow periods. The listed acreage does not account for specific river maintenance implementation techniques, such as river crossings.

Notations are added to the project duration to indicate if the project involved work in the river. Those projects requiring equipment to be working in the active portion of the river (either sitting in or touching) were designated with the notation "wet." Typically, this is the area of the river that is inundated at 1,000 cfs or less. Projects that could be implemented outside of the active portion of the river were designated as "dry." Where the channel was relocated such as the Santa Ana Project (Table I-9), the "wet" area included the relocated channel because these were the impacted, wetted channel areas, even though the relocation pilot channel was constructed prior to introducing river flows. Projects that did not span the entire river include only the portion of the affected channel at base flows, as designated using aerial photography (typically around 1,000 cfs). As noted in Table I-3, there are two projects that account for the maximum "wet" and "dry" acreages. The remaining 36 projects (Tables I-5 through I-12), have significantly less acreage. This can be seen graphically in Figure I-21 by noting that, between 2001–2012, less than 10% of the implemented river maintenance projects had a project footprint in the wet greater than 10 acres and in the dry greater than 20 acres. Figure I-22 shows individual project footprint by reach, along with statistical trendlines (average and one-half the standard deviation). Project names for site numbers listed in Figure I-22 are provided in Tables I-5 through I-12.

**Table I-5. Historical river maintenance work: Velarde to Rio Chama Reach (2001–2012 work)**

| Project Name | Site Number (Figure 22) | Project Type and Purpose | River Maintenance Methods | Construction Techniques (Method Category BMPs) | Access Roads (acres) | Project Impact Area in the Dry (acres) | Project Impact Area in the Wet (acres) | Project Duration | Habitat Features Created | Observations |
|---|---|---|---|---|---|---|---|---|---|---|
| La Canova (2005) | 1 | **New Site** – Project undertaken to stop bank line erosion on west bank that threatened integrity of irrigation facility. | Longitudinal stone toe with bioengineering, riparian vegetation establishment | Bank line work, material placement | 0.2 | 0.3 | 1.22 | 3 months (wet) | 0.2 acre of bioengineered bank line (inherent part of design). | • Native vegetation has become established.<br>• Design functioning as intended. |
| Lyden Outfall Structure (2007) | 2 | **New Site** – Project undertaken to address localized bank erosion at irrigation outfall (Reclamation constructed) that threatened to flank existing concrete structure. | Longitudinal stone toe with gabion basket revetment | Bank line work, material placement | 0.2 | 2.5 | 0.03 | 1 month (wet) | None. | • Design functioning as intended. |
| Salazar Pit (2005) | 3 | **New Site** – Project undertaken to address gully formation in an arroyo where there had been a pre-existing Reclamation rock quarry. Project was not on the MRG. | Gabion basket weirs | N/A – work was done out of MRG corridor on dry land | 2.8 | 0.5 | N/A | 7 months (dry) | None. | • Large rainfall event in 2006 caused damage to tops of constructed gabion weirs.<br>• Some concern that original design did not provide adequate bank reinforcement in some areas. |
| Salazar Pit (2007) | 4 | **Adaptive Management** – Project undertaken to correct damage and address observed concerns to original design (2005) that were observed as a result of the 2006 monsoonal events. | Gabion basket weirs | N/A – work was done out of MRG corridor on dry land | 2.8 | 0.5 | N/A | 6 weeks (dry) | None. | • Design functioning as intended after adaptive management. |

**Table I-6. Historical river maintenance work: Rio Chama to Otowi Bridge Reach (2001–2012 work)**

| Project Name | Site Number (Figure 22) | Project Type and Purpose | River Maintenance Methods | Construction Techniques (Method Category BMPs) | Access Roads (acres) | Project Impact Area in the Dry (acres) | Project Impact Area in the Wet (acres) | Project Duration | Habitat Features Created | Observations |
|---|---|---|---|---|---|---|---|---|---|---|
| San Ildefonso (2007) | 5 | **New Site** – Project undertaken to address bank erosion due to lateral migration of a river bend that threatened integrity of a fishing pond. | Riparian vegetation establishment, diagonal vane, trench-filled bendway weirs | N/A – work was done out of the MRG active channel on dry land. | 0.7 | 0.9 | N/A | 1 month (dry) | Planted tree poles (project mitigation). | • Localized scour in bend undercut bank vegetation during 2009 spring runoff.<br>• Bank erosion exposed three trench-filled bendway weirs, threatening to flank the northern ones.<br>• Exposed portions of diagonal vane were directing flow into the bank.<br>• Lost about quarter of planted poles from bank erosion. |
| San Ildefonso (2010) | 6 | **Adaptive Management** – Project undertaken to correct damage and address observed concerns to original design (2007) that were observed as a result of the 2009 spring runoff. This was an interim fix to provide time to plan and coordinate a longer-term solution. | Trench-filled riprap, riprap windrow. | N/A – work was done out of the MRG active channel on dry land. | 0.7 | 0.9 | N/A | 2 months (dry) | | • Design functioning as intended after adaptive management.<br>• Bank erosion continues but has not yet caused self-launching of the riprap windrow.<br>• Secondary currents have created scallop areas between the weirs in the bank that have variable depth and velocity areas. |

**Table I-7. Historical river maintenance work: Cochiti Dam to Angostura Diversion Dam Reach (2001–2012 work)**

| Project Name | Site Number (Figure 22) | Project Type and Purpose | River Maintenance Methods | Construction Techniques (Method Category BMPs) | Access Roads (acres) | Project Impact Area in the Dry (acres) | Project Impact Area in the Wet (acres) | Project Duration | Habitat Features Created | Observations |
|---|---|---|---|---|---|---|---|---|---|---|
| Santa Fe River Confluence (2004) | 7 | **New Site** – Project undertaken to address bank erosion south of the confluence with the Santa Fe River that threatened the integrity of a spoil berm protecting a drain facility. | Infrastructure setback, longitudinal bank lowering, riprap revetment, riparian vegetation establishment. | N/A – work was done out of the MRG active channel on dry land. | Used existing roads | 3.0 | N/A | 5 weeks (dry) | Reconnection of floodplain to river (1.6 acres), and native species planting (1.6 acres) (both inherent part of design). | • Design functioning as intended.<br>• Planted vegetation slow to establish. |
| Cochiti RM 228.9 (2007–2008) | 8 | **New Site** – Project undertaken to address bank erosion that threatened the integrity of a spoil berm protecting a drain facility. | Island and bank clearing and destabilization, side channels, longitudinal bank lowering, bank line embayment (backwater area), longitudinal stone toe with bioengineering, riparian vegetation establishment. | River diversion, river reconnection, river crossings, river work, material placement. | 0.4 | 1.0 | 1.9 | 7 months (wet) | Backwater area (3.0 acres), secondary channel network (3.5 acres), bioengineered bank line (0.1 acre), and natural reseeding at site (all inherent part of design). | • Longitudinal stone toe with bioengineering functioning as intended.<br>• Native riparian vegetation in backwater area is coming in well naturally.<br>• Side channel constructed through destabilized island has widened considerably and created riffles, runs, and an inset floodplain within the historical abandoned floodplain.<br>• Planted vegetation slow to establish. |
| Cochiti RM 231.3 (2007–2008) | 9 | **New Site** – Project undertaken to address bank erosion that threatened the integrity of a spoil berm protecting a drain facility. | Side channels, jetty removal, longitudinal stone toe with bioengineering, infrastructure setback (road), French drain, riparian vegetation establishment | River diversion, river reconnection, river work, material placement, material removal | 2.8 | 0.5 | 2.3 | 7 months (wet) | 0.6 acre of bioengineered bank line, and natural reseeding at site (both inherent part of design) | • Longitudinal stone toe with bioengineering functioning, but elevation to overtop stone toe is greater than design.<br>• Planted vegetation doing exceptionally well.<br>• French drain functioning as intended |
| San Felipe RM 213.4 (2010–2011) | 10 | **New Site** – Project undertaken to address bank erosion that threatened the integrity of a spoil berm protecting a drain facility. | Longitudinal stone toe with bioengineering, riparian vegetation establishment | River diversion, working platform, material placement | 0.9 | 9.0 | 2.4 | 9 months (wet) | Bioengineered bank (0.4 acre); inherent part of design. | • Design functioning as intended<br>• Planted vegetation slow to establish |
| San Felipe RM 213.7 (2010–2011) | 11 | **New Site** – Project undertaken to address bank erosion that threatened the integrity of a spoil berm protecting an irrigation facility. | Longitudinal stone toe with bioengineering, riparian vegetation establishment. | River diversion, working platform, material placement. | 0.9 | 9.0 | 2.5 | 9 months (wet) | Bioengineered bank (0.5 acre), and willow trench (0.1 acre) -– inherent part of design. | • Design functioning as intended<br>• Bioengineering vegetation slow to establish.<br>• Trench vegetation dong well. |
| San Felipe RM 212.0 (2011–2012) | 12 | **New Site** – Project undertaken to address bank erosion that threatened the integrity of a spoil berm protecting a drain facility. | Island and bank clearing and destabilization, riprap revetment, longitudinal stone toe with bioengineering, riparian vegetation establishment. | River reconnection, river crossings, working platforms, bank line work, river work, material placement, material removal. | 2.3 | 16.5 | 5.3 | 12 months (wet) | Bioengineered bank (0.8 acre); inherent part of design. | • Design functioning as intended.<br>• Multiple flow paths observed where portion of midchannel bar was removed. |

**Table I-7. Historical river maintenance work: Cochiti Dam to Angostura Diversion Dam Reach (2001–2012 work)**

| Project Name | Site Number (Figure 22) | Project Type and Purpose | River Maintenance Methods | Construction Techniques (Method Category BMPs) | Access Roads (acres) | Project Impact Area in the Dry (acres) | Project Impact Area in the Wet (acres) | Project Duration | Habitat Features Created | Observations |
|---|---|---|---|---|---|---|---|---|---|---|
| San Felipe Phase 1 Mitigation Sites (2010–2012) | 13 | **New Site** – Project required as mitigation for San Felipe Phase 1 project construction (RM 213.4, RM 213.7, RM 212.0, and RM 215.5) | Island and bank clearing and destabilization, bank line embayment (backwater area), side channels destabilization, riparian vegetation establishment. | River crossings, material placement. | 2.3 | 18.0 | 0.7 | 1 month (wet), 3 months (dry) | Five high-flow backwater areas (2.9 acres), connection bar (0.7 acre), flow through channel (1.1 acres). All featured were part of project mitigation. | • Design functioning as intended; no high spring runoff flows since project completion.<br>• Established side channel has groundwater connection to river that allows channel to flow without direct upstream connection. |
| San Felipe RM 215.5 (2011–2012) | 14 | **New Site** – Project undertaken to address development of alternating thalweg pattern and channel narrowing from vegetation encroachment that has the potential to cause bank erosion threatening the integrity of a road and nearby houses in the village of San Felipe. | Island and bank clearing and destabilization. | River crossings, river work, material removal. | 0.8 | 12.1 | 2.4 | 2 months (wet) | 0.2 acres of willow trench; inherent part of design. | • Design being amended to only include bar removal.<br>• Bar removal expected to be short term. |

**Table I-8. Historical river maintenance work: Angostura Diversion Dam to Isleta Diversion Dam Reach (2001–2012 work)**

| Project Name | Site Number (Figure 22) | Project Type and Purpose | River Maintenance Methods | Construction Techniques (Method Category BMPs) | Access Roads (acres) | Project Impact Area in the Dry (acres) | Project Impact Area in the Wet (acres) | Project Duration | Habitat Features Created | Observations |
|---|---|---|---|---|---|---|---|---|---|---|
| Santa Ana Restoration Phase 1 (2000–2001) | 15 | **New Site** – Phase 1 of a project undertaken to address bank erosion and channel incision that threatened the integrity of a spoil berm protecting a drain facility. | Channel relocation using pilot channel, longitudinal dikes, jetty removal, longitudinal stone toe with bioengineering, gradient restoration facility, sediment augmentation. | River diversion, river reconnection, dewatering, river crossings, river work, material removal, material placement | 2.0 | 5.5 | 62 | 16 months (wet) | 0.6 acre of bioengineering bank line (inherent part of design). | • Gradient restoration facility and longitudinal stone toe with bioengineering functioning as designed<br>• Potential for flanking of gradient restoration facilities (GRF) on west bank observed after the 2005 spring runoff.<br>• Potential for flanking of GRF on east bank observed after the 2010 spring runoff.<br>• Spoil pile from pilot channel was not removed by natural flows as per original designs.<br>• Planted vegetation doing exceptionally well.<br>• Potential for flanking of stone toe with bioengineering bank line protecting south bank of Jemez River at confluence with Rio Grande observed after the 2005 spring runoff. |
| Santa Ana Restoration Phase 2 (2002) | 16 | **New Site** – Phase 2 of a project undertaken to address bank erosion and channel incision that threatened the integrity of a spoil berm protecting a drain facility. | Bank line embayment (backwater area), longitudinal bank lowering, riparian vegetation establishment. | N/A – work was done out of the MRG active channel on dry land. | 0.8 | 47.5 | 2.4 | 4 months (dry) | 0.8 acre of backwater areas; 45 acres of floodplain reconnection (inherent part of design). | • Backwater areas had deposition at mouths and lacked drainage back to river.<br>• Portions of the riparian vegetation were eroded from the 2005 spring runoff. |
| Santa Ana Restoration Phase 2 (2004–2005) | 17 | **Adaptive Management** – Project undertaken to correct damage and address observed concerns to backwater area drainage from Phase 2 and natural spoil pile removal. | Bank line embayment (backwater area), riparian revegetation, sediment augmentation. | N/A – work was done out of the MRG active channel on dry land. | 2.0 | 5.5 | 10.5 | 4 months (dry) | Backwater areas planted with coyote willows (inherent part of design) | • Backwater areas were inundated during 2005 and subsequent spring runoff years. This brought in silt/clay material that deposited.<br>• Deposition has occurred at mouth of backwater areas.<br>• Backwater areas functioning as intended after adaptive management.<br>• Planted vegetation doing exceptionally well in backwater areas.<br>• Spoil pile management during 2005 spring runoff saw a portion of the sediment eroded, but significant amounts remained. Sediment appear to have deposited downstream and caused additional bank erosion. |
| Santa Ana Restoration Phase 3 (2007 and 2009) | 18 | **Adaptive Management** – Project undertaken to correct damage and address observed concerns to Phase 1 project that were observed as a result of the 2005 spring runoff and to remove the portion of the spoil pile that remained on Pueblo of Santa Ana land. Project also addressed bank erosion observed as a result of depositing sediment from 2005 spoil pile management. Also constructed a third backwater area. | Bank line embayment, backwater area, longitudinal bank lowering, trench-filled bendway weirs, riparian vegetation establishment. | River diversion, river reconnection, river crossings, material placement. | 0.8 | 2.5 | 8.8 | 8 months (wet) | 0.6 acre of backwater areas, 20 acres floodplain reconnection to river, and 0.4 acre of native species vegetation plantings (all are inherent part of design). | • Increased inundation of flood plain observed during the 2010 spring runoff as a result of the spoil pile removal.<br>• Areas repaired functioning as designed.<br>• Bank erosion area that was restored is functioning as designed.<br>• Planted vegetation doing well.<br>• Constructed backwater area doing well. |

**Table I-8. Historical river maintenance work: Angostura Diversion Dam to Isleta Diversion Dam Reach (2001–2012 work)**

| Project Name | Site Number (Figure 22) | Project Type and Purpose | River Maintenance Methods | Construction Techniques (Method Category BMPs) | Access Roads (acres) | Project Impact Area in the Dry (acres) | Project Impact Area in the Wet (acres) | Project Duration | Habitat Features Created | Observations |
|---|---|---|---|---|---|---|---|---|---|---|
| Santa Ana Restoration, GRF 1 Repair (2012) | 19 | **Adaptive Management** – Project undertaken to correct damage and address observed concerns to Phase 1 project that were observed as a result of the 2010 spring runoff. | Longitudinal stone toe with bioengineering, riparian vegetation establishment. | Partial excavation of bank, bank line work, material placement. | 1.2 | 1.3 | 6.2 | 2 months (wet) | Riparian planting on floodplain, and bioengineering planting –both are inherent part of design. | • Planted vegetation doing well |
| Las Huertas Creek (2002) | 20 | **New Site** – Project undertaken to address bank erosion on east bank of Rio Grande and south bank of Las Huertas Creek that threatened local landowner holdings. Project done as mitigation for landowner allowing access for Santa Ana projects. | Riprap revetment, riparian vegetation establishment. | Bank line work, material placement, material removal. | 1.1 | 8 | 0.2 | 2 months (wet) | None. | • Design functioning as intended.<br>• Planted vegetation doing well. |
| Bernalillo (2006–2007) | 21 | **New Site** – Project undertaken to address bank erosion that threatened the integrity of a spoil berm protecting a drain facility. | Island and bank clearing and destabilization, side channels, longitudinal bank lowering, jetty removal, riparian vegetation establishment, trench-filled bendway weirs rootwads, | River diversion, river reconnection, river crossings, river work, material placement, material removal. | 3.1 | 0.9 | 6.3 | 7 months (wet) | 2 acres of secondary channel, 1.1 acres of vegetation planting, 3.8 acres of floodplain lowering and riparian habitat (All are inherent part of design). | • Bendway weir design functioning as intended.<br>• Some of the bendway weirs have been exposed.<br>• Secondary currents have created scallop areas between the exposed bendway weirs in the bank that have variable depth and velocity areas.<br>• Side channels have filled in and function as high-flow channels.<br>• Planted vegetation doing well.<br>• Some native vegetation recruitment. |
| Sandia (2002) | 22 | **Interim Work** – Project undertaken to address bank erosion that threatened the integrity of a spoil berm protecting a drain facility. This was an interim fix to provide time to plan and coordinate a longer-term solution. | Riprap windrow | N/A – work was done out of the MRG active channel on dry land. | 0.8 | 1.6 | N/A | 2 months (dry) | None. | • Long-term project constructed before riprap windrow self-launched.<br>• Riprap windrow removed as part of 2007–2008 Sandia project. |

**Table I-8. Historical river maintenance work: Angostura Diversion Dam to Isleta Diversion Dam Reach (2001–2012 work)**

| Project Name | Site Number (Figure 22) | Project Type and Purpose | River Maintenance Methods | Construction Techniques (Method Category BMPs) | Access Roads (acres) | Project Impact Area in the Dry (acres) | Project Impact Area in the Wet (acres) | Project Duration | Habitat Features Created | Observations |
|---|---|---|---|---|---|---|---|---|---|---|
| Sandia (2007–2008) | 23 | **New Site** – Project undertaken to address bank erosion that threatened the integrity of a spoil berm protecting a drain facility. | Island and bank clearing and destabilization, bank line embayment (backwater area), side channels, longitudinal bank lowering, jetty removal, riparian vegetation establishment, trench-filled bendway weirs, rootwads. | River diversion, river reconnection, river crossings, river work, material placement, material removal. | 0.8 | 1.6 | 9.1 | 14 months (wet) | 0.65 acre - two backwater areas; 3.5 acres of secondary channels and bank lowering and vegetation planting areas (all are inherent part of design). | • Design discharge for crest height of weirs has increased due to incision. Bendway weirs still appear to be functioning as designed.<br>• Some of the bendway weirs have been exposed.<br>• Secondary currents have created scallop areas between the exposed bendway weirs in the bank that have variable depth and velocity areas.<br>• Some of the exposed weirs have extensive scalloping that, if it continues, may have the potential to cause flanking.<br>• Erosion at upstream and downstream ends that has the potential to flank rootwad bank protection.<br>• Side channels have filled in and function as high-flow channels.<br>• Backwater areas have filled in and require a higher discharge to inundate.<br>• Planted vegetation doing well.<br>• Native vegetation recruitment is high in backwater areas. |

**Table I-9. Historical river maintenance work: Rio Puerco to San Acacia Diversion Dam Reach (2001–2012 work)**

| Project Name | Site Number (Figure 22) | Project Type and Purpose | River Maintenance Methods | Construction Techniques (Method Category BMPs) | Access Roads (acres) | Project Impact Area in the Dry (acres) | Project Impact Area in the Wet (acres) | Project Duration | Habitat Features Created | Observations |
|---|---|---|---|---|---|---|---|---|---|---|
| Drain Unit 7 (2005) | 24 | **Unanticipated Work** – Project undertaken to address bank erosion observed during the 2005 spring runoff that threatened the integrity of a spoil berm protecting an irrigation facility. | Riprap revetment. | Bank line work, material placement. | 5.5 | 0.5 | 0.5 | 1 month (wet) | None. | • Placed riprap held bank line during 2005 spring runoff.<br>• Additional bank erosion upstream of the 2005 bank erosion was observed during the 2007 spring runoff. |
| Drain Unit 7 (2007) | 25 | **Unanticipated Work** – Project undertaken to address bank erosion observed during the 2007 spring runoff that threatened the integrity of a spoil berm protecting an irrigation facility. | Riprap revetment. | Bank line work, material placement. | 5.5 | 0.5 | N/A | 1 week (dry) | None. | • Placed riprap held bank line during 2007 spring runoff. |
| Drain Unit 7 (2009) | 26 | **New Site** – Project undertaken to address bank erosion that threatened the integrity of a spoil berm protecting an irrigation facility. | Riprap revetment, riprap windrow, riparian vegetation establishment. | Working platform, material placement. | 5.5 | 3.8 | 1.0 | 4 months (wet) | 0.04 acre of trench planting and 0.1 acre of soil choked riprap planting (project mitigation). | • Design functioning as intended.<br>• Vegetation cleared to allow project to proceed has returned and is doing well.<br>• Vegetation on banks has done well in areas where maintenance is not an issue.<br>• Planted vegetation has not been successful due to high water levels associated with checking up the water at the San Acacia Diversion Dam during irrigation season and from San Acacia Diversion Dam maintenance activities. |

**Table I-10. Historical river maintenance work: San Acacia Diversion Dam to Arroyo de las Cañas Reach (2001–2012 work)**

| Project Name | Site Number (Figure 22) | Project Type and Purpose | River Maintenance Methods | Construction Techniques (Method Category BMPs) | Access Roads (acres) | Project Impact Area in the Dry (acres) | Project Impact Area in the Wet (acres) | Project Duration | Habitat Features Created | Observations |
|---|---|---|---|---|---|---|---|---|---|---|
| San Acacia RM 113/114 (2005–2007) | 27 | **New Site** – Project undertaken to address bank erosion that threatened the integrity of a spoil berm protecting the LFCC. | Infrastructure setback jetty removal, riparian vegetation establishment, steel sheet pile grade control (on arroyo), sediment augmentation. | N/A – work was done out of the MRG active channel on dry land. | 12.0 | 12.6 | 9 (in LFCC) | 12 months (dry) | 187 acres of widening of river corridor (inherent part of design); 27 acres of native species planting; and 4 acres of environmental feature establishment (the last two were project mitigation). | • Design functioning as intended.<br>• Bank erosion has been allowed to proceed.<br>• San Lorenzo Arroyo has re-connected to the Rio Grande, bringing in additional sediment.<br>• Planted native vegetation is doing okay, still sparse groundcover.<br>• Some exotic vegetation control is still needed, especially saltcedar. |
| San Acacia RM 111 (2006) | 28 | **Interim Work** – Project undertaken to address bank erosion that threatened the integrity of a spoil berm protecting the LFCC. This was an interim fix to provide time to plan and coordinate a longer-term solution. | Riprap windrow. | N/A – work was done out of the MRG active channel on dry land. | 2.8 | 1.5 | N/A | 7 weeks (dry) | None. | • Long term project constructed before riprap windrow self-launched.<br>• Riprap windrow removed as part of 2007–2009 San Acacia RM 111 project. |
| San Acacia RM 111 (2007–2009) | 29 | **New Site** – Project undertaken to address bank erosion that threatened the integrity of a spoil berm protecting the LFCC. | Infrastructure setback, riparian vegetation establishment. | N/A – work was done out of the MRG active channel on dry land. | 7.9 | 7.2 | 6.4 (in LFCC) | 12 months (dry) | 59 acres of widening of river corridor (inherent part of design), and 1.8 acres of environmental feature establishment (project mitigation). | • Design functioning as intended.<br>• Bank erosion has been allowed to proceed.<br>• Planted native vegetation is doing okay, still sparse groundcover. |
| Arroyo de la Parida (2004) | 30 | **New Site** – Project undertaken to address bank erosion as a result of sediment from the Arroyo de la Parida pushing Rio Grande flows towards the west bank. The erosion threatened the integrity of sedimentation structure within the LFCC temporary outfall. | None. | Material removal (removal of sedimentation structure). | Used O&M roads | 0.5 | 0.2 (in LFCC) | 1 month (dry) | None. | • Erosion allowed to proceed with monitoring.<br>• LFCC temporary outfall structure operational without sedimentation structure. |

**Table I-11. Historical river maintenance work: San Antonio Bridge to River Mile 78 Reach (2001–2012 work)**

| Project Name | Site Number (Figure 22) | Project Type and Purpose | River Maintenance Methods | Construction Techniques (Method Category BMPs) | Access Roads (acres) | Project Impact Area in the Dry (acres) | Project Impact Area in the Wet (acres) | Project Duration | Habitat Features Created | Observations |
|---|---|---|---|---|---|---|---|---|---|---|
| BDA Channel widening (2003) | 31 | **New Site** – Project undertaken to provide mitigation (channel widening in a section of the MRG through BDA) for the 2000 Temporary Channel project. | Channel relocation using pilot cut, island and bank clearing and destabilization. | River diversion, river reconnection, river crossings. | 1.4 | 67.5 | 20.7 | 8 months (wet) | Widened river corridor (inherent part of design). | • Design functioned as intended.<br>• Channel widened from 150 feet to around 600 feet, majority during the 2005 spring runoff. |
| BDA Sediment Plug (2008) | 32 | **New Site** – Project undertaken to reconnect portions of the MRG separated by a sediment plug in order to facilitate delivery of water. | Pilot cut through sediment plug. | River reconnection, bank line work, river work. | 0.6 | 13.3 | 7.3 | 6 weeks (wet) | None. | • Design functioned as intended: river widened pilot cut channel to presediment plug channel width.<br>• Sediment continuity restored. |
| BDA Levee (2009–2010) | 33 | **Adaptive Management** – Project undertaken to strengthen existing levee (raising and widening) to provide ability to pass design capacity flows. | Levee strengthening. | N/A – work was done out of the MRG active channel on dry land. | 18.0 | 1.0 | N/A | 15 months (dry) | None. | • Design is functioning as intended. |
| BDA Levee (2012) | 34 | **Adaptive Management** – Project undertaken to strengthen existing levee (widening) to provide ability to pass design capacity flows. Widening stretch of BDA levee north of the BDA that was not widened in 2009–2010. | Levee strengthening. | N/A – work was done out of the MRG active channel on dry land. | 4.0 | 1.0 | N/A | 2 months (dry) | None. | • Design is functioning as intended. |

**Table I-12. Historical river maintenance work: River Mile 78 to Full Pool Elephant Butte Reservoir Level Reach (2001–2012 work)**

| Project Name | Site Number (Figure 22) | Project Type and Purpose | River Maintenance Methods | Construction Techniques (Method Category BMPs) | Access Roads (acres) | Project Impact Area in the Dry (acres) | Project Impact Area in the Wet (acres) | Project Duration | Habitat Features Created | Observations |
|---|---|---|---|---|---|---|---|---|---|---|
| Tiffany Sediment Plug (2005) | 35 | **New Site** – Project undertaken to reconnect portions of the MRG separated by a sediment plug in order to facilitate delivery of water. | Pilot cut through sediment plug. | River reconnection. | 0 | 7.3 | N/A | 9 weeks (dry) | None. | • Design functioned as intended: majority of river widened pilot cut channel to presediment plug channel width.<br>• Some portions of river did not widen out and spoil berms from pilot channel were left in place. |
| Tiffany Levee (2005) | 36 | **Unanticipated Work** – Project undertaken to strengthen existing levee (raising and widening) to address concerns about levee seepage problems and levee cracks caused by 2005 spring runoff flows. | Levee strengthening. | N/A – work was done out of the MRG active channel on dry land. | 4.0 | 1.0 | N/A | 2 months (dry) | None. | • Design is functioning as intended. |
| San Marcial Levee (2005) | 37 | **Unanticipated Work** – Project undertaken to repair levee breaches on access road between San Marcial Railroad Bridge and the San Marcial Levee and to strengthen existing levee (raising and widening) to address concerns about levee seepage problems and levee cracks caused by 2005 spring runoff flows | Levee strengthening. | N/A – work was done out of the MRG active channel on dry land. | 2.0 | 1.0 | N/A | 1 months (wet) | None. | • Design is functioning as intended. |
| Fort Craig Bend (2011) | 38 | **Interim Work** – Project undertaken to address bank erosion that threatened the integrity of a spoil berm protecting the LFCC. This is an interim fix to provide time to plan and coordinate a longer-term solution. | Riprap windrow, riparian vegetation establishment. | N/A – work was done out of the MRG active channel on dry land. | 3.6 | Used riprap stockpile as staging area | N/A | 3 months (dry) | Vegetation planting (project mitigation). | • Riprap windrow has not self-launched yet.<br>• Project mitigation is still in planning phase. |

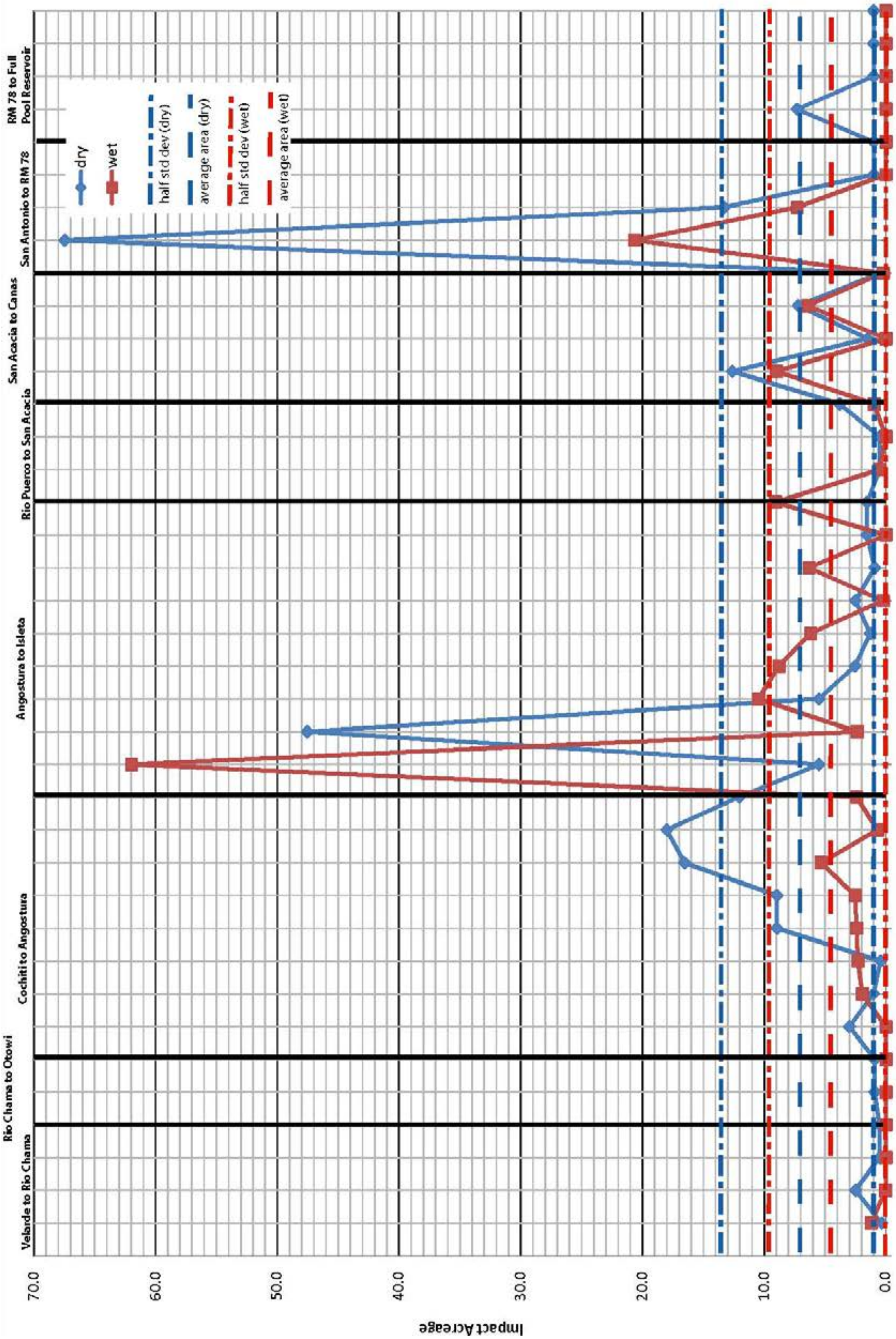



**Figure I-22. River maintenance project area by reach (2001–2012)**

#### *4.2.2.3 River Maintenance Support Activities*

There are several support activities for river maintenance actions that have required historical field activity to successfully and efficiently complete. These activities, summarized in the following sections, provide information on materials essential to complete river maintenance actions (Sections 4.2.2.3.1 and 4.2.2.3.2) and data collection (Section 4.2.2.3.3).

##### *4.2.2.3.1 Stockpiles and Storage Yards*

Reclamation currently has 10 established stockpile sites and 2 storage yards that support the MRG river maintenance needs within the defined action area. These areas are outside the floodplain of the MRG. The names and approximate acreage of these sites are listed in Table I-13. These sites were used on a recurring basis over the last 10 years, providing support through the storage of material, supplies, and equipment. This support activity, while useful for planned river maintenance actions, also allowed for a quicker response time in emergency situations.

**Table I-13. Reclamation stockpile sites and storage yards for the MRG**

| Site | Footprint (acres) |
|---|---|
| ***Stockpiles*** | |
| Velarde | 5.8 |
| Angostura | 1.2 |
| Bernalillo | 13.9 |
| Drain Unit 7 | 1.8 |
| RM 111 east | 6.8 |
| RM 111 west | 10.5 |
| Escondida | 2.7 |
| San Antonio – Highway 380 | 1.9 |
| Tiffany Junction | 1.4 |
| Ft. Craig | 19.2 |
| ***Storage Yards*** | |
| Socorro | 1.1 |
| San Marcial | 1.0 |

Stockpile sites primarily were used to store material, typically riprap, for a particular river maintenance project or for unspecified future river maintenance work. These sites also were used on a temporary basis to store equipment and other supplies for a nearby river maintenance project. Storage yards were used for continuous storage of equipment and supplies, but were also used to temporarily store material. Periodically, these sites required vegetation clearing (mowing and trimming), grading, graveling, drainage, and/or fencing. Appropriate land use and access permission and all necessary regulatory permits were obtained prior to initial use of the sites. All appropriate permissions and permits are kept current while these sites are being used.

##### *4.2.2.3.2 Borrow and Quarry Areas*

Reclamation currently has one active borrow area (Valverde Pit) and one active quarry area (Red Canyon Mine) to support river maintenance within the defined action area. The locations are outside the river corridor. Valverde Pit is located near Fort Craig and is used to provide soil material for use in river maintenance actions. Soil is extracted through a process that initially requires vegetation clearing (clearing) of the area and then removing the soil for placing at river maintenance sites. The total acreage of the Valverde Pit is around 114 acres, but the typical historical river maintenance project disturbance for acquiring soil material from Valverde Pit was 10 acres or less.

The Red Canyon Mine is used to produce and process riprap of a required gradation for use on river maintenance actions. This quarry location is located in the Magdalena front range on Bureau of Land Management (BLM) land. Extracting riprap involves a process that first requires placing explosives to break apart the rock walls of the quarry to produce variable-sized riprap. This is followed by processing the riprap to obtain the design gradation. If the blast was successful, the processing involved sieving the blasted material (typically done through using a grizzly) and loading the material onto transport trucks to take to a river maintenance project site or a riprap stockpile site. If the blast was not successful and produced larger than the desired size gradation, an additional processing step was necessary, requiring a rock breaker to break down the larger rock pieces. The total acreage of the Red Canyon Mine is around 18 acres. Appropriate land use and access permission and all necessary regulatory permits were obtained prior to initial use of these sites. All appropriate permissions and permits also are kept current while these sites are being used.

##### *4.2.2.3.3 Data Collection*

Data collection activities are required to support river maintenance actions and typically occur for two main purposes: specific projects and monitoring trends. Data collection for monitoring trends is necessary to assess changes in river bed elevation and slope, channel position, width, depth, flow velocity, sinuosity, channel capacity, and sediment. This data collection supports trend analysis and future projections of geomorphic trends, sediment transport, and hydraulic geometry—all of which are necessary and feed into river maintenance actions. Typically, these were a more spatially extensive, reach-based data collection effort. Similar types of data were collected for specific projects. Specific project data collection, however, was more localized and collected information that supported planning, design, environmental compliance, and maintenance/adaptive management implementation for specific river maintenance projects.

Rangelines were established along the river as part of Reclamation's hydrographic data collection program for river channel monitoring. These rangelines typically run perpendicular to the channel and allow collection of survey data within the channel and floodplain. For rangeline monitoring, these lines were cleared of vegetation (clearing and trimming by hand) to a width of about 3 feet to create a clear line-of-sight. Reclamation, on average, historically cleared and collected rangeline information for about 100 lines a year between 2001 and 2012 within the described action area. The range in any given year was 40–200 lines. Although the specific rangeline lengths vary throughout the MRG project area, a typical annual impact range for rangeline clearing was approximately 1–23 acres, with an average near 12 acres. A summary of the rangeline monitoring impact by reach and year is shown in Tables I-14 and I-15.

### 4.2.3 Other Reclamation MRG Project Historical Maintenance Actions

There are other activities, distinct from river maintenance actions and river maintenance support activities, that help achieve Reclamation's authorization under the Flood Control Acts of 1948 and 1950. These activities, as described in the authorization, include irrigation and drainage rehabilitation (maintenance) and operation and maintenance of the LFCC (Reclamation 1947, 2003b). Descriptions of the historical maintenance activities are provided in the following sections.

**Table I-14. Historical river maintenance rangeline monitoring (number of lines)**

| Reach | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Verlade to Rio Chama | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Rio Chama to Otowi Bridge | 0 | 0 | 0 | 0 | 9 | 0 | 0 | 10 | 6 | 0 | 0 | 0 | 2 |
| Cochiti Dam to Angostura Diversion Dam | 1 | 1 | 0 | 7 | 7 | 0 | 102 | 0 | 20 | 0 | 0 | 0 | 12 |
| Angostura Diversion Dam to Isleta Diversion Dam | 74 | 2 | 65 | 45 | 48 | 5 | 0 | 0 | 42 | 0 | 17 | 57 | 30 |
| Isleta Diversion Dam to Rio Puerco | 0 | 15 | 0 | 14 | 14 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| Rio Puerco to San Acacia Diversion Dam | 0 | 0 | 0 | 0 | 0 | 8 | 0 | 0 | 0 | 0 | 0 | 15 | 2 |
| San Acacia Diversion Dam to Arroyo de las Cañas | 0 | 32 | 28 | 7 | 55 | 9 | 0 | 0 | 15 | 42 | 0 | 13 | 17 |
| Arroyo de las Cañas to San Antonio Bridge | 0 | 10 | 0 | 0 | 11 | 0 | 0 | 0 | 11 | 0 | 0 | 23 | 5 |
| San Antonio Bridge to River Mile 78 | 5 | 16 | 3 | 5 | 17 | 0 | 5 | 11 | 10 | 0 | 0 | 18 | 8 |
| River Mile 78 to Full Pool Elephant Butte Reservoir Level | 10 | 44 | 30 | 49 | 35 | 27 | 64 | 47 | 0 | 0 | 0 | 0 | 26 |
| **Totals** | **90** | **120** | **126** | **127** | **196** | **49** | **171** | **68** | **104** | **42** | **17** | **126** | **103** |

**Table I-15. Historical river maintenance rangeline monitoring (acreage impacted)**

| Reach | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Verlade to Rio Chama | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Rio Chama to Otowi Bridge | 0 | 0 | 0 | 0 | 0.4 | 0 | 0 | 0.4 | 0.3 | 0 | 0 | 0 | 0.1 |
| Cochiti Dam to Angostura Diversion Dam | 0 | 0 | 0 | 0.3 | 0.3 | 0 | 3 | 0 | 0.6 | 0 | 0 | 0 | 0.4 |
| Angostura Diversion Dam to Isleta Diversion Dam | 3.6 | 0.3 | 3.2 | 2.3 | 2.4 | 0.2 | 0 | 0 | 1.9 | 0 | 0.8 | 2.7 | 1.5 |
| Isleta Diversion Dam to Rio Puerco | 0 | 1.2 | 0 | 1.1 | 0.9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.3 |
| Rio Puerco to San Acacia Diversion Dam | 0 | 0 | 0 | 0 | 0 | 0.6 | 0 | 0 | 0 | 0 | 0 | 0.9 | 0.1 |
| San Acacia Diversion Dam to Arroyo de las Cañas | 0 | 4.5 | 1.4 | 0.2 | 4.4 | 0.7 | 0 | 0 | 1.4 | 4.1 | 0 | 1.1 | 1.5 |
| Arroyo de las  Cañas to San Antonio Bridge | 0 | 0.5 | 0 | 0 | 0.6 | 0 | 0 | 0 | 0.6 | 0 | 0 | 1.6 | 0.3 |
| San Antonio Bridge to River Mile 78 | 1.5 | 4.3 | 0.9 | 1.5 | 4.6 | 0 | 1.5 | 2.6 | 2.8 | 0 | 0 | 5.1 | 2.1 |
| River Mile 78 to Full Pool Elephant Butte Reservoir Level | 1.5 | 9.8 | 7.2 | 14.8 | 9 | 4.2 | 17.2 | 8.7 | 0 | 0 | 0 | 0 | 6 |
| **Totals** | **7** | **21** | **13** | **20** | **23** | **6** | **22** | **12** | **8** | **4** | **1** | **11** | **12** |

#### *4.2.3.1 LFCC O&M Historical Actions*

The LFCC was constructed by Reclamation between 1951 and 1959. The LFCC was originally constructed at the site of the San Acacia Diversion Dam extending to the Narrows of Elephant Butte Reservoir, a distance of about 70 miles. The design capacity of the LFCC was originally 2,000 cfs. Its purpose was to reduce water loss due to evaporation and transpiration by conveying Rio Grande water in a narrower, deeper channel, rather than in the wider and shallower floodway. The portion of the LFCC between the southern boundary of BDA and the Elephant Butte Reservoir was constructed between 1951 and 1953, with river diversions into this reach beginning in 1953 at San Marcial (Reclamation 1953, 1956). The LFCC between San Acacia Dam and the southern boundary of BDA was constructed between 1956 and 1959, with diversions from San Acacia Dam beginning in 1959 (Reclamation 1959). High reservoir levels at Elephant Butte in the 1980s resulted in the lower 8 miles of the LFCC filling in with sediment (Klumpp and Baird 1995), so that by March 1985, the LFCC was forced out of operation (Reclamation 1985). While it was estimated that 50,000–70,000 AF of water were salvaged annually by operation of the LFCC (Reclamation 1985), diversions have been minimal after 1985. The only diversion has been into a 9-mile section of the LFCC (San Acacia Dam to the Escondida outfall), which also was used between 1997 and 2004 to conduct experimental operations (Tetra Tech 2004) to explore rehabilitation options for the LFCC (Reclamation 2001). It should be noted that between RM 111 and RM 114, the LFCC and the protecting spoil levee have been relocated. The relocated LFCC has a riprap-lined capacity of 500 cfs. It also should be noted that no LFCC operational changes from the status quo are proposed as part of this BA. Since the 1980s, the LFCC has functioned much in the same manner as an irrigation drain, collecting and transporting return flows.

Reclamation has continued to maintain the LFCC, as it does serve important functions, including improving drainage, supplementing irrigation water supply to MRGCD, and supplying water to BDA for irrigation and other uses. In many locations, the LFCC is the lowest point in the valley, and it provides essential drainage benefits by collecting ephemeral storm runoff, subsurface drainage water, irrigation return flows, and in some areas seepage water from the river.

Historical maintenance of the LFCC has included the following activities: vegetation control, removal of material, road maintenance, and structure maintenance. For all of these activities, equipment that was used on a given job underwent high-pressure spray cleaning and inspection prior to initial operation in the project area. Spill kits are kept with equipment to contain accidental releases of fluid.

#### *4.2.3.2 Project Drain Past Actions*

MRG project authorization provides for Reclamation (Reclamation 1947, 2003b) to perform irrigation and drain rehabilitation. The majority of drains and irrigation facilities in the MRG are currently operated and maintained by MRGCD. There are a few drains, however, that MRGCD does not maintain and that benefit the State by increasing water salvage, thereby assisting the State in fulfilling the Rio Grande Compact requirements. Historically, Reclamation usually performed drain maintenance under a cost-sharing arrangement in which Reclamation provided engineering, environmental compliance, and inspection, while a partner agency (most commonly NMISC) contributed funding to cover the cost of Reclamation's construction crew and equipment. Until about the year 2000, Reclamation regularly maintained the Project drains using the implementation techniques described in Part III, Section 1.7.2.1. During 2000–2010, drain maintenance was greatly reduced because of a sharp decrease in available funding from cooperating agencies. Activities during that period consisted of occasional mowing, road maintenance, and repairs to heavily damaged portions of the drains as necessary to maintain public safety.

### 4.2.4 The MRGCD MRG Historical Maintenance Actions

The MRGCD operates and maintains the diversion dams and its irrigation, drainage, recreation, and flood control facilities pursuant to the 1923 New Mexico Conservancy Act, Federal Congressional Acts of 1928 and 1935, Office of the State Engineer Permit No. 0620, and the 1951 Contract[19] to meet the following requirements:

- Diverting and delivering water stored in and released from El Vado Dam and native Rio Grande water to satisfy the needs of private property holders and users of water within its service area and newly reclaimed lands of the Six MRG Pueblos.
- Diverting and delivering native Rio Grande water for lands of the Six MRG Pueblos with federally designated prior and paramount water rights, through the Cochiti Heading and Angostura and Isleta Diversion Dams, as requested by the BIA-designated engineer.
- Rediverting the MRGCD's contracted SJC Project water, which, by statute, cannot be used by the United States for ESA purposes, except upon a willing seller basis.
- Maintaining the diversion dams.
- Operating and maintaining the MRGCD water delivery system (canals/drains) throughout the MRG.

The MRGCD constructs, maintains, modifies, repairs, and replaces irrigation and flood control structures and facilities throughout its boundaries to ensure the proper functioning of these facilities for their intended purpose. Maintenance typically has involved vegetation control or

[19] Contract No. 178r-423, dated September 24, 1951, between MRGCD and Reclamation for Rehabilitation and Construction of Project Works and Repayment of Reimbursable Construction Costs.

removal, debris removal, earthwork, sediment removal, concrete work, cleaning, painting, etc. Repair, replacement, and modification involved earthwork and concrete work.

The MRGCD consists of four divisions—Cochiti, Albuquerque, Belen, and Socorro—serving irrigated lands from Cochiti Dam to BDA. The full description of MRGCD facilities is located in the Joint Biological Assessment, Bureau of Reclamation and Non-Federal Water Management and Maintenance Activities on the Middle Rio Grande, New Mexico, Part I – Water Management.

The MRGCD operates and maintains a system of measurement stations, or gauges, along its canal and drain network. These gauges report water level and rates of flow back to the MRGCD on 30-minute intervals. Data are collected via FM radio telemetry, processed (converted from raw electronic signals to usable values and units), and then, through file transfer protocol, sent to three separate computer databases (MRGCD, Reclamation, and the Corps). This entire process occurs automatically, 24 hours a day, throughout the year.

At present, the MRGCD provides data from about 130 sites on its system, and continues to add several new locations each year. In addition, the MRGCD collects, processes, and distributes data from Reclamation's silvery minnow pumping sites in Socorro County, and the NMISC's silvery minnow Atrisco habitat project in Bernalillo County. The MRGCD maintains its gauge network through periodic calibration measurements using a variety of flow measuring devices. In addition, MRGCD makes flow measurements in ungauged areas of its system, and along the Rio Grande itself.

## 4.3 Climate

Climate varies across the Rio Grande Basin in both time and space. Most of the basin is arid or semiarid, generally receiving less than 10 inches of precipitation per year. In contrast, some of the high mountain headwater areas receive an average of over 40 inches of precipitation per year. Climatic conditions in the basin are highly variable, as is indicated by the previously mentioned order of magnitude variability in the annual unregulated flow volumes at Rio Grande stream gages.

Annual variations in timing and volume of streamflow are strongly influenced by ocean circulation patterns, such as the El Niño-southern oscillation, which affects annual variability, and the Pacific Decadal Oscillation (PDO), which affects climate and streamflow on a multiyear to multidecade basis. These oceanic patterns modulate seasonal cycles of temperature and precipitation and affect snow accumulation and melting (JISAO 2012). Particular combinations of these ocean circulation patterns also can result in extended drought or wet periods. An extended period of below average precipitation occurred in New Mexico from the 1940s through the mid 1970s, correlating with a negative/cool phase of the PDO; above-average precipitation then prevailed from 1981 through the mid-1990s, correlating with a positive/warm phase of the PDO. Drought returned in the late 1990s through 2004, along with the negative phase of the PDO (JISAO 2012, Corps et al. 2007).

Over the course of the 20th century, the Rio Grande Basin has become warmer. As is shown by the blue dots on Figure I-23, moving average temperature in the basin has increased by 1–2°F over the course of the 20th century. This warming of the Rio Grande Basin has not been steady in time. The basin's average temperature increased steadily from roughly the 1910s to the mid-1940s and then declined slightly until the 1970s before increasing steadily through the end of the century. This temporal pattern of warming is consistent with findings for other basins within the region. In northern New Mexico, recent annual average temperatures have been more than 2.0°F (1.1°C) above mid-20th century values (D'Antonio 2006, Rangwala and Miller 2010). The San Juan Mountains, the headwaters of the Rio Grande, have experienced a 1°C increase from 1895–2005, with most of the warming occurring during 1990–2005.

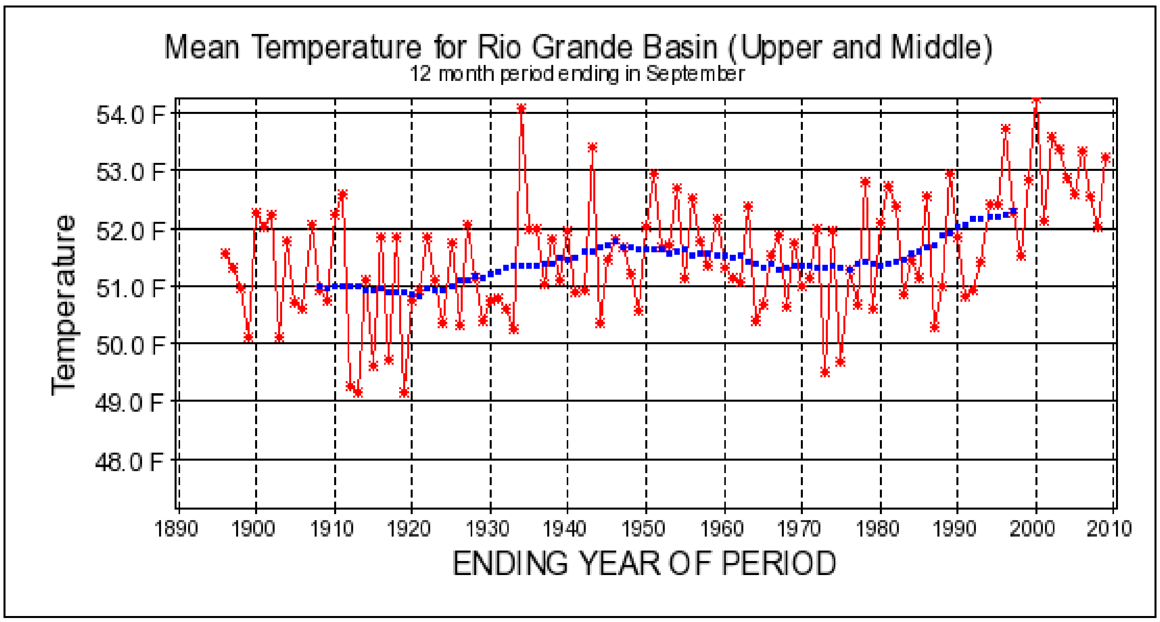



**Figure I-23. Observed annual temperature, averaged over the Rio Grande Basin above Elephant Butte. Source: Western Climate Mapping Initiative (WestMap) available at http://www.cefa.dri.edu/Westmap/. Red line indicates annual time-series for the given geographic region. Blue line indicates 25-year moving annual mean.**

A slight increase in basin precipitation is evident over the past century (Figure I-24); however, this apparent change in precipitation is subtle relative to annual variability.

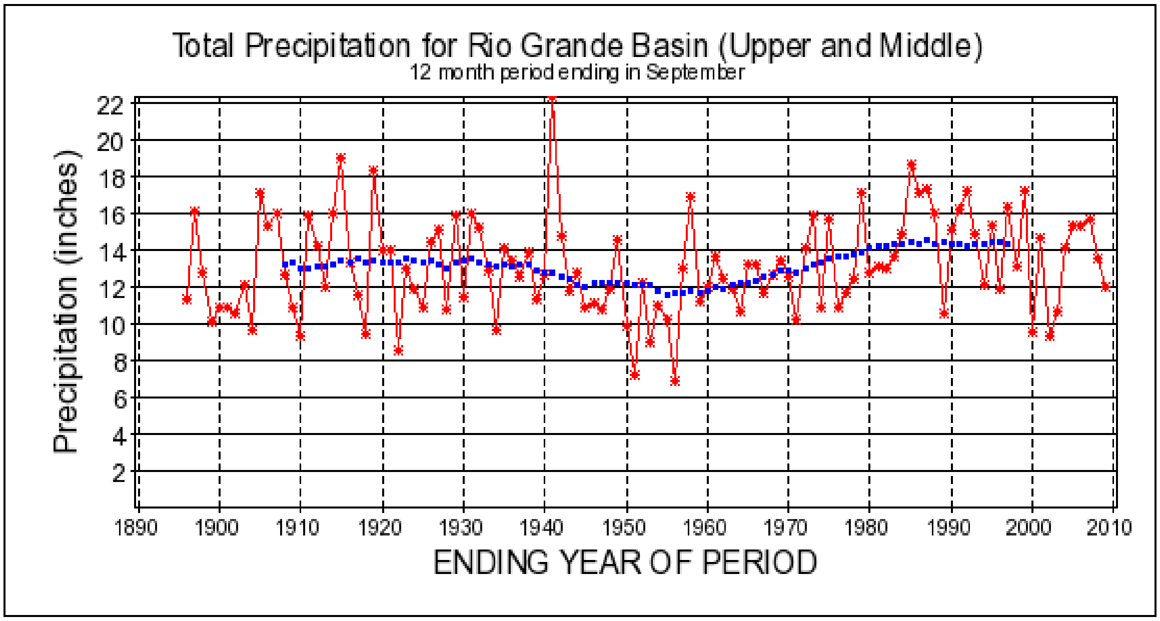



**Figure I-24. Observed annual precipitation, averaged over the Rio Grande Basin above Elephant Butte. Source: Western Climate Mapping Initiative (WestMap) available at http://www.cefa.dri.edu/Westmap/. Red line indicates annual time series for the given geographic region. Blue line indicates 25-year moving annual mean.**

Peak snowmelt runoff across northern New Mexico occurred, on average, 7 days earlier over the past half century than during the first half of the 20th century (Stewart et al. 2004, Enquist et al. 2008). In addition, streamflow in the winter months of January, February, and March has increased over the last quarter century relative to the century as a whole (Passell et al. 2004; Woodhouse et al. 2007).

Over the past 15-20 years, the MRG Basin has experienced one of the most water-scarce periods in recorded history culminating in the last 5 years of little to no snowmelt runoff in the Rio Grande within New Mexico. These long-term drought conditions, combined with warmer temperatures and other factors, have severely limited whatever flexibility may have existed in the system for providing environmental flows that protect and sustain plants and animals dependent on the river ecosystem. Of all the factors that affect sustainability of the MRG, the general warming trend associated with climate change has the greatest potential to diminish this flexibility in the long-term, due primarily to the global nature of the changes and the inability of local management decisions to change them (Reclamation 2013).

## 4.4 Hydrologic Regime

This section provides the hydrologic setting of the MRG and shows the following:

- The water supply to the MRG is limited and highly variable.

- Modifications have been made to the timing, distribution, and magnitude of flows in the MRG for purposes of flood control and maximization of the beneficial use of water, and include the following:
  - Suppression of large, channel-forming flows by flood-control dams.
  - Redistribution of flows by water storage reservoirs, so that water is available for water supplies and, consequently, for river flows during the irrigation season.
  - Diversion of surface water and drain flows for irrigation, which decreases the flow in the river.
  - Pumping of groundwater, so that significant groundwater drawdowns have developed, and the groundwater system now draws water from the river.

The hydrologic changes documented in this section are interconnected with the other changes that have occurred in this system, primarily geomorphic changes to the river channel, as discussed in the following section. Because of these geomorphic changes, the current hydrology is not sufficient to provide overbank flows in the upstream portions of the MRG. In the Angostura Reach, significant overbank flows begin to occur at flows above 6,500 cfs (Figure I-25). However, the maximum releases from Cochiti under its flood control rules are 7,000 cfs. Therefore, the available hydrologic operations have a very limited ability to provide significant overbank flows, which are important to the life cycle of the silvery minnow.

In the more downstream reaches, potential for overbank flows is more widespread, but diversions from the river decrease the flows that are conveyed to these reaches, and perching of the river channel makes it less likely that this channel will be able to maintain the flows that it receives from upstream. Frequent drying of the more downstream reaches of the MRG after the snowmelt runoff limits the degree to which they can support the post-spawn survival of the silvery minnow.

This subsection begins with a discussion of the water and river operations over the past decade, organized geographically from north to south, and concludes with the current hydrologic conditions.

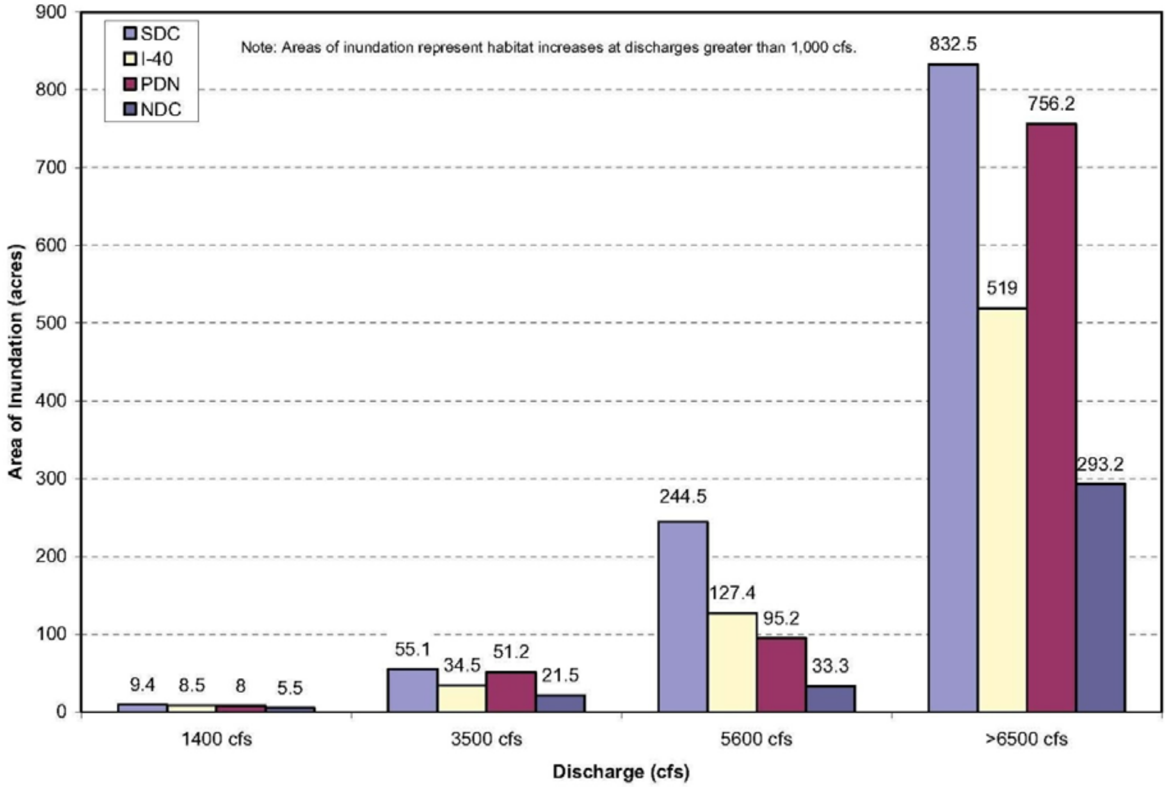



**Figure I-25. Bar graph showing area of overbank inundation in four subreaches of the Albuquerque Reach (the South Diversion Channel (SDC), Interstate 40 (I-40), Paseo del Norte (PDN), and North Diversion Channel (NDC) subreaches) prior to habitat restoration efforts by the Collaborative Program (Mussetter Engineering, Inc. 2006)**

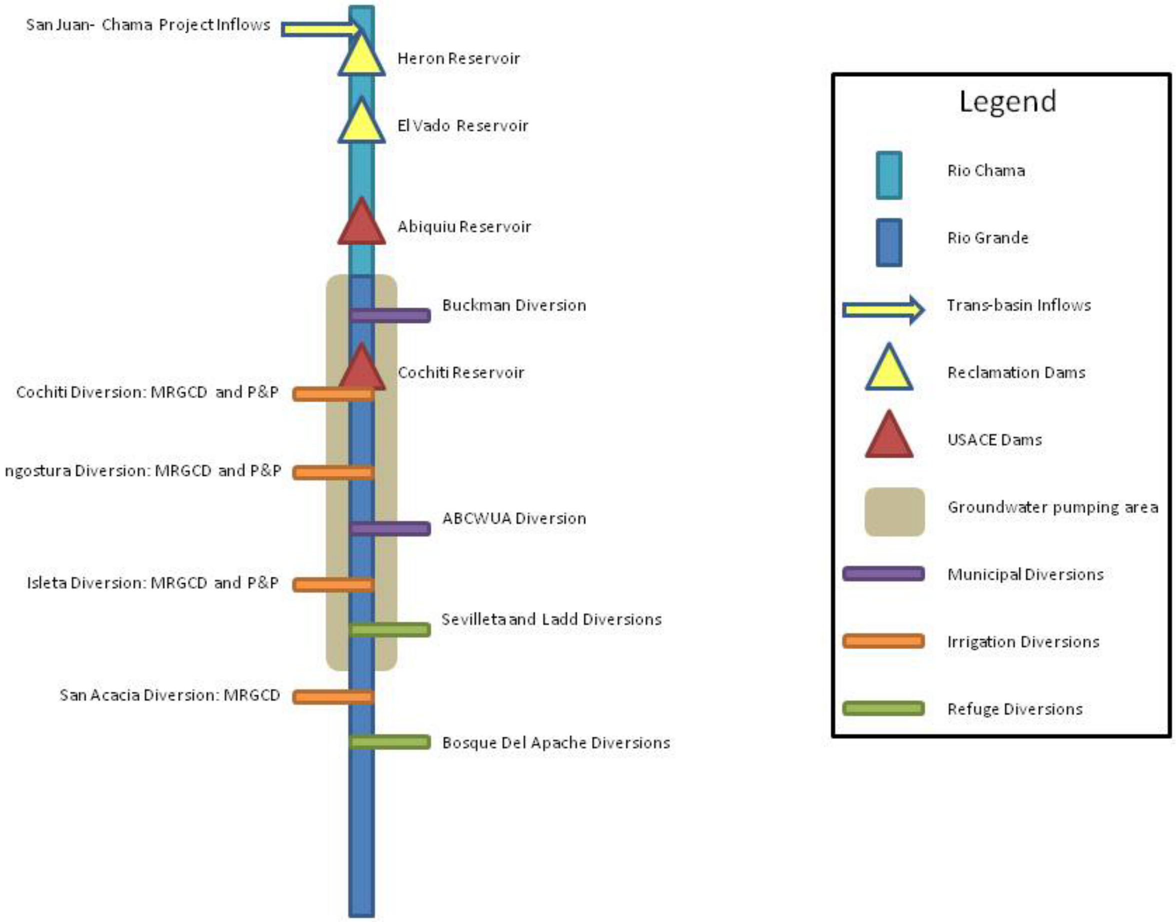
## 4.4.1 Baseline Water Operations

The term “water operations” describes the human operations of dams and diversions and activities that put water to beneficial use. Five types of water operations are implemented, often simultaneously, within the MRG system: (1) flood control, (2) irrigation, (3) municipal and industrial diversion, use, and return flow, (4) environmental operations, and (5) recreational/ rafting.

### *4.4.1.1 An Overview of MRG Water Management Facilities and Operations*

The MRG is an engineered system. River flow and water movement throughout the Rio Chama and MRG are constrained by the physical capabilities and existing authorities associated with the system’s water management facilities, operations, and policies. The MRG is affected by Colorado state line Compact deliveries, Rio Chama and other tributary inputs, imported SJC Project waters, the Corps’ flood control reservoirs along the Rio Chama and Rio Grande, and the MRG Project, all of which contribute to or regulate flows along the Rio Chama and the MRG.

Figure I-26 is a schematic representation of the Rio Chama and Rio Grande that shows the major facilities and/or entities that impact flows in the MRG—from Heron Reservoir operations at the




top to BDA at the bottom.

**Figure I-26. Schematic representation of major water facilities impacting river flows in the MRG**

The major federal reservoir facilities within the action area include the following:

- Rio Chama
  - Heron Dam Reservoir (owned and operated by Reclamation as part of the SJC Project)
  - El Vado Dam Reservoir (owned and operated by Reclamation as part of the MRG Project)
  - Abiquiu Dam and Reservoir (owned and operated by the Corps for flood control and SJC Project storage)
- Rio Grande

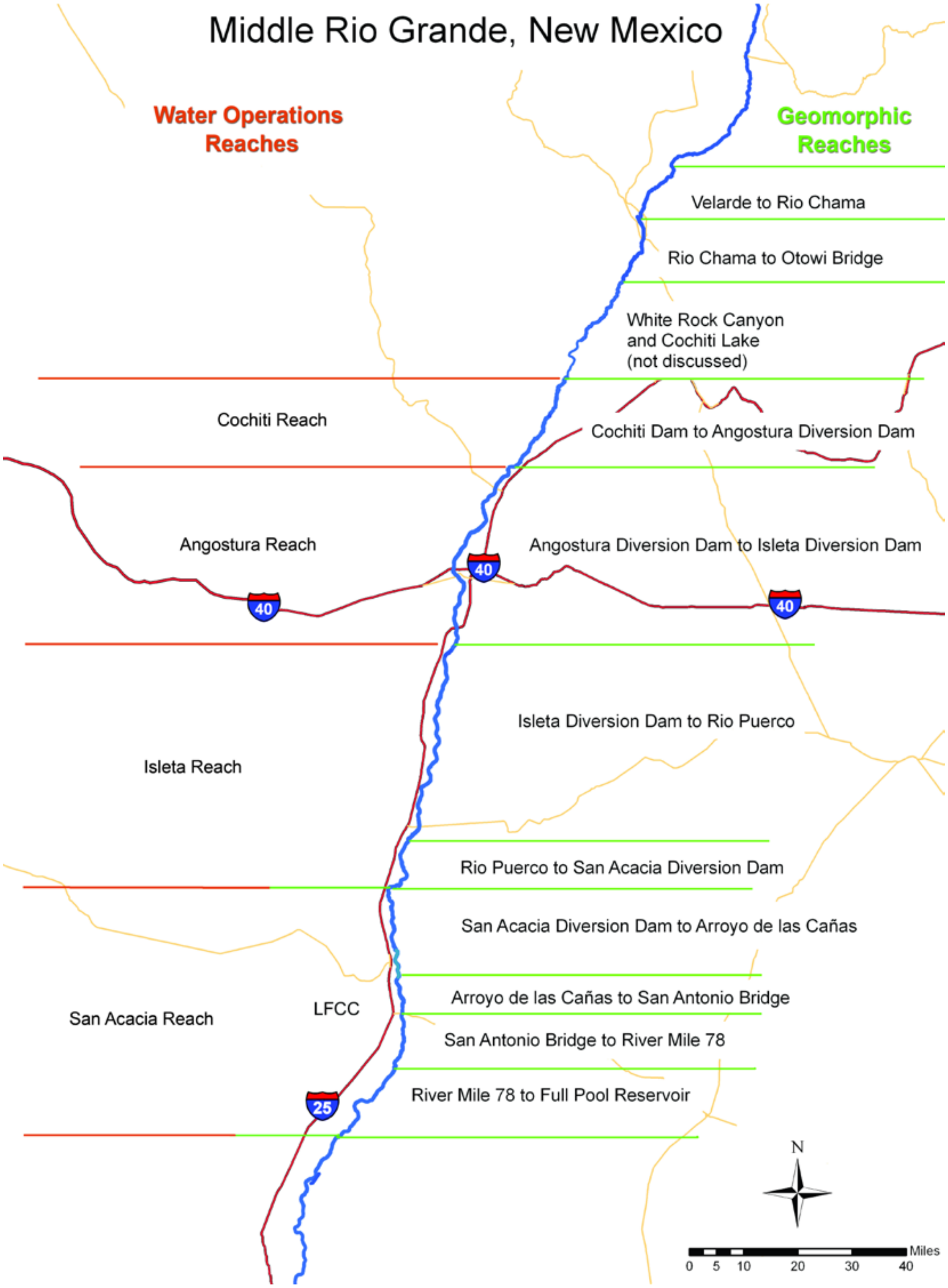
  - Cochiti Dam and Lake (owned and operated by the Corps for flood control)
- Off-Channel
  - Jemez Canyon Reservoir (owned and operated by the Corps for flood control)
  - Galisteo Dam (owned and operated by the Corps for flood control)

Heron Dam and Reservoir are located on Willow Creek, a tributary of the Rio Chama. Reclamation operates Heron Reservoir to manage imported SJC Project waters and passes all native Rio Grande flows. Reclamation operates El Vado Reservoir to store native Rio Grande water, when allowed by the Compact, for use in the MRG Project service area by non-Indian farmers and the Six MRG Pueblos. Reclamation stores native Rio Grande waters for prior and paramount water needs pursuant to the 1981 Agreement and discussed below. When space is available, El Vado also may store SJC Project water. Abiquiu Reservoir is authorized for flood control, sediment control, and storage of both SJC Project and native Rio Grande waters. However, storage of native Rio Grande water in Abiquiu is rare.

Very little native Rio Grande flow is actually captured and stored in the major reservoirs in this system. On average, only 100,000 AF of native Rio Grande water (less than 10% of annual average flow at Otowi gage) is historically stored (even temporarily) upstream of Elephant Butte Reservoir. The vast majority of combined storage in Heron, El Vado, Abiquiu, and Cochiti Reservoirs is imported SJC Project water (Flanigan 2007).

Rio Grande flows at Otowi gage, which is located just downstream from the confluence of the Rio Chama, consist of unregulated main stem Rio Grande flows crossing the border from Colorado and discharges from reservoirs along the Rio Chama, including both native Rio Grande watershed inputs and imported SJC Project waters. Cochiti Reservoir is the sole main stem reservoir capable of regulating these native Rio Grande flood flows. Native Rio Grande spring runoff from April–June typically is allowed to pass through Cochiti Dam unregulated, with the exception of peak flows that exceed safe channel capacity. Abiquiu Reservoir is the primary flood control reservoir along the Rio Chama, and the Jemez Canyon and Galisteo provide flood control on the Jemez and Galisteo Rivers, respectively—tributaries that discharge to the MRG. Releases from the other water supply reservoirs along the Rio Chama (i.e., Heron and El Vado Reservoirs) typically occur later in the year, from May–October, depending on irrigation demand and the need for available Supplemental Water to meet environmental flow requirements.

Water management reaches differ slightly from river maintenance geomorphic reach designations and are primarily defined by locations of mainstream irrigation diversion dams (Figure I-27). The upper reaches are similar to the river maintenance designations. The Cochiti Reach extends from Cochiti Dam to Angostura Diversion Dam. The reach from Angostura Diversion Dam to Isleta Diversion Dam is called the Angostura Reach (this reach is




interchangeably known as the Albuquerque Reach). The Isleta Reach is bounded upstream by Isleta Diversion Dam and downstream by San Acacia Diversion Dam.

**Figure I-27. Geomorphic reach designation**

Water management defines only one reach below San Acacia Diversion Dam to the full reservoir pool of Elephant Butte Reservoir, known as the San Acacia Reach, whereas there are several geomorphic designations within this reach.

The LFCC is a 54-mile-long riprap-lined channel that parallels the Rio Grande on the west side; it originally extended from San Acacia Diversion Dam to the narrows of Elephant Butte Reservoir, but now ends approximately at RM 60. The LFCC was constructed to aid delivery of Compact water and sediment to Elephant Butte Reservoir and serves to improve drainage of irrigated lands and provide additional water for irrigation by collecting water draining from farmland. The LFCC is owned, operated, and maintained by Reclamation.

New Mexico water law follows the Doctrine of Prior Appropriation, which gives senior water users a better right than junior water users in times of shortage. Under the doctrine, priority of water rights is determined through a stream system adjudication in a court of law. Water rights in the MRG have not yet been adjudicated to determine their nature and extent, and the waters of the MRG are fully appropriated.

#### *4.4.1.2 San Juan-Chama Water Operations*

The SJC Project operations augment the Rio Grande water supplies through transbasin diversion of Colorado River water. SJC Project water must be consumptively used in New Mexico and cannot be used for deliveries under the Compact.

Figure I-28 provides a summary of annual SJC Project diversions, which enter to the Rio Grande system via the Azotea Tunnel, annual inflows of SJC Project water to El Vado Reservoir, and annual amounts of water conveyed at the Otowi gage for consumption in the MRG.

During the 11-year period shown in Figure I-28, an annual average of about 61,550 AF of SJC Project water passed the Otowi gage in response to downstream demand by SJC Project contractor requests and Reclamation Supplemental Water Program releases. The remainder of SJC Project water remained stored in MRG reservoirs, especially El Vado and Abiquiu, as shown in Figure I-29.

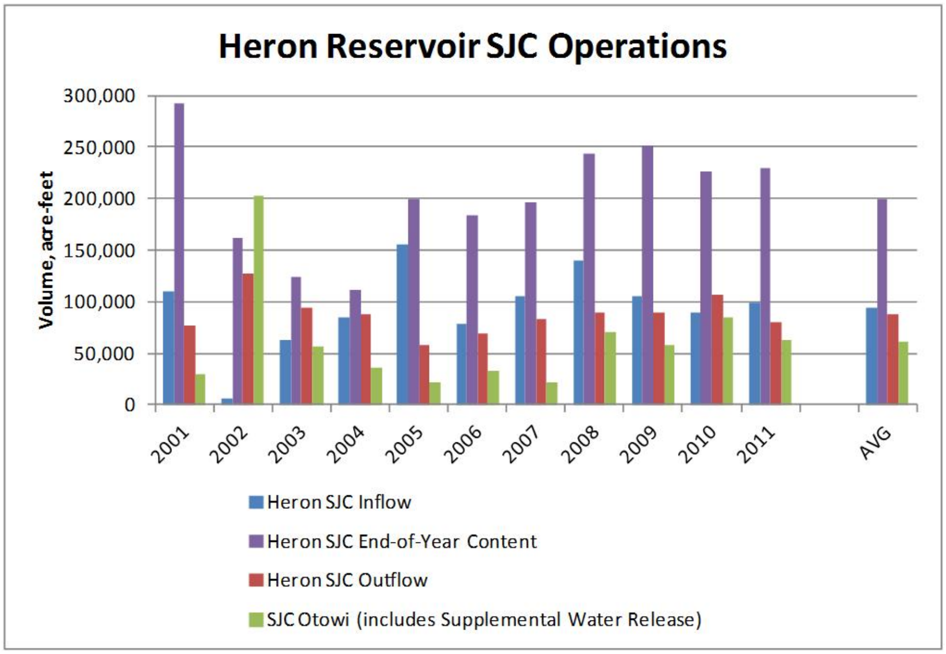



**Figure I-28. Summary of annual Heron Reservoir operations under the SJC Project, including inflows, outflows, and storage of SJC Project water and annual amounts of SJC Project water crossing the Otowi gage for consumption within the MRG**

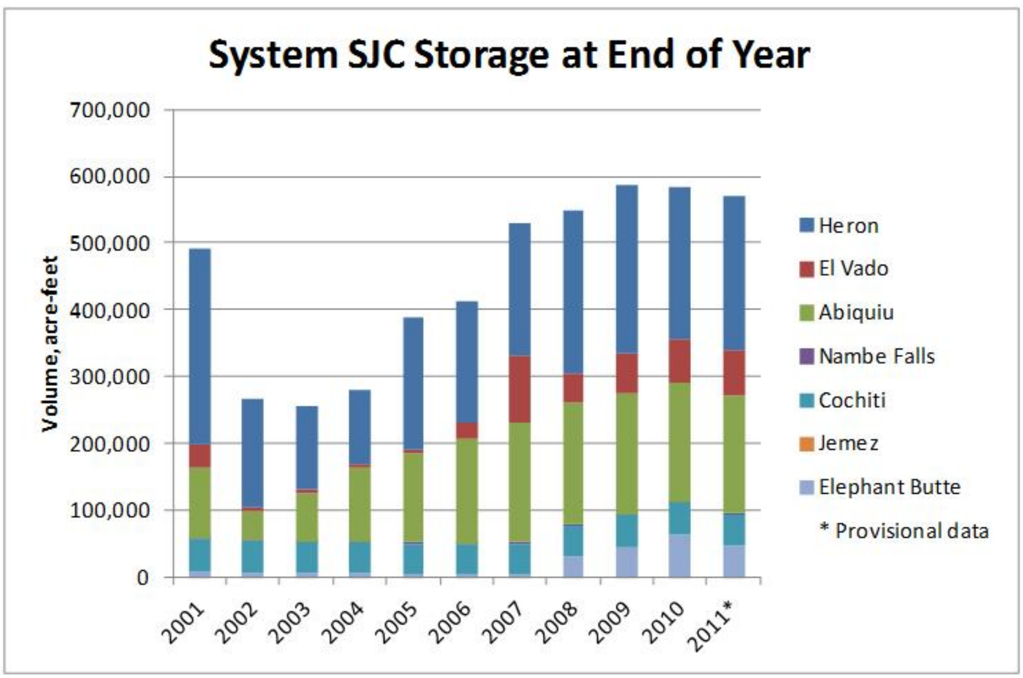



**Figure I-29. Summary of end-of-year storage of SJC Project water in MRG reservoirs**

#### *4.4.1.3 El Vado Storage and Release Operations*

Water storage dams, such as El Vado Dam, are managed to store and release water in a way that alters the spring hydrograph by scalping the peaks off the hydrographs and providing water when natural flows are lower and water needs are higher—times when the natural flows might not otherwise provide sufficient water to meet all the water needs.

Figure I-30 presents a summary of storage and release activities at El Vado Reservoir from 2001–2011 and visually shows the ways that El Vado Dam operations have affected the Rio Chama hydrograph. When Article VII storage restrictions under the Compact (Section 1.3.1) are not in effect, the peak inflows to El Vado Reservoir, shown in blue, tend to be larger than, and occur before, the peak outflows from the reservoir. In the summertime, the outflows from storage tend to exceed the inflows to the reservoir. This outflow from storage may be evident even when Article VII restrictions are in effect, due to releases of water stored earlier, when storage restrictions were not in place. Heron Dam outflows are also shown on Figure I-30. These flows represent SJC Project water, the non-native portion of the flow that passes through El Vado.

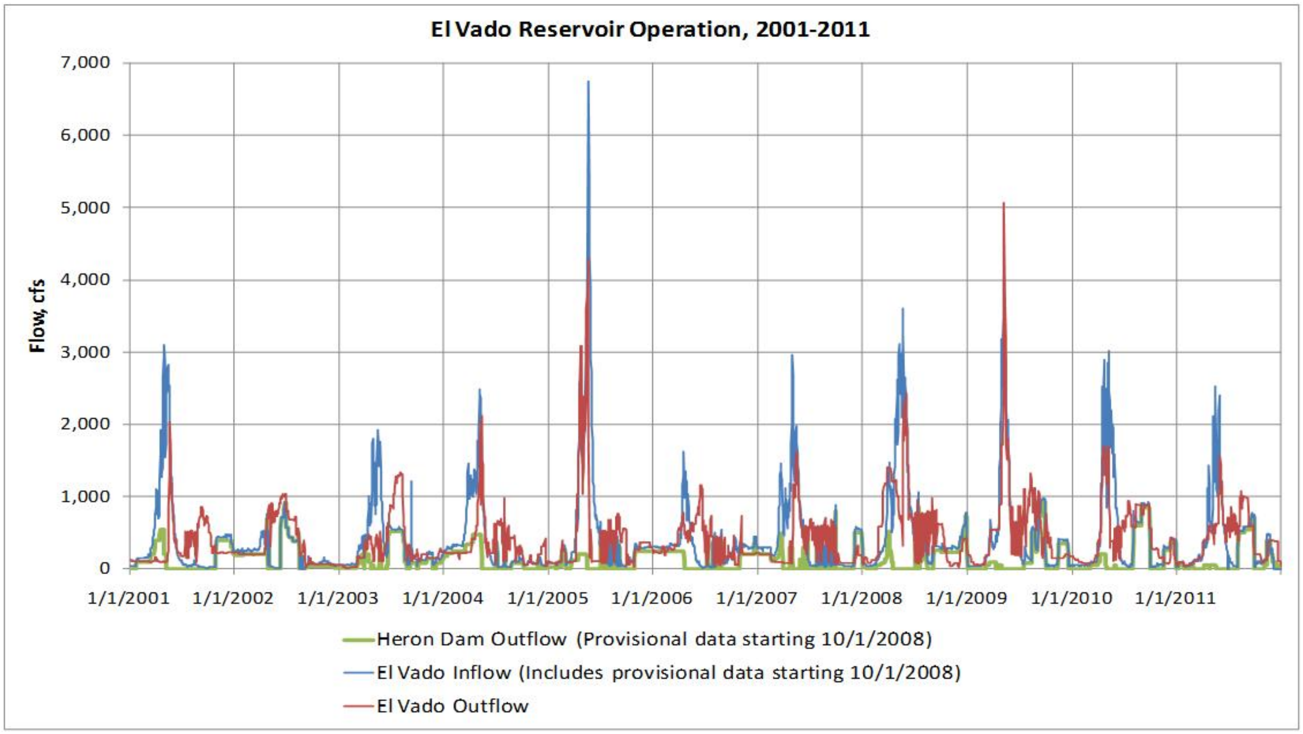



**Figure I-30. Hydrograph depicting El Vado Reservoir operations, 2001–2011, including a comparison of Heron Dam outflow, El Vado Reservoir inflow, and El Vado Dam outflow**

These relationships can be seen more clearly for the annual hydrograph for 2007, an example year with a typically shaped spring hydrograph, shown in Figure I-31. The difference between the Heron Dam outflow (green line) and the El Vado Reservoir inflow (blue line) represents the native inflow from the Rio Chama. The difference between the El Vado Reservoir inflow (blue line) and the El Vado Dam outflow (red line) shows the ways in which the operation of El Vado Dam affected the hydrograph of the Rio Chama.

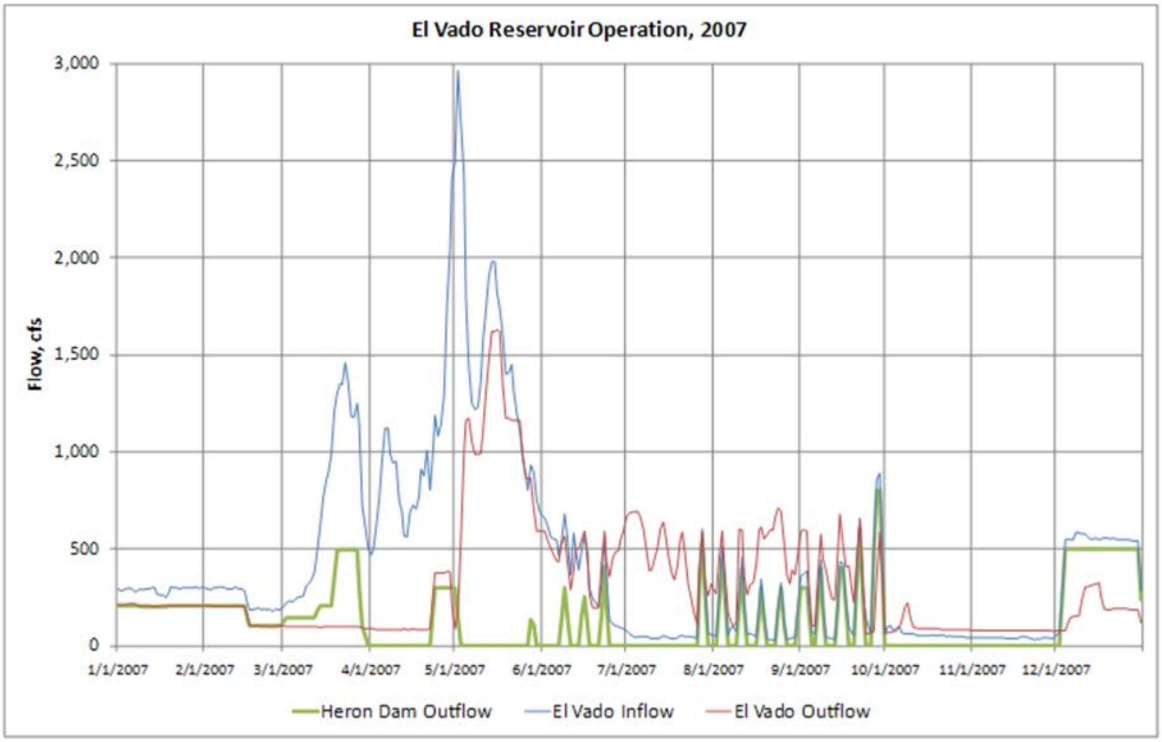



**Figure I-31. Comparison of Heron Dam outflow, El Vado inflow, and El Vado outflow, 2007**

Releases of stored water from El Vado are made at the request of the MRGCD, as needed to meet MRG irrigation demand, or, when the MRGCD is under shortage operations, by the BIA as needed to meet the irrigation demand of the lands of the Six MRG Pueblos with prior and paramount water rights. MRGCD operations are described in more detail in Section 4.4.1.10.

#### *4.4.1.4 Flood Control Operations*

The Corps owns and operates Abiquiu and Cochiti Dams, which are primarily used for flood control. Flood control dams affect flows in the river by storing and releasing water in a manner that decreases flood peaks but does not cause significant changes in the shape of the hydrograph or in the annual total flow volume (Corps et al. 2007). The flood control dams in the MRG system are operated to pass all inflows except those that exceed a designated safe channel capacity downstream from the dam, currently 1,800 cfs below Abiquiu Dam and 7,000 cfs below Cochiti Dam.

Figure I-32 displays the inflow to and outflow from Cochiti Reservoir over the past decade. The general character of each annual hydrograph is similar, indicating that the dam operations do not fundamentally change the character of the hydrograph, except in removing flows that exceed 7,000 cfs, the designated safe channel capacity in the MRG. When inflow exceeds this designated safe channel capacity, releases are cut to below 7,000 cfs, and the duration of the high-flow event is extended until the floodwaters have been released. Such an operation can be seen in 2005 during the snowmelt runoff, but at no other time during the past decade.

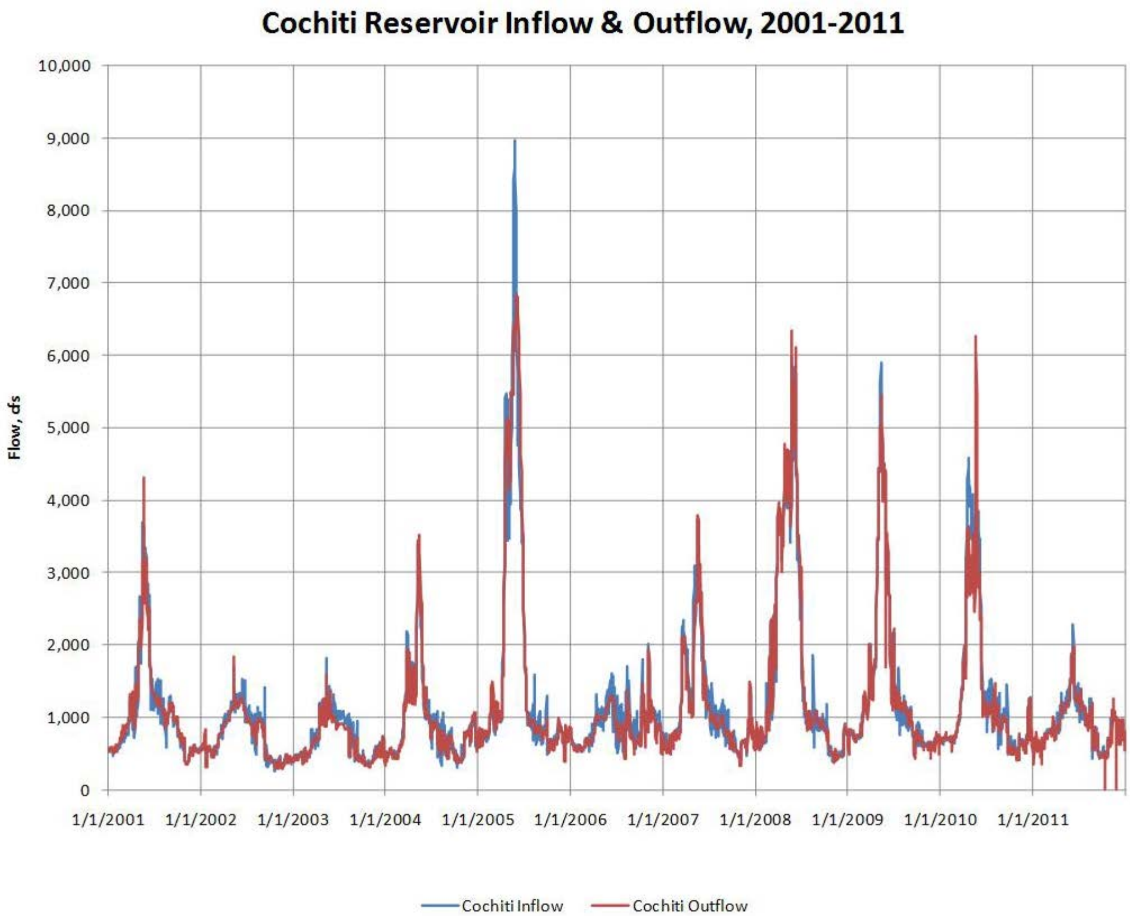



**Figure I-32. Comparison of inflow to and outflow from Cochiti Reservoir, 2001–2011, showing flood control operations in 2005**

Figure I-33 presents a comparison of inflow and outflow hydrographs for Cochiti Reservoir for 2005 only. This comparison provides detail on the changes to the hydrograph caused by the spring 2005 flood control operations.

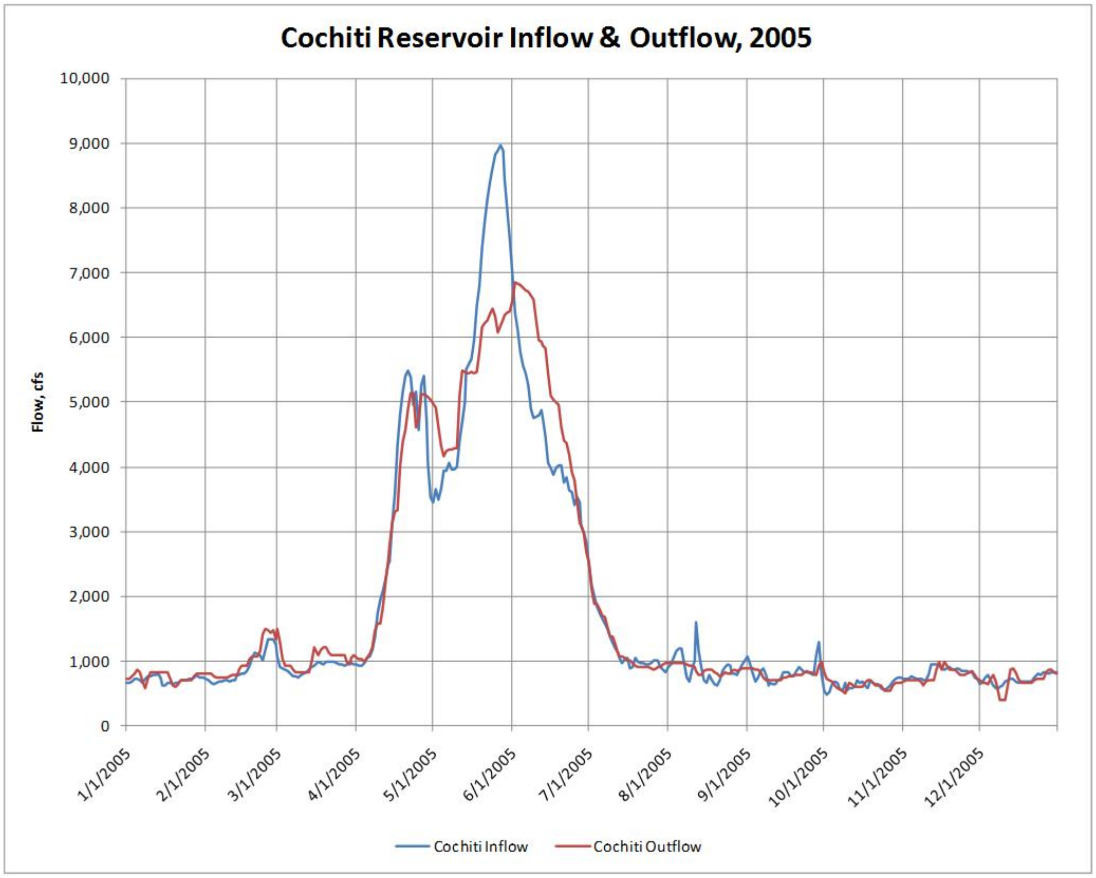



**Figure I-33. Comparison of inflow to and outflow from Cochiti Reservoir, 2005, showing flood control operations**

Figure I-34 shows the inflow to and outflow from Abiquiu Reservoir from 2001–2011. The designated safe channel capacity below Abiquiu Dam is only 1,500–1,800 cfs, due to capacity restrictions in the reach directly below the dam, as well as the presence of numerous rock and brush diversions in the vicinity of Chamita (Corps 1996a). The effects of flood operations are therefore more apparent on the hydrograph, and can be seen in 2001, 2004, 2005, 2008, 2009, and 2010. These flood control operations prevent the flows on the Rio Chama from significantly contributing to overbank or recruitment flows in the MRG.

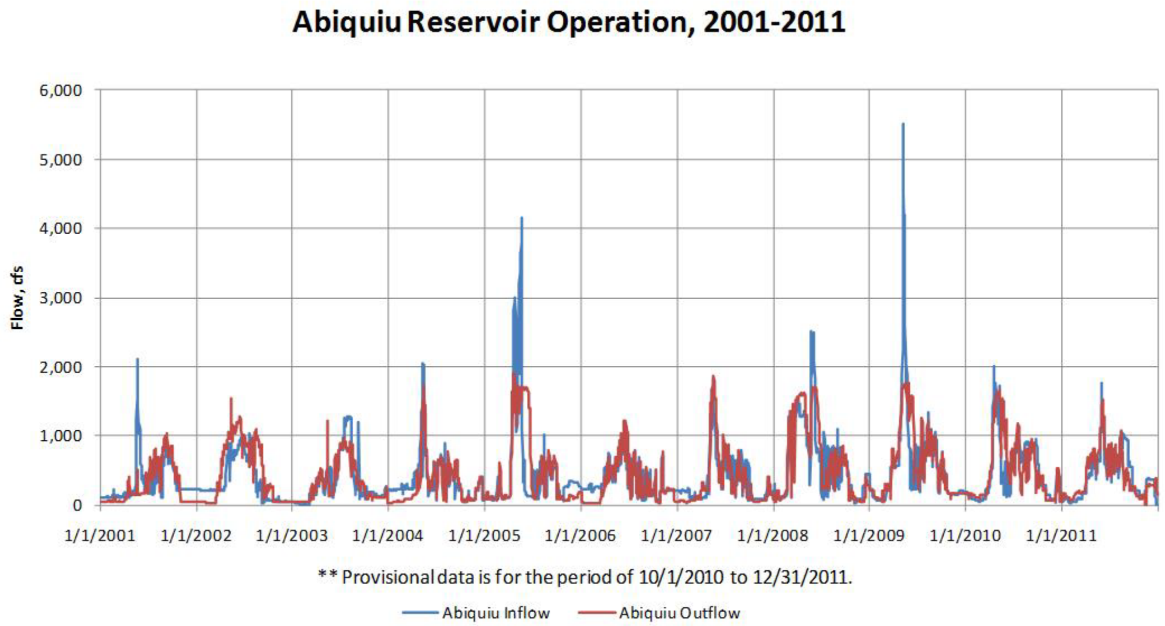



**Figure I-34. Comparison of inflow to and outflow from Abiquiu Reservoir, 2001–2011, showing flood control operations in 2001, 2004, 2005, 2008, 2009, and 2010**

#### *4.4.1.5 Santa Fe's Buckman Direct Diversion*

The City and County of Santa Fe use their SJC Project allotments and native Rio Grande water to support their water supply utilities through the Buckman Direct Diversion Project (Buckman Project). The Santa Fe National Forest, in concert with the City and County of Santa Fe, consulted with the Service (Consultation #22420-2006-F-0045) on the construction and operation of this project. The Service identified reasonable and prudent measures (RPMs) that would minimize the incidental take resulting from this project and determined that this action, along with the proponents' environmental commitments and the Service's RPMs, likely would not jeopardize the continued existence of the silvery minnow and will not adversely modify its designated critical habitat (Service 2007c).

The City and County of Santa Fe have initiated, under the Buckman Project, direct use of their 5,605 AFY allocation of SJC Project and native Rio Grande water to supplement their other water supplies. The partners have been diverting water to the Buckman Project from the Rio Grande since January 2011. Performance and acceptance testing was performed in April 2011, and operation was turned over from the design and construction contractor to the City, as the current project manager, for full operations in May 2011.

The current Record of Decision from the Buckman Project Environmental Impact Statement allows the Buckman Project to divert an annual average diversion of 12.06 cfs, which includes 7.75 cfs of SJC Project water and 4.31 cfs of native Rio Grande water. The Buckman Project's peak day capacity is 28.2 cfs. Additionally, up to 4 cfs of carriage water is diverted and is returned to the river, along with diverted river sediment, immediately downstream from the diversion structure. The Buckman Project is intended to divert water year-round.

Consistent with the terms of the ESA consultation, the Buckman Project will curtail diversions of native water at times when the native Rio Grande flow at Otowi gage is less than 325 cfs and will cut off all diversions of native water if the native Rio Grande flow at Otowi gage is less than 200 cfs. Curtailment when Otowi flows are 200–325 cfs will be scaled by linear interpolation. Under these conditions, the project still can divert its allocation of SJC Project water. When Abiquiu Reservoir is under flood operations, the Buckman Project will not call for release of its SJC water from upstream reservoirs and instead use either native Rio Grande water or exchange and divert SJC water stored in Elephant Butte. Additional environmental commitments associated with the construction and operation of this project, which include restoration, maintenance, and monitoring of riparian and riverine habitat, are spelled out in the Record of Decision for the project, found at http://www/bddproject.org/reports.htm.

#### *4.4.1.6 Cochiti Deviations*

In 2007, the Rio Grande Compact Commission approved deviations from the Corps' normal reservoir operation schedule (as specified in its Water Control Manual) to support minnow spawning and recruitment. Such deviations from normal operations were implemented in 2007 and 2010, in coordination with the Service and federal and non-federal water management agencies. Such deviations from normal operations of Cochiti Dam to support overbank or recruitment flows have been approved by the Corps, and therefore may be implemented as deemed appropriate through 2011, with the option of a 2-year extension to 2013. The Corps has completed consultation with the Service under section 7 of the ESA for Cochiti deviations and is operating pursuant to its biological opinion.

During a "Cochiti deviation," waters on the ascending limb of the spring runoff hydrograph are held back and temporarily stored in Cochiti Lake in an amount sufficient to allow the desired discharge volume and duration during peak flows when these waters are released. In this way, the Corps is authorized to temporarily store up to 10,000 AF of water in Cochiti Reservoir.

A deviation was implemented in 2007 to create a minnow spawning and recruitment flow of over 3,000 cfs, as measured at the Central Avenue (Albuquerque) gage, for a period of 7–10 days. The deviation operations produced an extended peak runoff flow resulting in 26 days above 2,500 cfs and 10 days above 3,000 cfs at Albuquerque. In 2010, a deviation was implemented to achieve an overbank flow of 5,800 cfs at the Central Avenue gage for 5 days. However, only a 2-day overbank flow of this magnitude was achieved. Annual hydrographs displaying the effects of the 2007 and 2010 Cochiti deviations are presented in Figures I-35 and I-36.

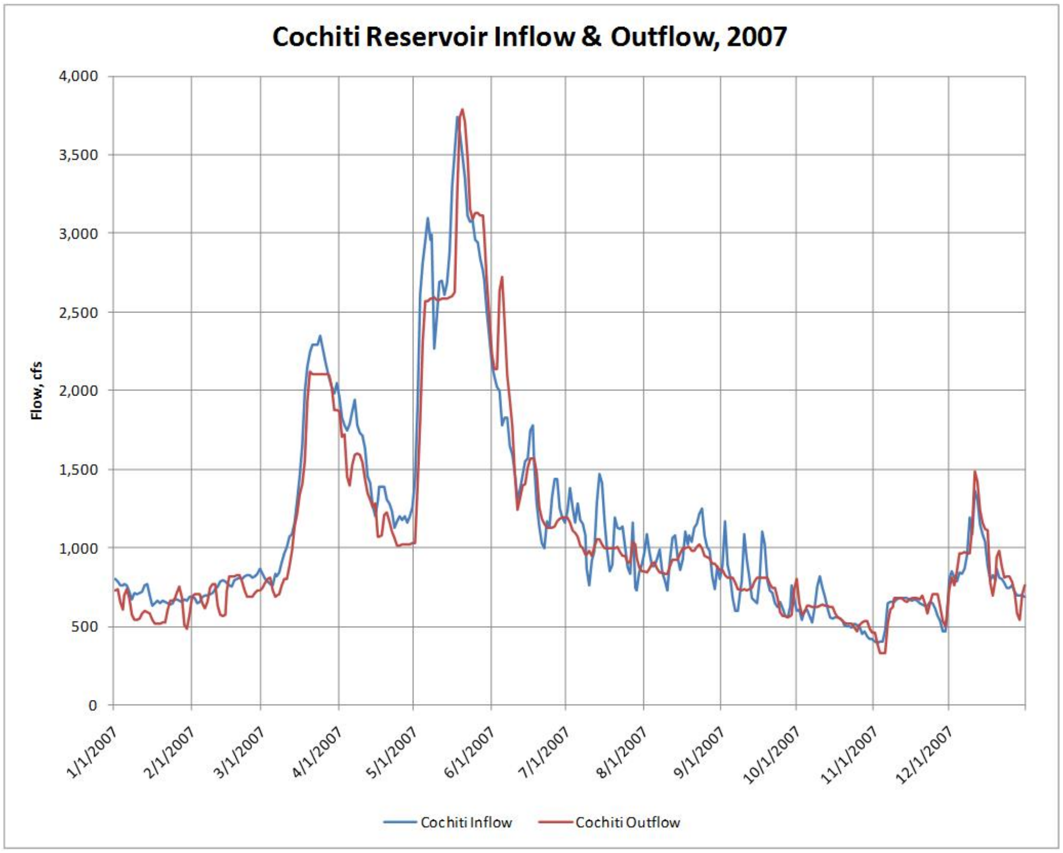



**Figure I-35. Comparison of inflow to and outflow from Cochiti Reservoir, 2007, showing the effects of "Cochiti deviation" operations**

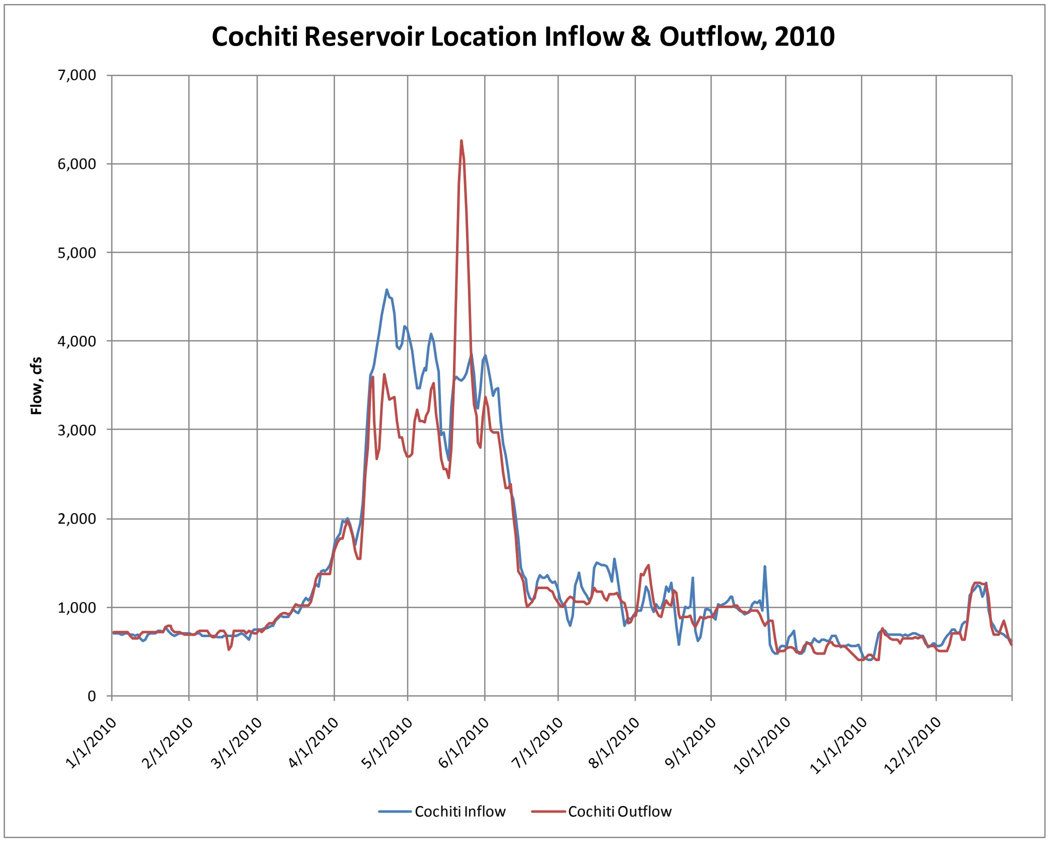



**Figure I-36. Comparison of inflow to and outflow from Cochiti Reservoir, 2010, showing the effects of "Cochiti deviation" operations**

### *4.4.1.7 Groundwater*

Since the 1940s, population growth, combined with technological improvements in well drilling and pumping, have led to dramatic increases in groundwater pumping in the MRG, primarily for domestic, municipal, and industrial use (McAda and Barroll 2002). As of 1999, it was estimated (Bartolini and Cole 2002, after MRG Water Assembly, 1999) that 170,000 AFY are pumped from the river-connected aquifer in the MRG, up to 110,000 AFY of which were pumped by the ABCWUA for use in Albuquerque and Bernalillo County (ABCWUA 2010), although ABCWUA has now cut back that pumping to near half that amount, as it phases in use of its SJC Project water. This pumping has caused groundwater drawdowns of up to 160 feet in some areas of Albuquerque (McAda and Barroll 2002). Ultimately, the water pumped is made up for by seepage from the river into the groundwater system. Recharge from the river to the aquifer through the MRG was estimated in 1999 to total 295,000 AFY.

The NMOSE has calculated the depletions caused to the river by groundwater pumping, and requires that the entities who do the pumping replace the water volume to the system, including the river and other affected users, through return flows, the purchase of water rights, or repayment of the water from upstream storage using SJC Project water.

The NMOSE provides Reclamation with letters describing, for each pumper, the time period of depletions from the river, the volume of water depleted from the river, and a deadline for the pumpers to release SJC Project water to replace the water that was lost from the river and was not offset through the purchase of water rights or through return flows to the river. The depletions are described by the NMOSE as cumulative effects on Elephant Butte Reservoir (and therefore to New Mexico's deliveries under the Compact) due to depletions above and/or below the Otowi gage and cumulative effects on the Rio Grande in the MRG above and/or below the Otowi gage. Depletions that occur during the irrigation season are considered effects on the MRG and are replenished by releases to the MRGCD, which has the right to divert that flow. Depletions that occur outside of the irrigation season are considered effects on Elephant Butte Reservoir and are replenished to the Rio Grande.

The replacement SJC Project water requested by the NMOSE is released from reservoirs on the Rio Chama. If the depletion is deemed to have affected the MRGCD, the MRGCD can request to have the water stored or released to the Rio Grande for use in irrigation. If the depletion is deemed to have affected Elephant Butte Reservoir, the water is released to the Rio Grande to be delivered to Elephant Butte Reservoir. Reclamation has received letters from the NMOSE requesting releases to replace water depleted over the current year, previous year, and sometimes 3 previous years. The depletions occur gradually and are replaced by an equivalent volume over a short period, typically 1–10 days. These short duration replacements typically occur months to years after the depletion. Total volumes of the depletions made up through "letter-water" deliveries of SJC Project water over the 2001–2010 period ranged from 1,000–7,000 AFY. At the end of 2010, the State Engineer requested releases for the following contractors to offset 2009 depletions: 93 AF for the City of Española, 161 AF for the Village of Los Lunas, 13 AF for the Town of Taos, 6 AF for the Village of Taos Ski Valley, 47 AF for the City of Belen, and 2,024 AF for the ABCWUA.

#### *4.4.1.8 Water Right Transfers*

The NMOSE has jurisdiction over water rights administration in New Mexico, and water rights are alienable private property rights that can be conveyed like other property rights. The majority of water rights sold in the MRG have been purchased by large corporate entities, such as developers or the Cities of Rio Rancho and Albuquerque. Other purchasers include some primary income farmers who purchase water rights or additional agricultural land to expand operations, as well as private entities involved in water intensive activities, such as residential developers, utilities, and technology. The transfer of land and water from agricultural to urban uses in the MRG was modeled by Sandia National Laboratory in November 2004 (Sandia National Laboratory 2004). Analyzing trends in water rights transfers is difficult because data are not readily available, accurate, or up to date (Sandia National Laboratory 2004).

The aquifer in the MRG, consisting of Santa Fe Group and younger alluvial deposits, is known to be hydrologically connected to the Rio Grande surface water system. Because groundwater diversions from aquifers hydrologically connected to the Rio Grande affect the fully appropriated surface flow, the NMOSE conjunctively manages the water resources within the MRG Basin. On September 13, 2000, the NMOSE established guidelines for the Middle Rio Grande Administrative Area (MRGAA) (NMOSE 2000) to ensure compliance with the Compact, to prevent impairment to existing rights, to limit the rate of decline of groundwater levels so that the life of the aquifer is extended, and to minimize land subsidence.

The guidelines embody NMOSE's existing practice for evaluating applications for permits for groundwater use in the MRGAA and recognize that offsetting the effects of groundwater diversions is critical to the conjunctive management of water resources within the MRG stream system. Accordingly, the guidelines provide that permitted groundwater diversions shall be limited to the amount of valid consumptive use surface water rights held and designated for offset purposes by the permittee plus any NMOSE-approved flow returned directly to the Rio Grande. As mentioned above, the use of offsets or return flows replaced the depleted surface water in volume but does not restore the timing of flows in the river.

#### *4.4.1.9 Water Management to Meet the Needs of the Six Middle Rio Grande Pueblos*

The Six MRG Pueblos (Cochiti, Santo Domingo, San Felipe, Santa Ana, Sandia, and Isleta) hold aboriginal, time immemorial, reserved, and in some instances, contract water rights that are recognized and protected under federal law. A certain portion of their water rights is statutorily recognized under the 1928 Act and the Act of 1935, 49 Stat. 887 (1935 Act). Water rights have been statutorily recognized for 20,242.25 acres, consisting of 8,847 acres of prior and paramount lands, 11,074.4 acres of newly reclaimed lands, and 320.65 acres of lands purchased by the United States pursuant to the Pueblo Lands Act of 1924 (43 Stat. 636). The 1928 Act also recognizes a prior and paramount right to water for domestic and stock purposes. These Acts of Congress do not establish the full extent of the water to which these Pueblos are entitled, and references to the Pueblos' "prior and paramount" rights under these Acts are not intended to limit or suggest that the Pueblos do not have other water rights in the MRG or tributaries that are senior to other water uses in the system.

Reclamation engages in water operations to serve the water rights of the Six MRG Pueblos recognized by the 1928 Act and the 1935 Act. Each year over the past three decades, Reclamation has stored water in El Vado Reservoir to ensure an adequate supply of prior and paramount water for the Six MRG Pueblos pursuant to the 1981 Agreement. The BIA Designated Engineer and Reclamation have calculated the quantity of water to be stored at El Vado Reservoir for prior and paramount irrigation needs, based on the gap between the forecasted demand for the 8,847 acres of lands and the anticipated available supply of the river. The Coalition of the Six MRG Pueblos has then directed the Designated Engineer to request that

Reclamation release the stored water according to the schedule provided by the Pueblos. This stored water has been, or is intended to be, delivered to the Pueblos by the MRGCD through downstream diversions.

A summary of the water stored for the prior and paramount rights and released annually since 2002 is provided on Figure I-37. During a number of the years in the past decade, water was stored for prior and paramount uses during years with Article VII storage restrictions in place under the Rio Grande Compact. Remaining prior and paramount water in El Vado that was stored when Rio Grande Compact Article VII restrictions were in place was released for delivery to Elephant Butte Reservoir after the irrigation season, usually in November or December. This water is shown as released to Elephant Butte Reservoir in Figure I-37. Unused prior and paramount water stored in El Vado outside of Article VII storage restrictions was retagged as native Rio Grande water, and is shown in Figure I-37 as being released to the Rio Grande account. Water shown as released to the MRGCD is water released for irrigation beyond the requirements of the prior and paramount rights.

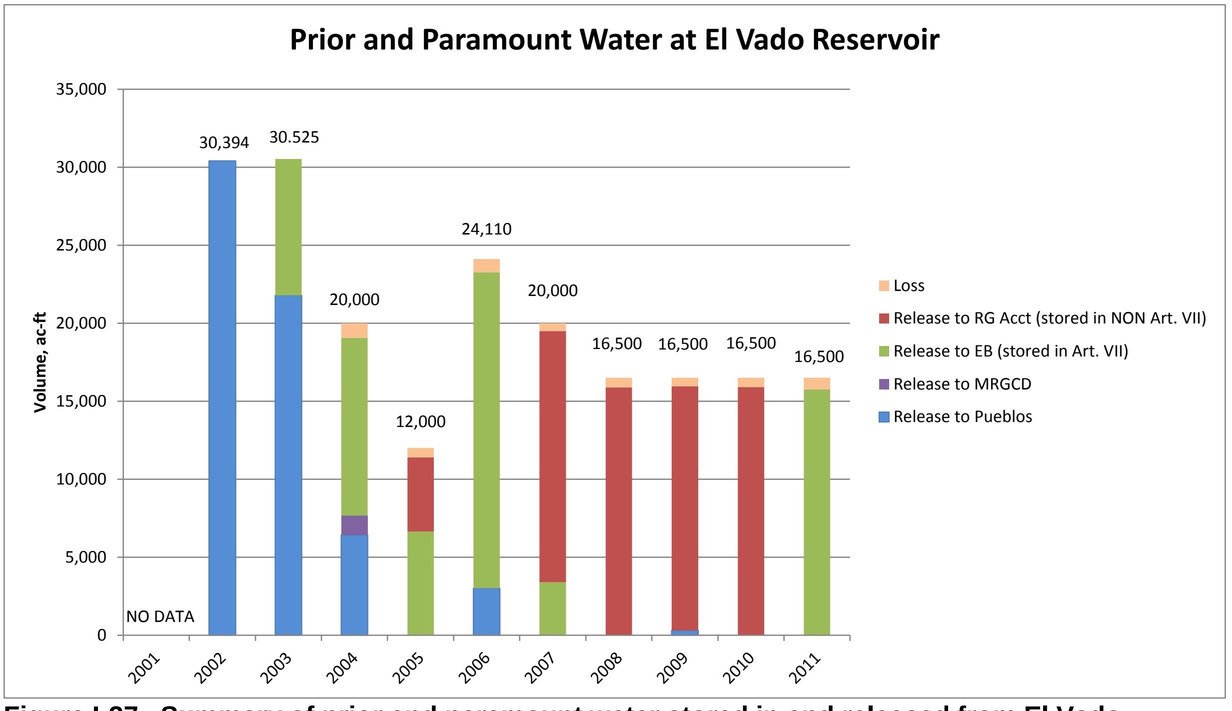



**Figure I-37. Summary of prior and paramount water stored in and released from El Vado Reservoir for irrigation of lands**

### *4.4.1.10 MRGCD Operations*

Early in the decade, an extensive effort was undertaken by the NMISC, the New Mexico Water Trust Board, Reclamation, and the MRGCD to increase the MRGCD's water management efficiency and decrease the MRGCD's irrigation diversions, especially during water-short periods. Progress was made through infrastructure and metering improvements and through improvements in irrigation-system operations, such as the implementation of rotational water delivery and the development of a Decision Support System to model demand within the network and develop efficient water delivery schedules. Figure I-38 shows the effects of these improvements. Total MRGCD diversions during the 1990s were approximately 600,000 AF; after 2001, typical total MRGCD diversions ranged from 300,000 to 400,000 AF.

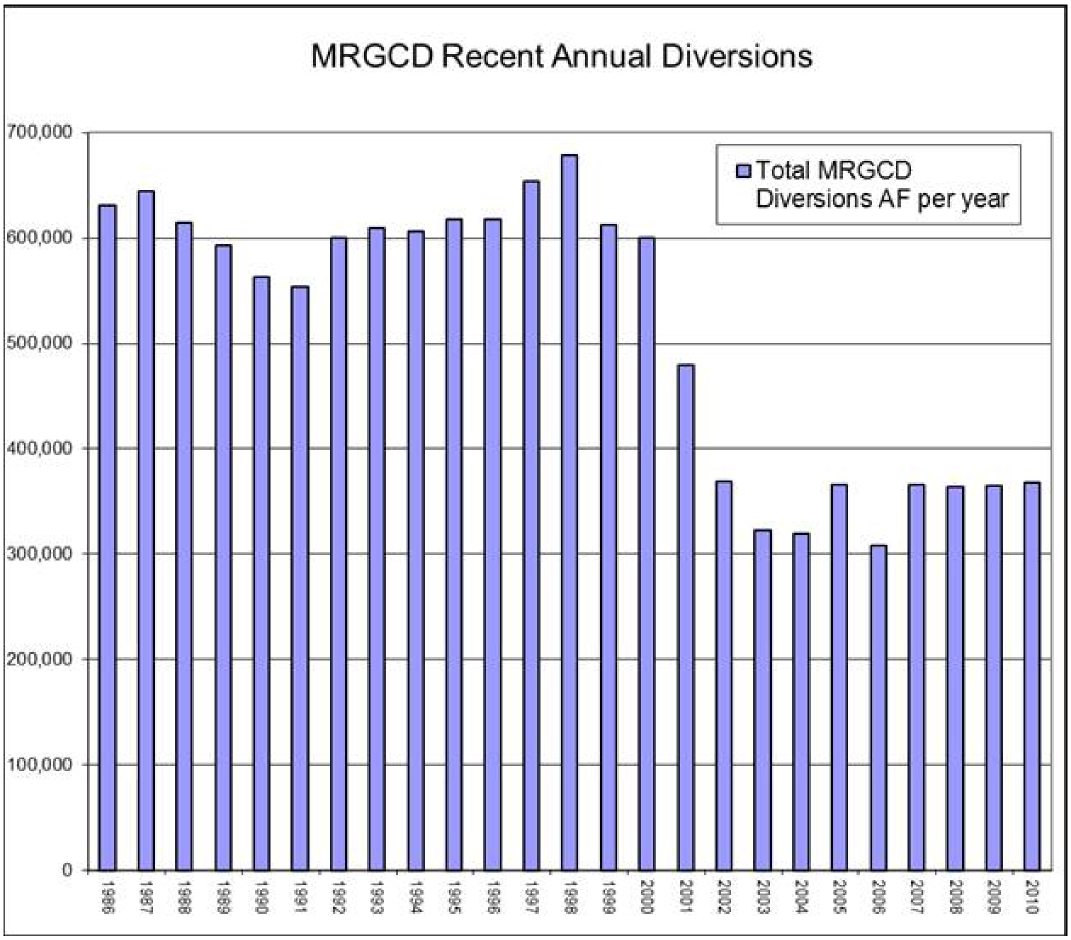



**Figure I-38. Summary of total water diversions by the MRGCD, 1996–2010. Diversions since 2010 are similar to 2007-2010.**

These operational improvements have the effect of leaving more water in the river during periods of high native flow on the main stem. They also have the effect of extending the irrigation season during dry years by extending the availability of stored water in El Vado Reservoir. During dry times, water released from El Vado Reservoir for MRG irrigation supports river flows throughout the MRG, especially in the Albuquerque Reach. Therefore, extending the length of the irrigation season measurably decreases the Supplemental Water required to meet MRG ESA flow targets.

Figure I-39 breaks down the diversions by MRGCD division. This breakdown shows that the largest diversions occur at the Isleta diversion structure for the Isleta division of the MRGCD. These diversions at Isleta also support the San Acacia division, which receives the tailwater from the Isleta division.

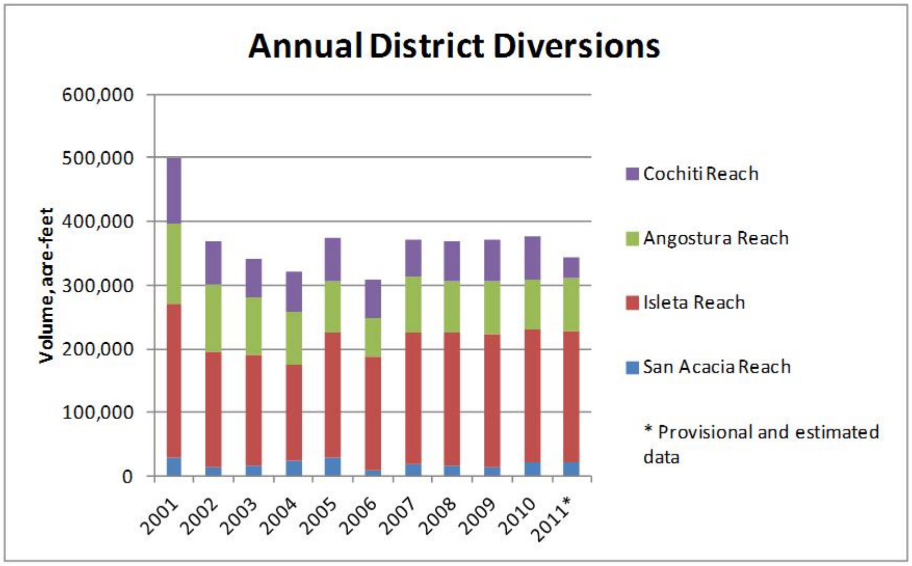



**Figure I-39. Summary of annual diversions from the Rio Grande to the MRGCD at the four MRG diversion structures. Data since 2011 are consistent with trends shown here.**

These diversions are made primarily during the summer months. The monthly average of diversions over the past decade is shown on Figure I-40.

MRGCD return flows are also an important part of the irrigation system and river operations. District management of return flows provides regularly wetted conditions downstream from the outlets of wasteways. MRGCD return flows can strategically release water to key reaches during low-flow or drying periods in the Albuquerque or Isleta Reaches (the return flows in the San Acacia Reach return to the LFCC rather than to the river).

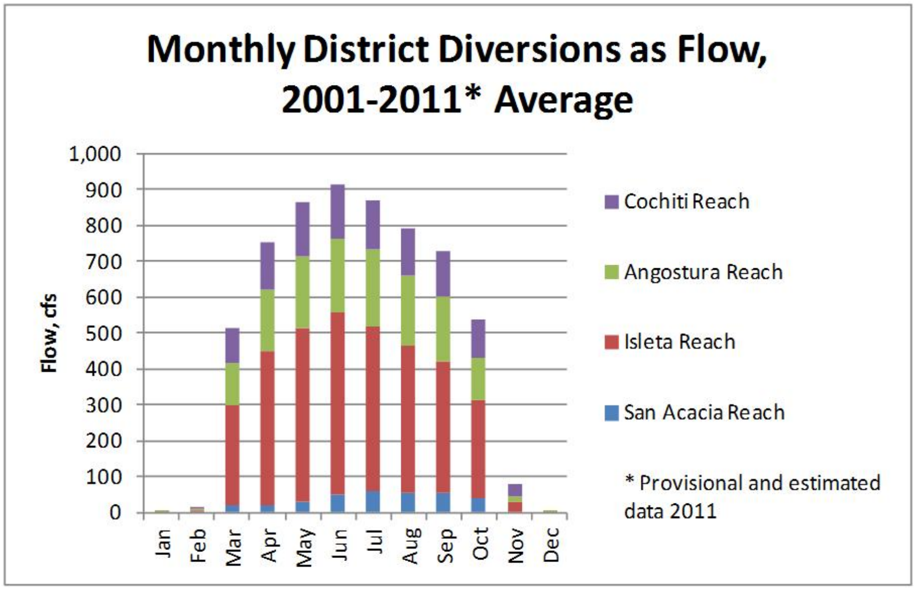



**Figure I-40. Monthly breakdown of average annual diversions to the MRGCD at the four MRG diversion structures, 2001–2011**

Figures I-41 and I-42 show the monthly average return flows from wasteways in the Albuquerque and Isleta Reaches, which enter the river from the left side (left descending bank, which is the right side as you look at a map with north at the top) or the right side (right descending bank, which is the left side as you look at a map with north at the top). It can be seen on these figures that some wasteways release water from drains, which collect groundwater that is used both to supplement irrigation supplies and to return water to the river. These wasteways have higher discharge rates in the winter and lower discharge rates in the summer. Other wasteways discharge water from canals that collect tailwater from irrigation. Returns from these wasteways are lower in the winter and higher during the irrigation season.

The first graphs in each set present average wasteway and drain returns for the baseline period without 2003. The later graphs in each set present 2003 alone. 2003 stands out as the year during which the MRGCD most fully applied rotational water delivery to the laterals within its system. The difference between the graphs showing 2003 releases and those showing average releases during the other years highlights the tradeoffs between MRGCD operational efficiency, as is apparent in 2003, and the incidental benefits provided by less efficient system operation, including wasteway returns that support flows in critical reaches.

**Legend for Figures I-41 and I-42**

| | | | | |
|---|---|---|---|---|
| 240WW | 340 Feeder Wasteway | | LP1DR | Lower Peralta Drain Outfall #1 |
| ALJWW | Alejandro Wasteway | | LP2DR | Lower Peralta Drain Outfall #2 |
| ARSDR | Albuquerque Drain Outfall | | LSJDR | Lower San Juan Drain Outfall |
| ATRDR | Atrisco Drain Outfall | | PERWW | Peralta Wasteway |
| BELDR | Belen Drain Outfall | | SABDR | Sabinal Drain Outfall |
| CENWW | Central Avenue Wasteway | | SANWW | Sandia Lakes Wasteway |
| CORWW | Corrales Wasteway | | SFRDR | San Francisco Drain Outfall |
| FD3WW | Feeder 3 Wasteway | | SILWW | Sile Main Wasteway |
| HAYWW | Haynes Wasteway | | STYWW | Storey Wasteway |
| LCRDR | Lower Corrales Drain Outfall | | UCRDR | Upper Corrales Drain Outfall |
| LJYDR | La Joya Drain Outfall | | UN7WW | Unit 7 Wasteway |

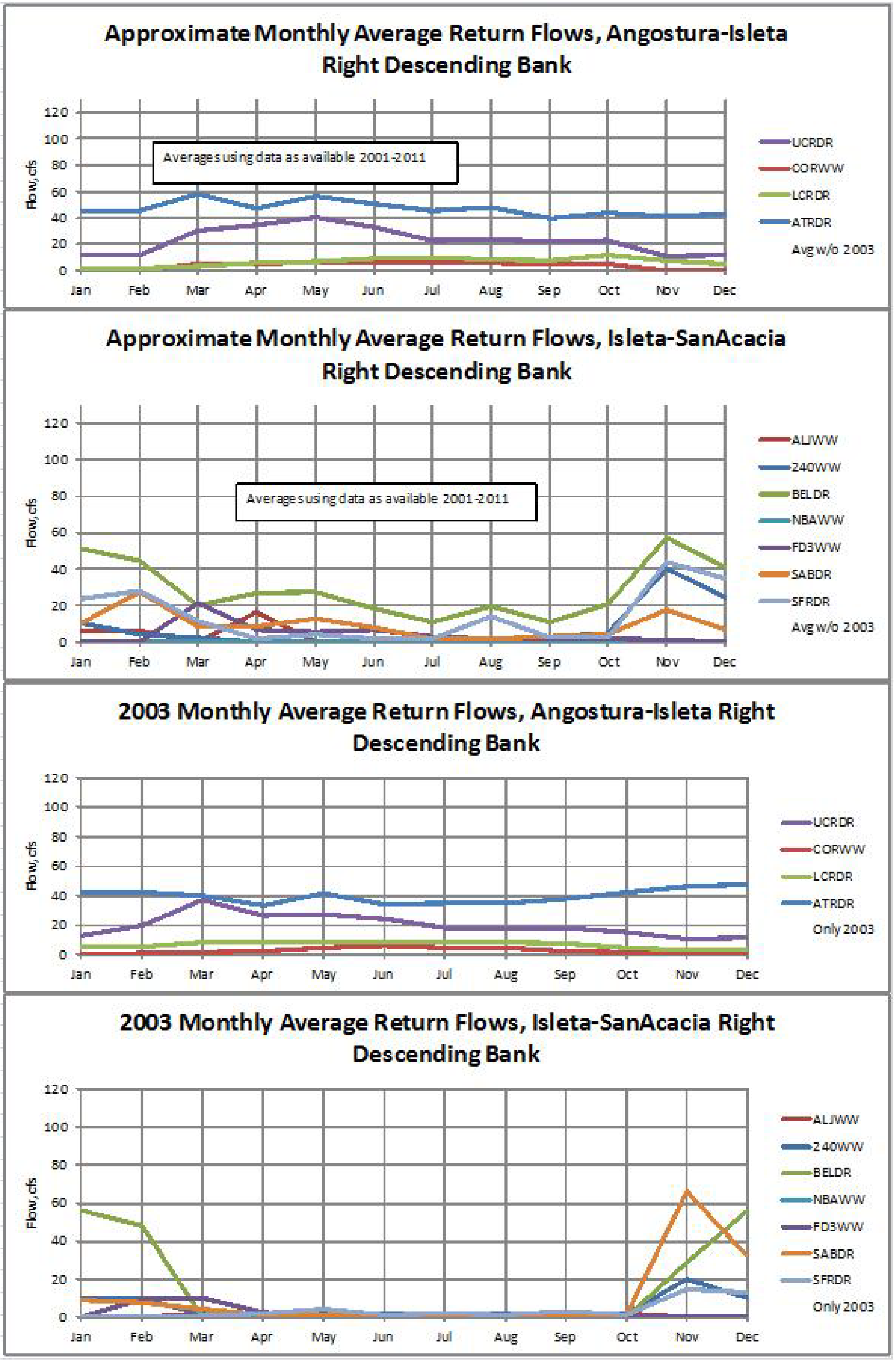



**Figure I-41. Summary of average district drain and tailwater returns to the Rio Grande, by month, 2001–2011, right descending bank**

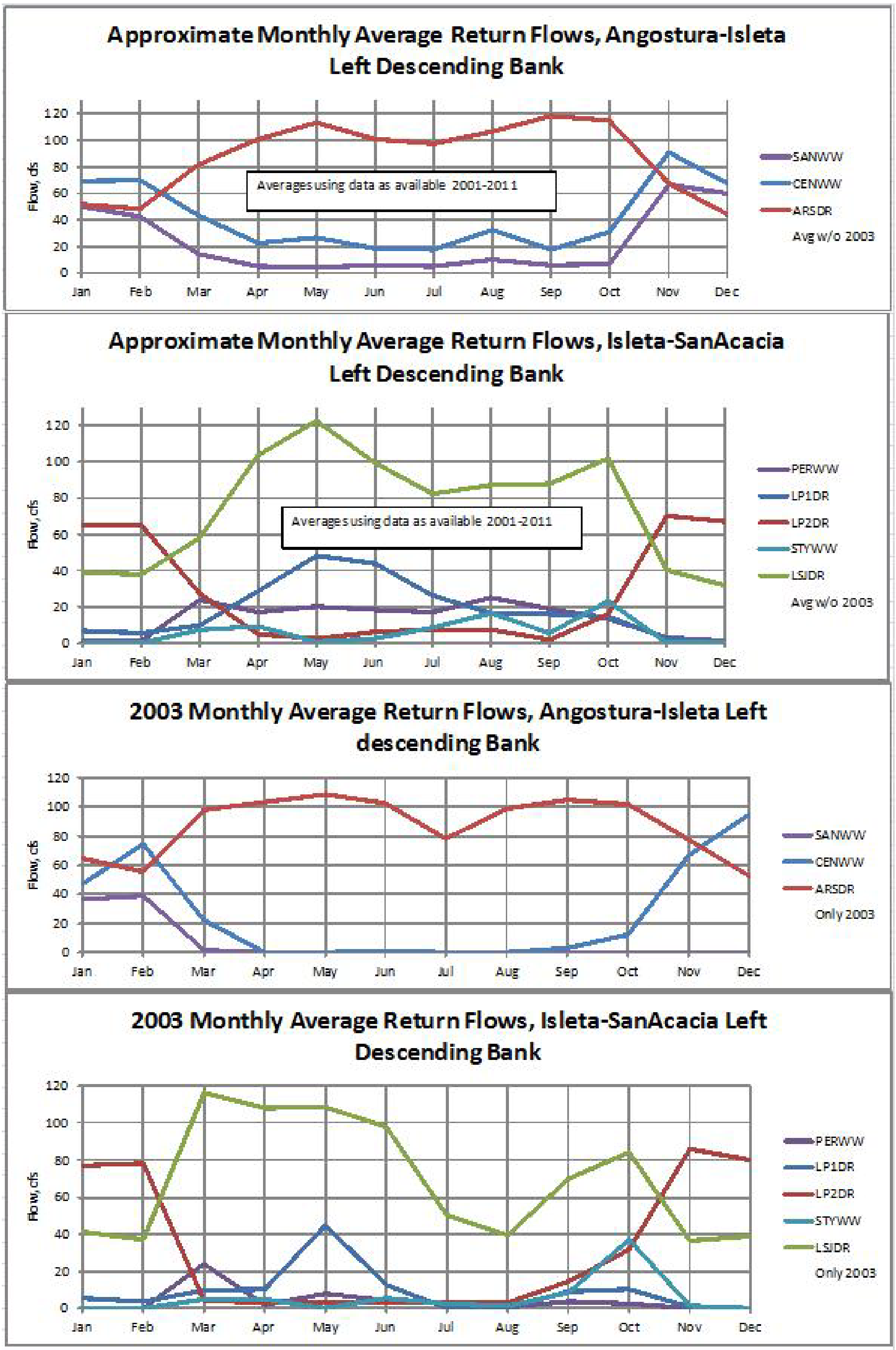



**Figure I-42. Summary of average district drain and tailwater returns to the Rio Grande, by month, 2001–2011, left descending bank**

#### *4.4.1.11 Albuquerque Bernalillo County Water Utility Authority Drinking Water Project*

The ABCWUA's primary use of SJC Project water is to support its Drinking Water Project in Albuquerque. After taking delivery of its SJC Project water from Heron Reservoir, the ABCWUA manages the majority (approximately 94%) of the 180,000 AF that can be stored at Abiquiu Reservoir for this water.

In 2004, Reclamation, in concert with ABCWUA, consulted with the Service under ESA, section 7, on this project (Consultation #2-22-03-F-0146). The Service determined that this action, along with the proponent's environmental commitments and the RPM associated with the consultation, likely would not jeopardize the continued existence of the silvery minnow and would not adversely modify its designated critical habitat (Service 2004a).

Until 2008, the City of Albuquerque's and Bernalillo County's potable water supplies were provided exclusively from groundwater, which was pumped from the alluvial and colluvial aquifer filling the Albuquerque basin. The impact on the river of this extensive groundwater pumping has been made up to the MRGCD and to New Mexico's delivery of water to Elephant Butte under the Compact through annual "letter-water" releases from Albuquerque's allotment of SJC Project water, as described generally above. Furthermore, the groundwater pumping that is foreseen as a component of ABCWUA's Drinking Water Project is covered under the consultation for the Drinking Water Project described above.

The now-combined municipal supplier, ABCWUA, recently has initiated use of its allocation of SJC Project water for urban uses and drinking water supply through implementation of its Drinking Water Project. Over the past 4 years, ABCWUA has been phasing in the diversion of surface water for municipal supply and the diversion of nonpotable water from a collection gallery beneath the river. The intent is for ABCWUA to conjunctively use groundwater and surface water for its future municipal supply, and for its SJC Project allocation to make up the majority of the consumed water, which is typically about half of the total amount of water pumped or diverted. Figure I-43 shows the total drinking water supply to the city and county, the total nonpotable supply over the past 10 years, and its distribution between groundwater and surface water. It can be seen on this figure that the total potable water supply to the city is typically between 100,000 and 110,000 AFY. The figure further shows that use of the SJC Project water as a portion of that supply began at a testing level in 2008 and increased to over 40,000 AFY by 2010. Diversion of SJC Project water to the nonpotable water system began in 2003 and continued through the decade at up to 2,500 AFY.

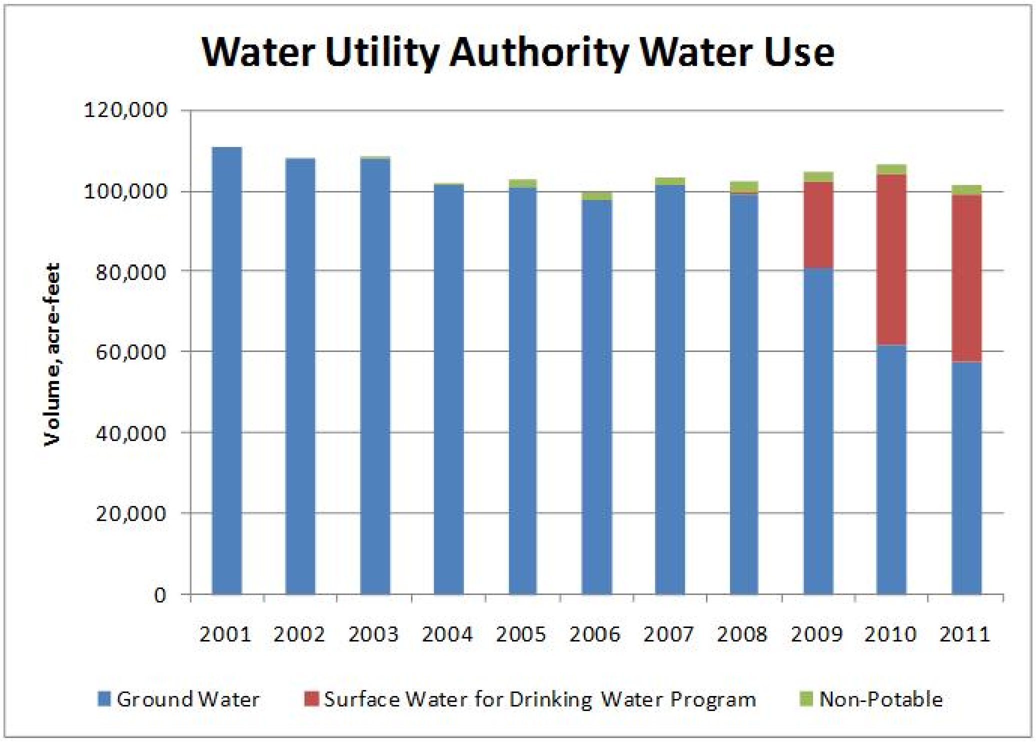



**Figure I-43. Gross municipal supply, including groundwater and surface water contributions to the drinking water supply and nonpotable supply, to ABCWUA, 2001–2011**

Since the ABCWUA began diverting its SJC Project allotment from the Rio Grande, release of this SJC Project water from upstream storage has supplemented river flows on the Rio Chama and the Rio Grande from the Rio Chama confluence downstream to the ABCWUA's diversion structure between the Alameda Boulevard and Paseo del Norte crossings in Albuquerque. The City's diversion includes its SJC Project water allotment plus an approximately equal amount of native water, which is returned to the river downstream, at the outflow from the Albuquerque WWTP. The total amount of water returned to the river at the Albuquerque WWTP outfall, 16 river miles downstream, is summarized on Figure I-44.

ABCWUA's diversion of native water along with its SJC Project water decreases flows in the 16-mile reach from the diversion downstream to the WWTP return flow. This reach includes the Albuquerque/Central Avenue gage, a key flow target location in the 2003 BO; therefore, operation of the drinking water project was deemed to have the potential to affect how flow targets were met at this gage. For this reason, ABCWUA committed, through its ESA consultation, to curtail its diversions when native flows in the Rio Grande at the point of diversion drop below 195 cfs, and suspend diversions completely when these flows drop below 130 cfs, or when the flow at the Albuquerque gage (Central Avenue) drops below 122 cfs.

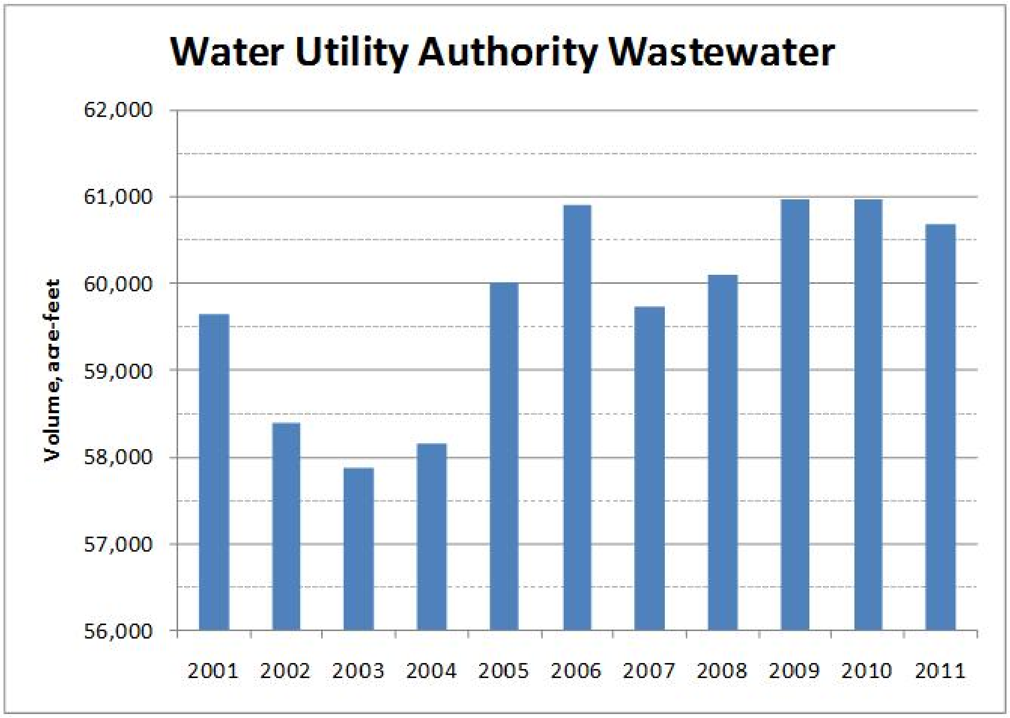



**Figure I-44. Summary of return flows from the Albuquerque WWTP, 2001–2011**

ABCWUA also curtails its diversions during high flows, when the turbidity gets high. As previously noted, the use of Albuquerque's supply of SJC Project water for urban uses and drinking water decreases the supply of water available to Reclamation for its Supplemental Water Program.

ABCWUA's obligation to make up for the effects on the river of past groundwater pumping continues, even if the majority of the current demand is met with surface water. For this reason, ABCWUA must continue to provide a portion of its SJC Project allotment, or native water for which it has rights, to the river for use by the MRGCD or for delivery to Elephant Butte under the Compact.

#### *4.4.1.12 Bosque del Apache National Wildlife Refuge Operations*

The Service manages BDA and is operating pursuant to a completed internal ESA consultation (Service 2001a). The Service possesses 12,417 AFY of senior surface water rights to support its irrigation and wildlife (mainly bird) management activities in the lower portion of the San Acacia Reach. A portion of this water is obtained during the irrigation season from tailwater from the MRGCD irrigation network. The majority of BDA's supply is from direct diversions from the LFCC at the north boundary of the refuge and at a second point in the middle of the refuge. These diversions can decrease the availability of water to Reclamation's LFCC pumping program, which was required under the 2003 BO.

Water use for irrigation occurs mainly during the summer months. Irrigation on the refuge uses water from both MRGCD tailwater and LFCC diversions. The refuge differs from most other water users in the MRG Valley in that a significant portion of its diversions occurs in the winter from the LFCC to support ponded habitat.

Figure I-45 summarizes the water consumption of the BDA, broken down by year and by season. The refuge also passes substantial amounts of water through its water distribution network that is returned at the southern boundary of the refuge. This water is not portrayed in these consumption tallies.

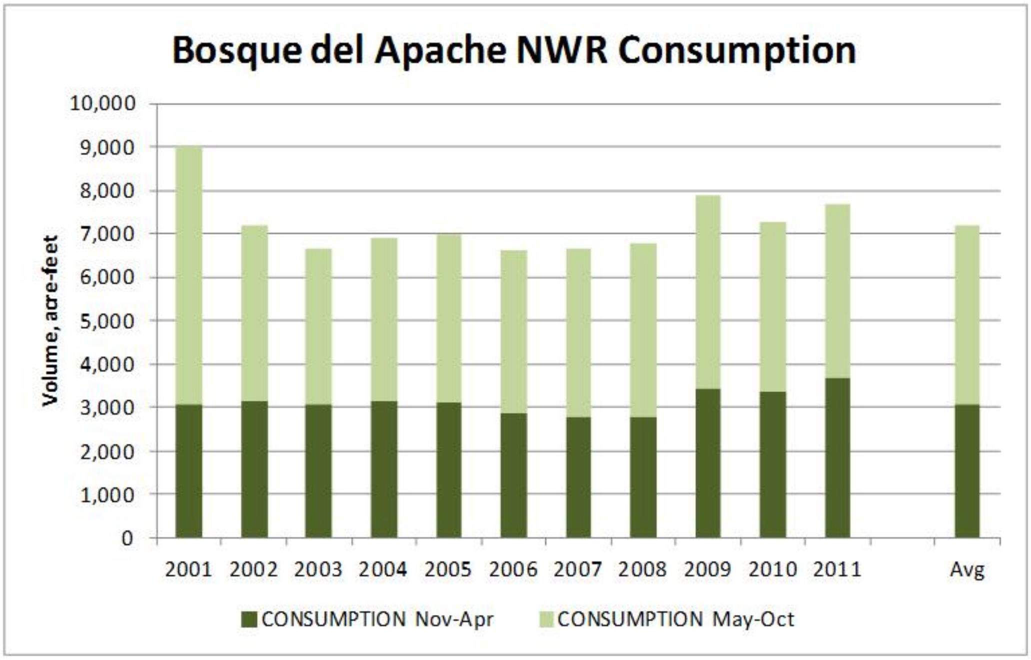



**Figure I-45. Seasonal breakdown of water consumption within BDA**

When water supplies are short, water from the LFCC cannot fully meet the needs of both the refuge diversion and LFCC pumping under Reclamation's Supplemental Water Program. In its ESA consultation (Service 2001a), the refuge concluded that it would contribute up to 10% of its water supply to support endangered species needs when necessary. In several instances during the time period of operations under the 2003 BO when river conditions were in danger of violation of the flow targets in the 2003 BO, the refuge has decreased its diversions from the LFCC to allow more water to be available to Reclamation's Supplemental Water Program to avoid violating the continuous flow requirements of the 2003 BO.

### 4.4.2 Recent Hydrologic and Administrative Conditions

This section summarizes the hydrologic and administrative (i.e., Article VII restrictions under the Compact) conditions in the recent past.

#### *4.4.2.1 Article VII Status and Credits under the Rio Grande Compact*

As described in the previous section, Article VII of the Compact restricts storage in upstream reservoirs constructed after 1929 if there is less than 400,000 AF of usable storage for the Rio Grande Project in Elephant Butte and Caballo Reservoirs. Article VII storage restrictions were in place for a majority of the period covered by the 2003 BO. These storage restrictions helped Reclamation achieve flow requirements because, as described above, years are classified as “dry” under the 2003 BO if the Article VII storage restrictions are in place at the beginning of the spring snowmelt runoff (April 1). Years classified as “dry” under the 2003 BO had lower flow requirements and a longer period in which drying is permitted than was authorized for years with “average” or “wet” classifications. The recent recurring periods when storage restrictions per Article VII were in place came after a long period, from 1978–2002, in which storage restrictions were never in effect. Figure I-46 shows New Mexico’s Article VII status from 1978–2010.

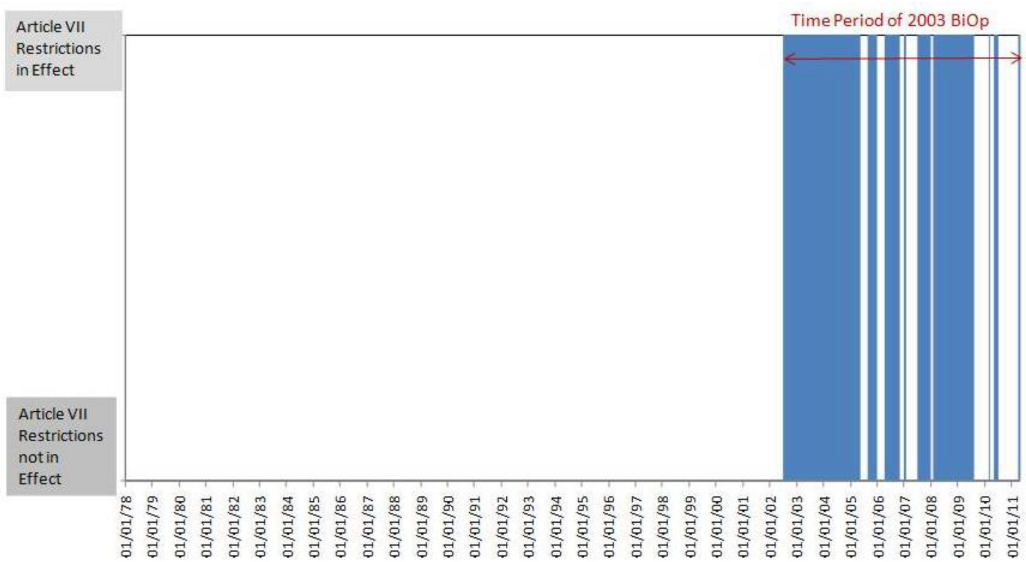



**Figure I-46. Article VII status under the Rio Grande Compact, 1978–2011**

During the period covered by the 2003 BO, New Mexico regularly accrued credits under the Compact because this period did not include any very wet years, and also likely due to channel construction by Reclamation and the State in the headwaters of Elephant Butte Reservoir. In addition, it is possible that Supplemental Water released by Reclamation for ESA purposes, which has been exchanged with a like amount of native water so that it can be passed downstream, contributes to this accrual. New Mexico has relinquished credits several times during this period and has made a portion of this relinquished water available to Reclamation’s

Supplemental Water Program under the Conservation Water Agreement and the Emergency Drought Water Agreement.

#### *4.4.2.2 Water Year Designation Under the 2003 BO*

The 2003 BO flow requirements are based on an annual year type designation of "dry," "average," or "wet." The following are the specifications for each of the 3 year-type designations, as described in the 2003 BO. "Dry years" are those for which the NRCS April 1 streamflow forecast for the Otowi gage is less than 80% of average, with average determined based on the streamflow at Otowi gage over the 30-year period from 1971–2000. "Dry year" flow requirements also can be invoked for years in which Article VII storage restrictions under the Compact are in effect on April 1. "Average years" are those for which the NRCS April 1 streamflow forecast for the Otowi gage is between 80–120% of average, and Article VII storage restrictions are not in effect. "Wet years" are those for which the NRCS April 1 streamflow forecast for the Otowi gage is greater than 120% of average, and Article VII storage restrictions are not in effect.

These designations are determined based on a combination of the April 1 hydrologic forecast for that year and the administrative conditions—specifically, whether Article VII restrictions under the Compact are in place on April 1. If Article VII storage restrictions are in effect on April 1 in a given year, that year is designated as a "dry" year regardless of the hydrologic conditions. Article VII status determined that 2003, 2004, 2005, 2006, 2007, and 2010 would be dry years, regardless of hydrologic conditions.

Figure I-47 presents the Article VII status at the beginning of the spring runoff for each of the years in the past decade and the corresponding water year designation. Because 2001 and 2002 were prior to the 2003 BO, they were not classified (another classification was in place under the 2001 BO). "Dry year" flow targets were in effect from 2003–2007 due to a combination of dry hydrologic conditions and Article VII Compact restrictions. The highest flow volume of the decade passed the Otowi gage in 2005; however, because Article VII restrictions were in effect as a result of low reservoir levels at the end of the drought period, the less stringent "dry year" flow requirements were in place. It was not until 2008 that Article VII Compact restrictions were lifted. Therefore, the more stringent "wet year" flow requirements were in place for that year, but that was the only year in the decade for which they were. "Average year" flow requirements were in place in 2009, and Article VII restrictions returned in 2010, so "dry year" flow requirements were observed. The year 2011 was designated as a dry year based on both Article VII Compact restrictions and an extremely low snowmelt-runoff.

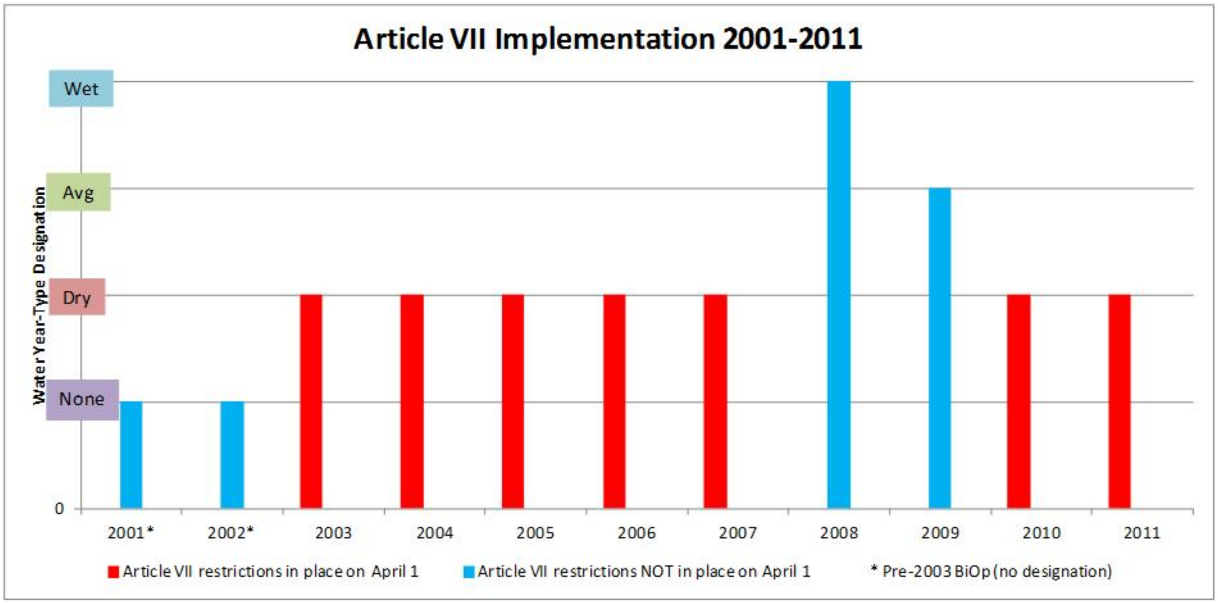



**Figure I-47. Article VII status under the Compact on April 1 of each year and water year-type designations under the 2003 BO, 2003–2011 (not applicable for 2001 and 2002)**

### *4.4.2.3 Recent River Flow Conditions*

The first decade of the 21st century began with high reservoir levels at Elephant Butte Reservoir due to a number of high water years in the 1980s and 1990s. The first half of the decade (2000–2004) was characterized by record drought, which diminished those reservoir levels. Beginning in 2005, hydrologic conditions became wetter; however, Article VII storage restrictions, resulting from low Elephant Butte Reservoir levels due to the drought, persisted until 2006 and then recurred several times through the remainder of the decade.

For purposes of this analysis, we have divided the past decade into high-volume years and low-volume years, based on the total flow passing the Otowi gage that year. The high-volume years are defined as those with a total flow past Otowi gage of 800,000 AF or more and include 2005, 2007, 2008, 2009, and 2010. Figure I-48, which presents the hydrographs at Otowi gage for these years, reveals a pattern of snowmelt driven hydrographs, with spring pulses between April and June, that are typically bimodal, representing the smaller runoff from the Rio Chama followed by the larger runoff from the Rio Grande main stem. These hydrographs also are characterized by low summertime flows, interspersed with occasional monsoonal spikes.

The highest-volume year of the decade was 2005. That year had a very large and long duration spring snowmelt runoff. Starting in mid-July, it had similar flows to the other years, and therefore would have required significant quantities of Supplemental Water if it had been designated as a wet year under the 2003 BO. However, it was designated as a dry year, as Article VII restrictions under the Compact were in place at the start of the runoff.

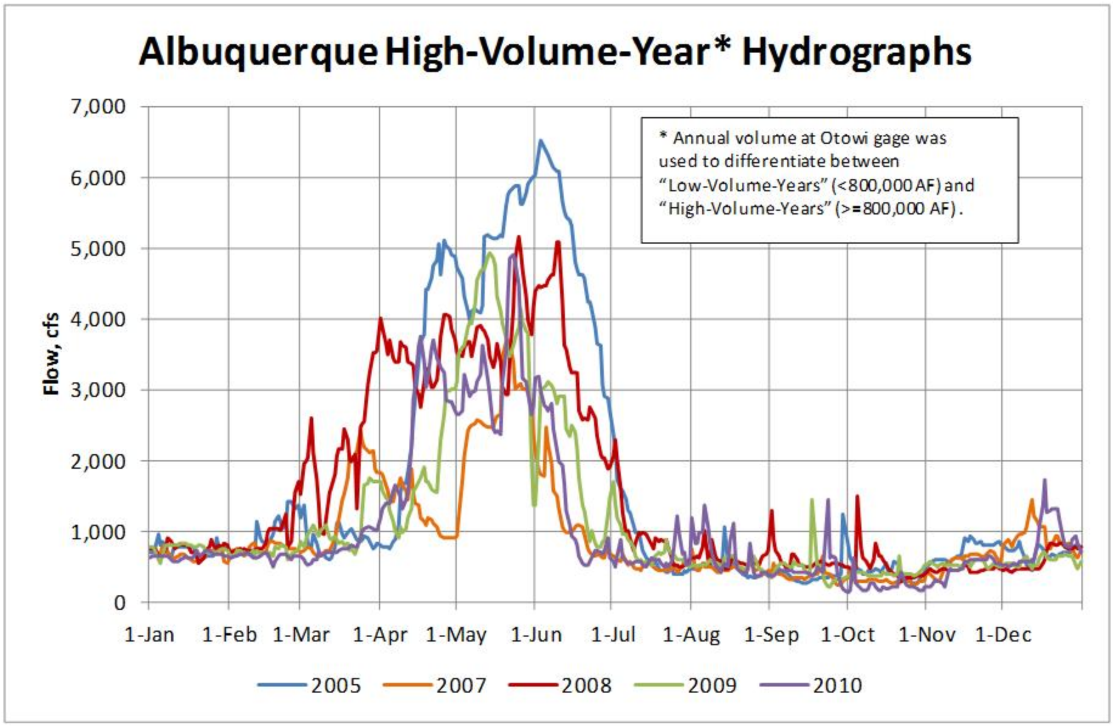



**Figure I-48. Hydrographs of flows at Otowi gage for the higher-volume years during 2001–2011**

The years 2008, 2009, and 2010 also had flows in Albuquerque of over 3,000 cfs for a significant period of time. The year 2008 was designated as wet year, and significant Supplemental Water was released to maintain higher summer flows in the Isleta and San Acacia Reaches. In 2007 and 2010, authorized deviations from normal Cochiti Dam operations were used to engineer flow spikes. In 2007, a flow spike of over 3,500 cfs was created in late May. In 2010, a flow spike of 5,800 cfs out of Cochiti Reservoir was created but maintained for only 2 days.

Figure I-49 presents the hydrographs at Otowi gage for the lower-volume years of the past decade—those years with a total flow past Otowi gage of less than 800,000 AF. These years include 2001, 2002, 2003, 2004, 2006, and 2011. Among these lower-volume years, 2006 stands out, both for its lack of a spring runoff (springtime flows never exceeded 800 cfs) and for its significant monsoon flows, including numerous spikes with daily-average flows over 1,000 cfs. These conditions led to a considerable accumulation of New Mexico credits under the Compact. The years 2002 and 2003 were dry throughout the year, with poor snowmelt runoffs and low-volume monsoons. The other years shown, 2001, 2004, and 2011, exhibit more traditional hydrographs, with bimodal spring snowmelt runoffs (representing the Rio Chama runoff followed by the main stem runoff), and low summertime flows, punctuated by occasional monsoon spikes.

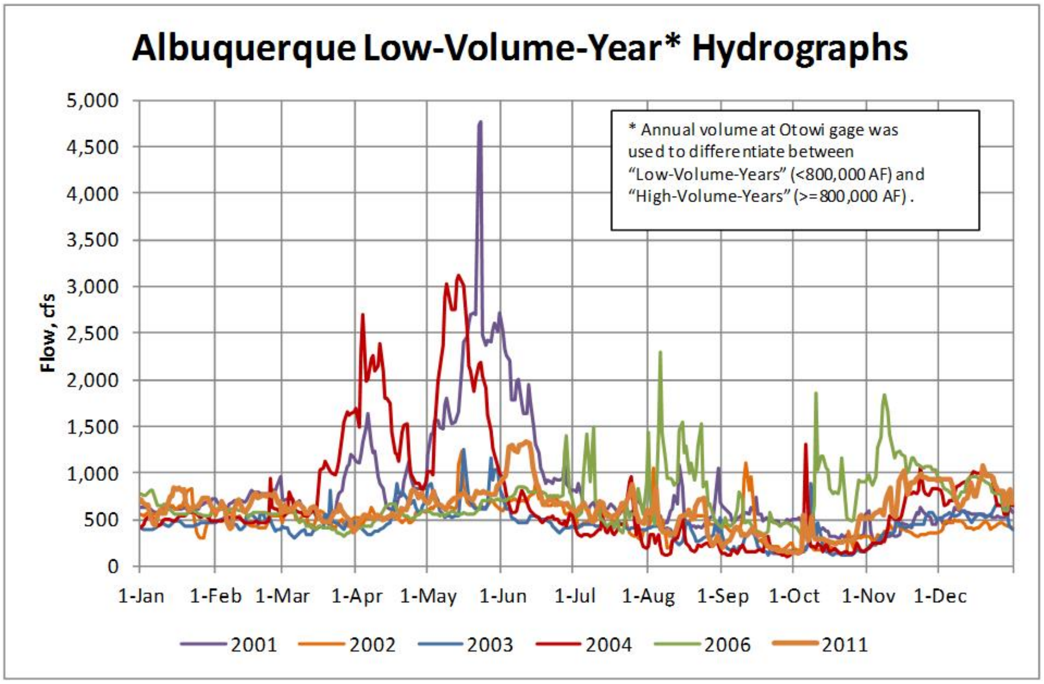



**Figure I-49. Hydrographs of flows at Otowi gage for the lower-volume years during 2001–2011**

Dry years and, to some degree, the years following dry years tend to exhibit higher losses from the river to the groundwater system and to evapotranspiration. This, in turn, affects river drying, as described in the following subsection.

### *4.4.2.4 River Drying*

RiverEyes data have been used to deduce trends in river drying, and threshold flows below which river intermittency should be expected. For example, river observations suggest that whenever gauged flows drop below 150 cfs at the Bosque Farms or below 200 cfs at the San Acacia gage, downstream drying is likely. The timing of drying is highly variable, affected in part by antecedent hydrologic conditions (whether the previous year was wet or dry), local weather (which affects the rates of evaporation and evapotranspiration), the degree and nature of the wetted sands, the magnitude of local return flows, the timing and nature of tributary inflows from the Rio Puerco and Rio Salado, and the degree of floodplain connectivity.

As can be seen in Table I-16, since implementation of the 2003 BO flow targets, river conditions have ranged from the rather extreme drying that occurred in 2003 to a continuous flowing river throughout 2008. The extreme river drying in 2003 occurred in response to low snowmelt runoff and a poor monsoon season that year, in combination with extremely dry antecedent conditions, which resulted in lower reservoir levels and high loss rates from the river. The MRGCD storage in El Vado was depleted; therefore, non-Indian irrigators were in "run-of-the-river" operations from late August through the end of the irrigation season. Irrigation water released from storage for delivery to downstream irrigation structures was not available to supplement river flow.

**Table I-16. River drying by reach and by percent of critical habitat that dried (2001–2011)**

| Year | Source | Total Critical Habitat Dry (of 163 mi) (%) | ABQ Reach Dry (%) | Isleta Reach Dry (%) | San Acacia Reach Dry (%) | Maximum Combined Drying (miles) | Maximum Drying Isleta Reach (of 53 mi) (miles) | Maximum Drying San Acacia Reach (of 58.5 mi) (miles) |
|---|---|---|---|---|---|---|---|---|
| 2001 | Service | 6 | 0 | 0 | 17 | 10 | 0** | 10 |
| 2002 | RE, Anec | 31 | 0 | 0 | 43 | 50.2 | 18.2 | 25 |
| 2003 | RE Sum | 57 | 0 | 72 | 95 | 93.5 | 38 | 55.5 |
| 2004 | RE GIS | 30 | 0 | 36 | 50 | 48.5 | 19 | 29.5 |
| 2005 | RE GIS | 26 | 0 | 11 | 63 | 43 | 6 | 37 |
| 2006 | RE GIS | 15 | 0 | 11 | 31 | 24 | 6 | 18 |
| 2007 | RE, Exp | 21 | 0 | 18 | 42 | 34 | 9.5 | 24.5 |
| 2008* | RE | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2009 | RE | 9 | 0 | 0 | 26 | 15 | 0 | 15 |
| 2010 | RE | 18 | 0 | 17 | 36 | 30 | 9 | 21 |
| 2011 | RE | 25 | 0 | 25 | 47 | 40.5 | 13 | 27.5 |

* 2008 was designated as a wet year; BO did not permit drying.
** 0 assumed at Isleta, 2001.
ABQ = Albuquerque
Anec = Anecdotal information
Exp = 2007 experimental activities
GIS = Geographic information system
RE = RiverEyes
Sum = Summary information

Over 72% of the Isleta Reach and 95% of the San Acacia Reach experienced river drying, and an estimated 57% of total silvery minnow critical habitat dried in 2003. The 2006 spring runoff was also well below average because of lower than normal snowpack. In May 2006, year-to-date precipitation was well below average, and the snow pack was at 20% of average in the Rio Grande Basin. Fortunately, a strong monsoon season led to the wettest July and August within our period of monitoring. Consequently, only 26.5 miles of river dried in the summer of 2006 in the Isleta and San Acacia Reaches. Fortunately, a succession of higher runoff years followed. In 2008, the river was continuous throughout the entire year. In 2011, however, dry conditions returned to the MRG, with total drying in the Isleta and San Acacia Reaches of over 40 miles.

Figures I-50 and I-51 summarize the extent of river drying over the past decade, in terms of both the total number of river miles dried each year and the days of drying per year in the Isleta and San Acacia Reaches.

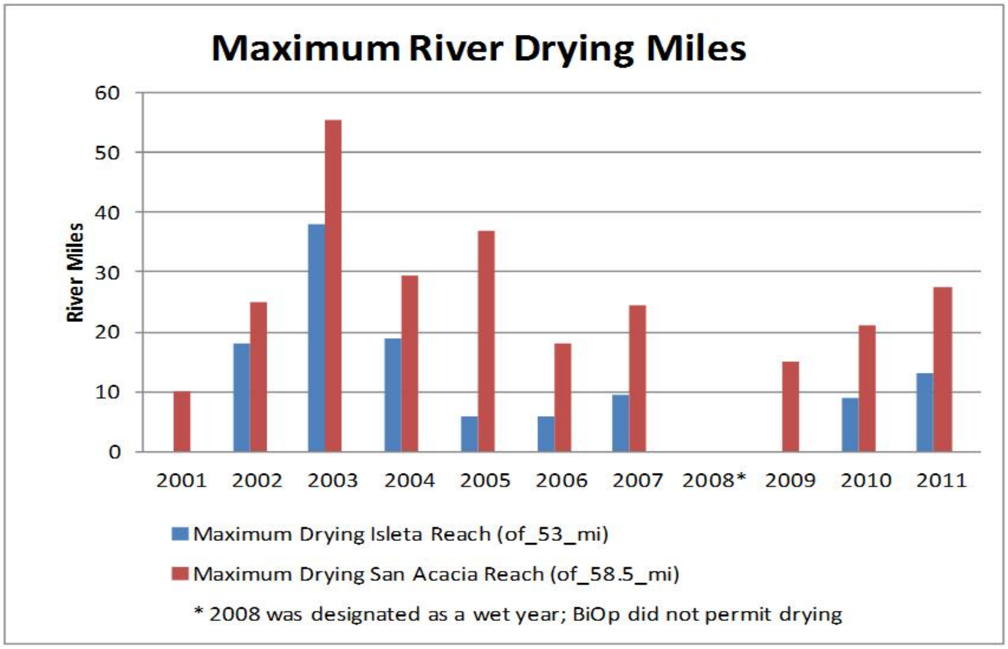



**Figure I-50. Summary of river miles that dried in the Isleta and San Acacia Reaches, 2001–2011**

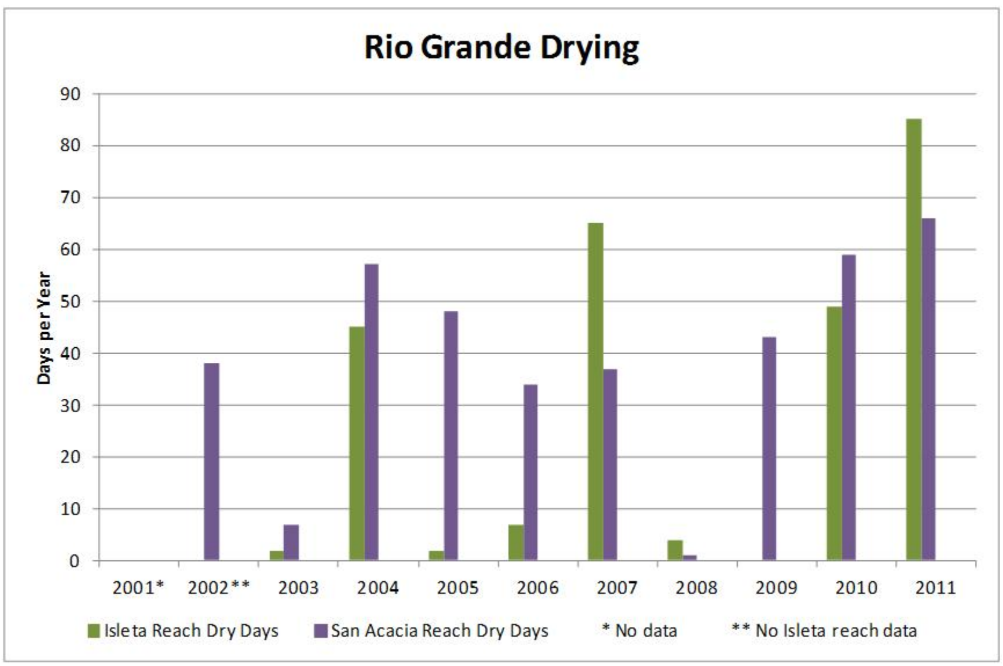



**Figure I-51. Number of days per year of river drying in the Isleta and San Acacia Reaches, 2001–2011**

Drying did not occur in the Cochiti Dam and Albuquerque Reaches during this time period. River operations in 2001 and 2002 were subject to different criteria, drying restrictions, and flow targets than were the years covered by the 2003 BO.

Figures I-52 and I-53 depict the timing of this river drying from 2001–2011 in the Isleta and San Acacia Reaches by depicting the first and last day of reported drying in each reach. The years 2002, 2006, and 2011 are noteworthy for experiencing drying in the San Acacia Reach prior to June 15.

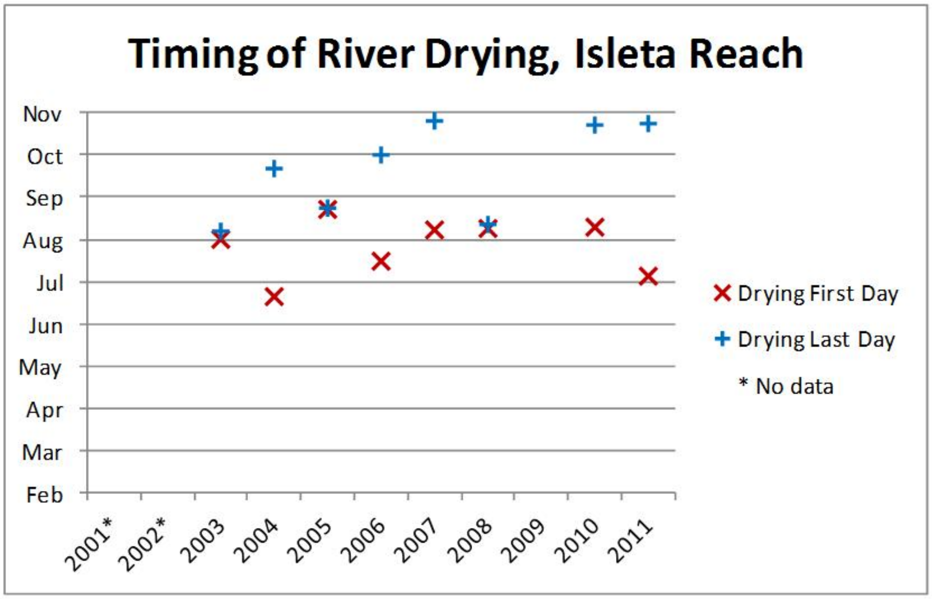



**Figure I-52. First and last calendar days of river drying in the Isleta Reach, 2001–2011**

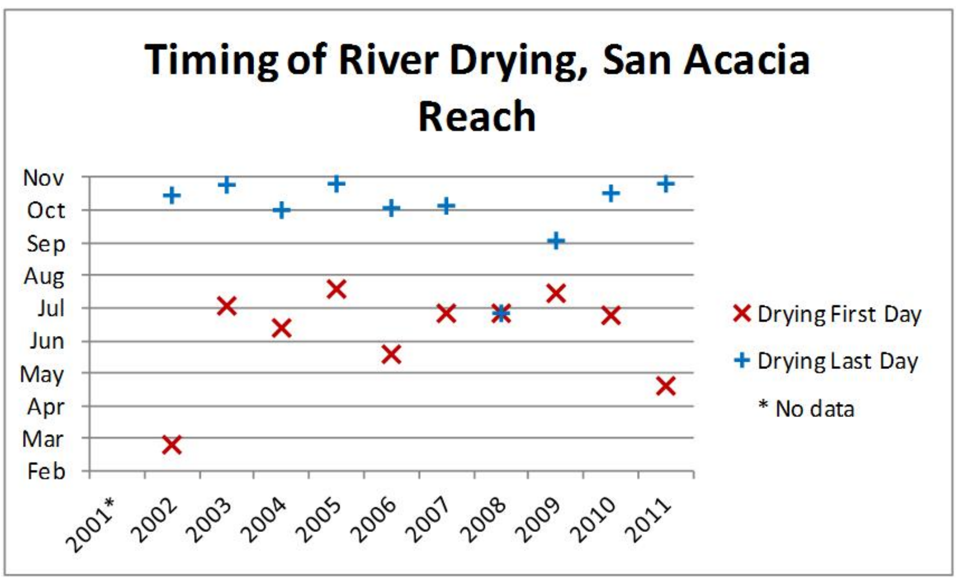



**Figure I-53. First and last calendar days of river drying in the San Acacia Reach, 2001–2011**

#### *4.4.2.5 Meeting the 2003 BO Flow Targets*

Reclamation consistently achieved compliance with flow targets established in the 2001 and 2003 BOs due to a combination of factors:

- High reservoir levels in the drier years and low reservoir levels in the wetter years.
- A sequence of hydrologic years that was favorable under the flow target calculations.
- Lease agreements with SJC Project contractors who had not yet developed the capacity to use that water for its intended purpose.
- Agreements for water with the State (the Conservation Water Agreement and the Emergency Drought Water Agreement).

Because conditions were dry during the first half of the decade and became significantly wetter during the second half of the decade, Article VII restrictions under the Compact were put in place early in the decade and remained in place or returned for several of the later, wetter years. The Article VII storage restrictions allowed the later, wetter years to have “dry year” flow targets under the 2003 BO; therefore, the water requirements to meet those targets were lower than they otherwise would have been.

Additionally, a larger amount of water has been available for Reclamation’s Supplemental Water Program than Reclamation can rely on in the future. Direct diversion projects for municipal use of SJC Project water by the city and county of Santa Fe and ABCWUA have decreased the amount of SJC Project water available for lease to Reclamation. Also, Reclamation has had the benefit of leased water from the State under the Emergency Drought Water Agreement (EDWA)/ Conservation Water Agreement (CWA), which it cannot count on in the future. It is estimated that gains to Elephant Butte Reservoir were fairly high in recent years as compared to historical conditions, partially due to the lower reservoir level during much of the period, but also due to extensive river maintenance activities in the Elephant Butte delta. The resulting gains in Elephant Butte deliveries resulted in greater Compact credits for New Mexico. The State was then able to relinquish an appreciable quantity of Compact credits and subsequently allow for emergency drought water to be stored at El Vado Reservoir and be used for meeting the flow targets of the 2003 BO.

## 4.5 Channel Conditions and Dynamics

The following discussion is summarized from the 2012 report *Channel Conditions and Dynamics of the Middle Rio Grande* (Makar and AuBuchon 2012). The channel conditions of a river are the integrated outcome of physical processes such as weathering, erosion, transport, and deposition of sediment and the natural and anthropogenic influences on those processes. Knowledge of the history of changes, both natural and anthropogenic, and the adjustment sequence within the alluvial watershed and channel provides a better understanding of this complexity to help interpret significant trends and estimate future conditions (Schumm et al. 1984, Kondolf and Piegay 2003). The interrelationship between the flow of water, the movement of sediment, and the variable character and composition of the channel boundaries over time and space essentially determines the current channel morphology that is observed (Schumm 1977, Leopold et al. 1964). This channel morphology can be constantly changing as the river seeks to balance the movement of sediment (sediment supply) with the power available from the flow of water (sediment transport capacity) (Schumm et al. 1984, Reclamation 2005). It is the imbalance between sediment transport capacity and sediment supply that is a key cause of most channel and floodplain adjustments (Lane 1955, Schumm 1977, Biedenharn et al. 2008).

Climatic changes, flood and sediment control, regulation of flows for irrigation, land use, vegetation changes, and channelization have altered the water and sediment supplied to the MRG over time. Factors affecting the imbalance between sediment transport capacity and sediment supply can be categorized as drivers of adjustment and controls on adjustment. Both drivers and controls can be modified through natural or anthropogenic means.

Important drivers on the MRG include flow frequency, magnitude and duration, and sediment supply. Changes in these drivers that have resulted in recent geomorphic channel changes on the MRG include decreased flow peaks, increased low flows of longer durations, and decreased sediment supply. Decreased peak flows result in the existing channel not being reworked on as large a scale as it was historically. Increased low flows of longer durations provide more water during dry periods. The flows can sustain vegetation, but also aid encroachment of vegetation into the active channel that narrows it. Increased low flows of longer durations occur as a result of anthropogenic regulation of the flows in the water system. This includes holding back flood flows that naturally would occur and scour emergent vegetation during the snowmelt runoff and monsoonal events and releasing that water during non-flood periods, such as during the summer and winter months. Increased low flows of longer durations also occur as a result of moving water, beyond the native flow, to keep the river wet and to facilitate the transfer of water downstream. Decreases in sediment supply, such as those due to land use changes in the watershed or the storage of sediment behind dams and diversion structures or stabilized banks and bars, can cause an increase in the likelihood of channel erosion.

There are several factors that can limit or control the effects of the drivers on channel adjustment and the observed reach characteristics. Controls of channel adjustment such as bank stability, bed stability, base level, floodplain lateral confinement, and floodplain connectivity influence the extent of effect that the drivers have on the observed characteristics of a reach. Bank stability can be affected by natural (e.g., riparian vegetation) or mechanical (e.g., riprap) means. Similarly, bed stability can come from channel armoring through bed material coarsening or from cross channel facilities. An example of a base level control is a change in pool elevation of a reservoir. The change can result in an upstream channel response, such as channel degradation or aggradation. Levees and geologic outcrops can create lateral confinement of the floodplain and limit channel migration. A well-connected floodplain dissipates the energy of flood flows, reducing the sediment transport capacity.

The fact that many changes, both natural and anthropogenic, occurred contemporaneously on the MRG greatly complicates interpreting the drivers and controls of the observed trends of channel and floodplain adjustments and also the prediction of future trends. Figure I-10, in the introduction of this chapter, Environmental Baseline, illustrates the timing of many of these events and dates of significant floods. A more detailed history of events affecting the morphology of the MRG can be found in the report *Channel Conditions and Dynamics of the Middle Rio Grande* (Makar and AuBuchon, 2012).

### 4.5.1 MRG Reach Geomorphic Parameters and Current Trends

The field of geomorphology uses certain parameters to better understand the observed trends and to help predict how a river self-adjusts to move toward a balance between sediment transport capacity and sediment supply. These geomorphic parameters help identify and document changes in the drivers and controls of channel adjustment. Geomorphic parameters currently evaluated on the MRG, from both direct measurement and/or analysis, include the following:

- Discharge magnitude and frequency
- Sediment supply
- Channel width
- Channel planform and location
- Slope
- Sinuosity
- Bed material size and type
- Channel and floodway topography

These parameters and their applicability to the MRG are further described in the report *Channel Conditions and Dynamics of the Middle Rio Grande* (Makar and AuBuchon 2012). For the ensuing discussions, reach designations follow geomorphic breaks described in the same report. Most of the discussion in this document focuses on the reaches between Cochiti Dam to the Elephant Butte Full Pool Reservoir. The majority of Reclamation’s investigations have been in this historically more geomorphically active reach; thus, more data are available. This area also corresponds to the section of the river occupied by silvery minnow.

The first two geomorphic parameters—discharge magnitude and frequency and sediment supply—are geomorphic drivers. Changes in flow and sediment supply continue to impact the morphology of the MRG. The decreased annual peak flows, which are now typically less than 5,000 cfs, and the reduced sediment supply are documented changes in the drivers that are correlated in time with observations of channel narrowing, vegetation encroachment, and incision, which in turn influence bank height, and bed material size, and generally lead to a more uniform channel. These observations are much more noticeable upstream of Albuquerque, where significant changes to the drivers have occurred. South of Albuquerque, especially south of the Rio Puerco, the effects of the changes to the drivers is less consequential because of the influence on the morphology from the tributary flows and sediment supply. These less-altered tributaries allow for a higher variability in both flow and sediment supply, which dampens the effects of the upstream changes to the drivers. These tributaries can also bring in coarser material that influences bed stability at lower flows.

The next six parameters (channel width, channel planform and location, slope, sinuosity, bed material size and type, and channel and floodway topography) are characteristics that help describe conditions of a reach. Controls on channel adjustment, such as bank stability, bed stability, base level, floodplain lateral confinement, and floodplain connectivity, interact with the drivers and influence the extent of effect that the drivers have on the observed characteristics of a reach. A lower bank and bed stability may have the potential to add to the sediment supply, whereas increases in the stability (bed and/or bank) or floodplain connectivity (which may cause lower-velocity areas) can reduce the sediment supply.

The influence of drivers and controls along the MRG is variable, but commonalities have been identified. It is the commonalities in the river's responses to drivers and controls present that help identify and separate the MRG into reaches with similar trends. The analysis of the geomorphic parameters, beyond identifying current trends on the MRG, also provides a summary of traits or characteristics for these reaches and a trajectory of expected changes. A summary of these six geomorphic parameters that influence the drivers and currently observed trends is provided in Table I-17. Additional information and discussions on reach specific details are provided in the report *Channel Conditions and Dynamics of the Middle Rio Grande* (Makar and AuBuchon 2012).

**Table I-17. Reach geomorphic parameters**

| Water Operations Reaches | Geomorphic Reaches | River Miles (RM) | Average Width (feet) | Planform | Slope | Sinuosity | Bed Material Type | Current Observations of -Channel and Floodway Topographical Changes | Currently Relevant Trends |
|---|---|---|---|---|---|---|---|---|---|
| Velarde | **Velarde to Rio Chama** (sediment transport capacity greater than (>) sediment supply) | 285–272 | 190 [a] | Low sinuosity, single channel. | 0.00224 [d] | N/A | Gravel and small cobble | • Horizontal alignment fairly stable. Tributary sediment deposition can induce bank erosion.<br>• A few migrating bends, but dense vegetation has limited the extent.<br>• Low/moderate channel incision.<br>• Minor amount of narrowing where riparian vegetation is encroaching on the active channel. | • Channel narrowing<br>• Vegetation encroachment<br>• Bank erosion<br>• Coarsening of bed material<br>• Increased channel uniformity |
| Española | **Rio Chama to Otowi Bridge** (sediment transport capacity > sediment supply) | 272–257.6 | 310 [a] | Low sinuosity, single channel, some split channels. | 0.00162 [d] | N/A | Gravel and coarse sand | • Local increase in bank height and incision or channel bed degradation.<br>• Horizontal alignment fairly stable.<br>• Moderate channel incision.<br>• A few migrating bends—river bed below the riparian root zone in some areas.<br>• Minor amount of narrowing where riparian vegetation is encroaching on the active channel. | • Channel narrowing<br>• Vegetation encroachment<br>• Bank erosion<br>• Coarsening of bed material<br>• Increased channel uniformity |
| Cochiti | **Cochiti Dam to Angostura Diversion Dam** (sediment transport capacity > sediment supply) | 232.6–209.7 | 220 [b] | Moderate sinuosity, single channel, with islands/bars. Constrained channel width less than (<) calculated meander belt width. | 0.00123 [e] | 1.15 [g] | Gravel and small cobble dominated, with some sand | • Channel disconnection with floodway due to high historical incision.<br>• Bank heights are very high.<br>• Bars are becoming stabilized with vegetation, and some are continuing to increase in size.<br>• Vertical stability is fairly stable due to gravel dominated bed, but there can be degradation locally. Some tributaries bring in coarse materials that act as local grade control. | • Channel narrowing<br>• Vegetation encroachment<br>• Bank erosion<br>• Coarsening of bed material<br>• Increased channel uniformity |
| Albuquerque | **Angostura Diversion Dam to Isleta Diversion Dam** (sediment transport capacity > sediment supply) | 209.7–169.3 | 390 [b] | Transition from wide braided to single channel. | 0.00091 [e] | 1.16 [g] | Sand changing to gravel dominated in upper portion, sand bed in lower portion | • Channel disconnection with floodway due to high historical incision in upper portion of reach.<br>• Banks and bed in lower portion have been relatively stable.<br>• There is potential for additional incision and bend migration.<br>• Narrowing where riparian vegetation is encroaching on the active channel.<br>• Bar formation and stabilization.<br>• Vertical and lateral accretion of bars.<br>• Complexity within the braided planform and active floodplain in lower portion.<br>• Significant amount of floodway modifications to reconnect channel with floodway.<br>• Moderate incision—greater upstream. | • Channel narrowing<br>• Vegetation encroachment<br>• Increased bank height<br>• Incision or channel bed degradation<br>• Bank erosion<br>• Coarsening of bed material<br>• Increased channel uniformity |
| Isleta | **Isleta Diversion Dam to Rio Puerco** (sediment transport capacity > sediment supply) | 169.3–127 | 350 [b] | Narrowing through island and bar development, becoming single thread. | 0.00077 [f] | 1.08 [g] | Sand, a few gravel deposits forming | • Narrowing through vegetation growth stabilizing islands and bars.<br>• Bank height increasing due to sediment deposition (vertical accretion).<br>• The channel cross section is becoming more uniform.<br>• Potential for channel incision as the channel continues to narrow.<br>• Horizontal alignments have been fairly stable (little bend migration) as the banks are densely vegetated.<br>• Low incision, increasing to high downstream.<br>• Bed elevation and channel slope have been relatively stable. | • Channel narrowing<br>• Vegetation encroachment<br>• Increased bank height<br>• Coarsening of bed material<br>• Increased channel uniformity |

**Table I-17. Reach geomorphic parameters**

| Water Operations Reaches | Geomorphic Reaches | River Miles (RM) | Average Width (feet) | Planform | Slope | Sinuosity | Bed Material Type | Current Observations of -Channel and Floodway Topographical Changes | Currently Relevant Trends |
|---|---|---|---|---|---|---|---|---|---|
| Isleta (cont.) | **Rio Puerco to San Acacia Diversion Dam** (sediment transport capacity > sediment supply) | 127–116.2 | 250 [b] | Single thread with islands, narrowing. | 0.00069 [f] | 1.10 [g] | Bimodal gravel and sand | • Localized channel incision, and bend migration in the downstream area.<br>• Entrenched with low bank height due to inset floodplains.<br>• Coarse Rio Salado deposits acting as bed control. | • Channel narrowing<br>• Vegetation encroachment<br>• Increased bank height<br>• Incision or channel bed degradation<br>• Coarsening of bed material<br>• Increased channel uniformity |
| San Acacia | **San Acacia Diversion Dam to Arroyo de las Cañas** (sediment transport capacity greater than [>] sediment supply) | 116.2–95 | 270 [b] | Single channel—low to moderate sinuosity. | 0.00078 [f] | 1.11 [g] | Bimodal gravel and sand | • High incision, decreasing downstream<br>• Bend migration threatening riverside infrastructure.<br>• Active channel area and width has decreased through 2001 but currently stable.<br>• Point bar growth is present where the banks migrate.<br>• Tributary reconnections may increase sediment supply. | • Vegetation encroachment<br>• Increased bank height<br>• Incision or channel bed degradation<br>• Bank erosion<br>• Coarsening of bed material<br>• Increased channel uniformity |
| | **Arroyo de las Cañas to San Antonio Bridge** (sediment transport capacity less than [<] sediment supply) | 95–87.1 | 320 [b] | Becoming single thread and narrowing, slightly meandering thalweg is beginning to form. | 0.00076 [f] | 1.11 [g] | Sand | • Horizontal and vertical stability historically and in short term.<br>• Channel filling with sediment; in the downstream portion, sediment plugs may be possible.<br>• Transition between upstream degradation and downstream aggradation.<br>• Vegetation growth causing local narrowing and increasing channel uniformity.<br>• Low potential for general bend migration however it may occur locally.<br>• Recent aggradation increasing downstream; Elephant Butte pool elevation may have low level effect.<br>• Tributary reconnections may increase sediment supply. | • Channel narrowing<br>• Vegetation encroachment<br>• Aggradation<br>• Increased channel uniformity |
| | **San Antonio Bridge to River Mile 78** (sediment transport capacity < sediment supply [m]) | 87.1–78 | 230 [b] | Becoming single thread and narrowing, potential for avulsions. | 0.00071 [k] | 1.12 [g] | Sand | • Previously slightly aggrading, recently highly aggrading.<br>• Bank heights low; floodplain connectivity high except very downstream section.<br>• Increasing loss of sediment transport capacity except very downstream section.<br>• Prone to sediment plugs.<br>• Vegetation growth is narrowing the channel.<br>• Bed elevation influenced by large variations in the water surface elevation of Elephant Butte Reservoir. | • Channel narrowing<br>• Vegetation encroachment<br>• Aggradation<br>• Channel plugging with sediment<br>• Perched channel conditions<br>• Increased channel uniformity |
| | **River Mile 78 to Elephant Butte full pool** (sediment transport capacity < sediment supply [l]) | 78–(~)60 | 130 [c] | Narrow single thread. | 0.00058 [k] | 1.16 [g] | Sand | • Normally aggrading, recently degrading.<br>• Area between the levees is perched above the historical floodplain, but recent channel degradation has reduced the main channel bed elevation.<br>• Historical loss of channel capacity and sediment plug formation.<br>• Bed elevation influenced by large variations in the water surface elevation of Elephant Butte Reservoir.<br>• Floodplain disconnection in lower portion of this reach.<br>• A few migrating bends—river bed below the riparian root zone in some areas.<br>• Some island and bar formation.<br>• San Marcial Railroad Bridge narrows active floodplain. | • Channel narrowing<br>• Vegetation encroachment<br>• Increased bank height<br>• Incision or channel bed degradation<br>• Bank erosion<br>• Coarsening of bed material<br>• Increased channel uniformity |

[a] 2002 photography.
[b] 2008 photography.
[c] 2007 photography.
[d] 2000 data.
[e] 2002 data.
[f] 2007 data.
[g] 2006 photography.
[h] 2009 data N/A – data not available.
[i] Elephant Butte Dam to Palomas Creek.
[j] Water Operation reach extends from the north (~RM 84) to south (~RM 74) boundary of the BDA.
[k] 2010 data.
[l] This is the historically most common condition. The sediment balance may change to the condition of sediment transport capacity is > sediment supply in portions of these reaches, depending upon the extent of the base level lowering of the Elephant Butte Reservoir, the duration that the reservoir pool is down, and the incoming sediment supply.

The major current trends observed on the MRG, although not every trend on every reach, are listed below.

- Channel narrowing
- Vegetation encroachment
- Increased bank height
- Incision or channel bed degradation
- Bank erosion
- Coarsening of bed material
- Aggradation (river bed rising due to sediment accumulation)
- Channel plugging with sediment
- Perched channel conditions (river channel higher than adjoining riparian areas in the floodway or land outside the levee)
- Increased channel uniformity

These trends and their applicability to the MRG are discussed in the following subsections. The relationship between sediment transport capacity and sediment supply is also identified for each trend. This relationship is key to anticipating future changes in reach trends and the direction of river responses, which helps determine potentially more sustainable corrective actions. Additional details supporting these trends and the relationship between sediment transport capacity and sediment supply are provided in the report *Channel Conditions and Dynamics of the Middle Rio Grande* (Makar and AuBuchon 2012).

#### *4.5.1.1 Channel Narrowing (Sediment Transport Capacity Can Be Either Greater or Less than Sediment Supply)*

The channel narrowing that has occurred since 1949 is likely the result of some combination of decreased peak flows, increased low flows of longer duration, decreased sediment supply, increased bank stability, increased floodplain lateral confinement, and decreased floodplain connectivity. The particular combination is dependent on reach-specific conditions.

When sediment transport capacity is greater than sediment supply, bed degradation or channel incision can occur. More bed degradation occurs in the channel thalweg (deepest area of the channel) than in shallower areas resulting in channel narrowing. For the case where the sediment transport capacity is less than the sediment supply, channel narrowing can occur as a result of sediment deposition in the form of medial or bank attached bars during high flows (lateral accretion). When subsequent flows are lower, these bars may not remobilize and so result in channel narrowing. Based on historical accounts and survey data, the MRG has narrowed significantly over the last century (Makar et al. 2006). For both cases, the resulting more confined, uniform sections offer little diversity of instream habitats for silvery minnow and low floodplain connectivity. Narrow, confined channels have less low-velocity habitat for silvery minnow and often require higher flows to inundate riparian vegetation, which is important for the flycatcher.

#### *4.5.1.2 Vegetation Encroachment (Sediment Transport Capacity Can Be Either Greater or Less than Sediment Supply)*

Significant vegetation encroachment into the active channel has occurred historically and again during the recent drought cycle as documented by historical photography and in Scurlock (1998), Lagasse (1980), Makar et al. (2006), and Makar (2010). This is likely the result of decreased peak flows, increased low flows of longer duration, and the variable influence of monsoons. Increased low flows of longer duration provide water more consistently and encourage vegetation growth near and in the active channel. At the same time, the decreased peak flows have insufficient shear stresses to uproot the established vegetation. Existing hydrology and flood control operations for safe channel capacity make an event large enough to destabilize the current vegetation extremely unlikely on the MRG. It is therefore likely that, on a reach scale, bank erosion and subsequent bank migration have been restricted, provided the bed elevation has not degraded below the root zone of established riparian vegetation. These channel resetting events maintained a diversity of habitats, backwaters, and side channels within the river channel for silvery minnow and a variety of successional stages of vegetation with riparian zone for flycatchers.

Conditions where the sediment transport capacity is greater than the sediment supply can lead to bed degradation or channel incision, as described above in the section on channel narrowing. The channel incises more along the thalweg than in other portions of the river bed; therefore, adjoining, higher areas of the river bed are less frequently inundated and mobilized, which creates a condition conducive to vegetation encroachment within the channel. This vegetation growth then reduces the width of the active channel.

Conditions in which the sediment transport capacity is less than the sediment supply can result in sediment deposition. These deposits can become vegetated if they are not remobilized by high flows, thereby narrowing the channel. These more confined, uniform sections offer little diversity of instream habitats for silvery minnow and low floodplain connectivity. The mature vegetation associated with this encroachment is valuable habitat for flycatchers, and potentially for cuckoos, but has a limited lifespan of suitability. Habitat diversity both in the riparian zone and within the channel has decreased due to lack of channel resetting events.

#### 4.5.1.3 Increased Bank Height (Sediment Transport Capacity Can Be Either Greater or Less than Sediment Supply)

The increase in bank height that has occurred is likely the result of some combination of decreased sediment supply, increased bank stability, low bed stability, lowered base level (e.g., Elephant Butte Reservoir pool elevation), increased floodplain lateral confinement, and floodplain connectivity (lower velocities in floodplain cause sediment to settle and result in vertical accretion in floodplain). The particular combination is dependent on reach-specific conditions.

If the sediment transport capacity is greater than the sediment supply, bank height increases can occur as a consequence of channel degradation or incision, which can reduce floodplain connectivity as well. When sediment transport capacity is less than sediment supply, bank height can increase due to sediment deposition in the floodplain (vertical accretion). This is primarily due to the lower sediment transport capacity of the floodplain when flows go overbank. An example of vertical accretion on the MRG is the observation of surface deposits during the high flows in the spring of 2005 on vegetated bars and islands within the Albuquerque area (Meyer and Hepler 2007). Similarly, after the 2005 spring runoff ended, field observations indicated significant vertical accretion occurred on the bars, islands, and floodplains in the Isleta to Rio Puerco Reach, especially near areas of flowing water (Bauer 2007). These higher features subsequently require larger magnitude runoff events to inundate. These more confined, uniform sections offer little diversity of instream habitats for silvery minnow and low floodplain connectivity.

#### 4.5.1.4 Incision or Channel Bed Degradation (Sediment Transport Capacity Is Greater than Sediment Supply)

When banks are more resistant than the bed, the river seeks to increase its sediment supply by transporting additional sediment from the bed. The incision that has occurred is likely the result of some combination of decreased sediment supply, increased bank stability, low bed stability, lowered base level (e.g., Elephant Butte Reservoir pool elevation), increased floodplain lateral confinement, and decreased floodplain connectivity. The last three factors all contribute to higher flow energy, which adds to the river’s need to self-adjust through channel bed degradation. The particular combination of factors is dependent on reach-specific conditions.

Incision on the MRG between Cochiti and Isleta has been impacted most strongly by construction of Cochiti and Jemez Canyon Dams, and these effects appear to be continuing to extend downstream. The lack of upstream sediment supply exacerbated the combined effects from the placed jetty fields of the more efficient channel and the reduction of bank material as a sediment source and resulted in degradation of the river channel and disconnection from the adjacent floodplain. Another example of this trend in the lower reaches of the MRG is due to the recent low elevation of Elephant Butte Reservoir. The low reservoir elevation is one of the causes of erosion of the upstream channel and delta deposits that has led to channel degradation from the southern BDA to the pool. Due to these changes, the channel has become disconnected from the surrounding floodplain in some areas. The extent (depth and length) of degradation depends on the extent of the base level lowering and the duration that the reservoir pool is lower.

The incision throughout the MRG also has the effect of lowering the water table in the vicinity of the active channel, which diminishes the ability of the river to recharge perennial and ephemeral wetland areas. These more confined, uniform sections offer little diversity of instream habitats for silvery minnow and low floodplain connectivity.

#### *4.5.1.5 Bank Erosion (Sediment Transport Capacity Is Greater than Sediment Supply)*

The bank erosion that has occurred is likely the result of some combination of decreased sediment supply, low bank stability, higher bed stability, lowered base level (e.g., Elephant Butte Reservoir pool elevation), increased floodplain lateral confinement, and decreased floodplain connectivity. The last three factors all contribute to higher flow energy that adds to the river's ability to self-adjust through bank erosion. The particular combination of factors contributing to bank erosion is dependent on reach-specific conditions. When the bank stability is less than the bed stability, the channel responds to unmet sediment transport capacity by bank erosion and lengthening of the channel, thereby increasing sinuosity. An overly lengthened channel may reduce sinuosity when a more hydraulically efficient cutoff channel develops and straightens that bend. These dynamic processes can form side channels and other features that may contribute to habitat diversity within the reach. Higher sinuosity areas are more likely to contain features such as backwaters and low-velocity side channels that are important to all life stages of silvery minnow and overbank wetted vegetation used by flycatchers. It should be noted, however, that on the reach scale, the MRG is classified as having low sinuosity.

Bed material coarsening (discussed below) can make the bed more resistant to erosion than the banks. Channel degradation or incision leads to taller banks that are often less stable, again resulting in bank erosion. At present, the bank heights in several reaches of the MRG are generally tall enough for the river's thalweg to intersect the banks beneath the root zone of the riparian vegetation, creating conditions in which the banks are more easily eroded. This, coupled with a single-channel planform and a thalweg that alternates between the banks, has led to the development of a series of migrating bends in those reaches.

#### *4.5.1.6 Coarsening Bed Material (Sediment Transport Capacity Is Greater than Sediment Supply)*

As the channel bed degrades or incises, bed sediment of finer sizes, which are more easily transported, are removed from the bed while coarser sizes remain. Figure I-54 presents the median size of the bed material over time in the MRG and shows the coarsening trend. Coarsening of bed material is likely the result of some combination of decreased sediment supply, increased bank stability, low bed stability that allows transport of finer bed particles, lowered base level (e.g., Elephant Butte Reservoir pool elevation), increased floodplain lateral confinement, and decreased floodplain connectivity. The first three factors may contribute to channel narrowing, which may lead to or be coupled with channel bed degradation. The last three of these factors all contribute to higher flow energy, which adds to the river's ability to move bed material. Under all of these conditions, the bed material may potentially coarsen further. Because the amount of energy to move a particle is proportional to its size, only the very coarsest materials remain. The particular combination of factors contributing to coarsening of bed material is dependent on reach-specific conditions.

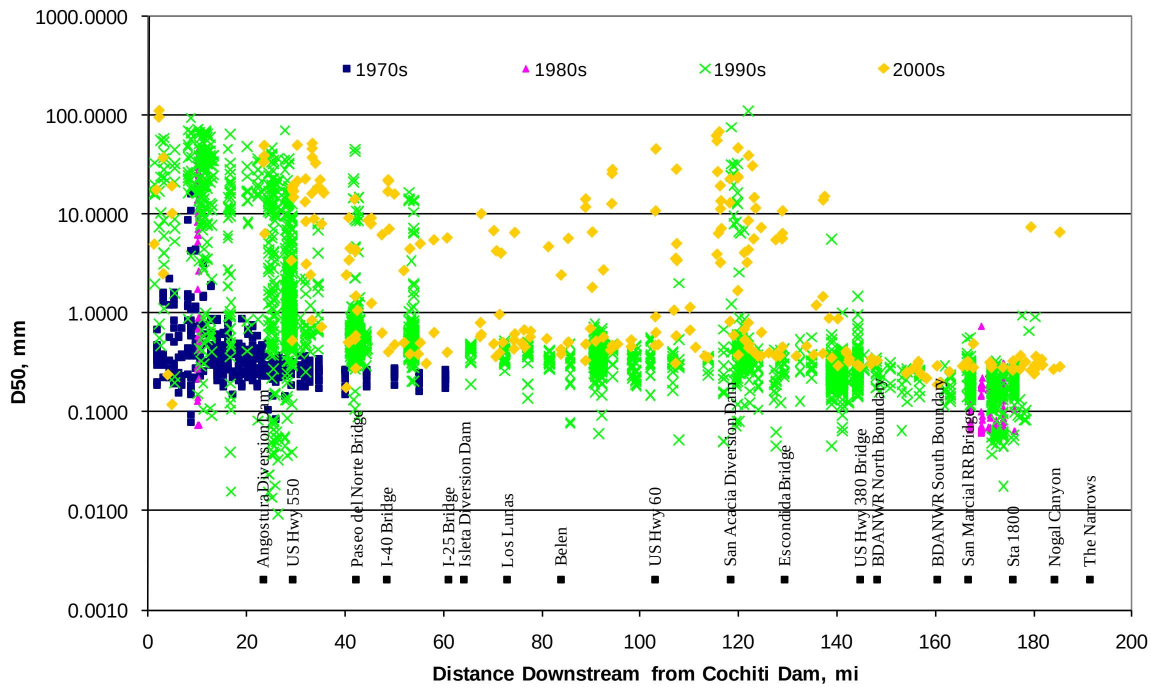



**Figure I-54. Median bed material size on the MRG over time (Bauer 2009)**

### *4.5.1.7 Aggradation (River Bed Rising Due to Sediment Accumulation – Sediment Transport Capacity Is Less than Sediment Supply)*

Aggradation is likely the result of some combination of high sediment supply, increased bank stability, higher base level (e.g., Elephant Butte Reservoir pool elevation rising that causes flatter slopes and increased flow resistance upstream, which tend to decrease the channel's sediment transport capacity), increased floodplain lateral confinement (which causes increased aggradation, due to limitation of the available area for deposition), and increased floodplain connectivity. The particular combination of factors contributing to aggradation is dependent on reach-specific conditions.

When sediment deposition occurs, it raises the bed elevation in both the main channel and the adjoining riparian zone. The extents and amounts are dependent upon the magnitude of the sediment transport imbalance; the greater the imbalance, the greater the deposition. The aggradation rate in the San Marcial area has been historically greater than any other reach. From 1900–1937, the riverbed aggraded more than 16 feet at the San Marcial Railroad Bridge. It has aggraded almost 13 more feet through 1999 (Makar 2009). The railroad bridge has been raised three times for a total of 22 feet (Van Citters 2000). Aggradation is currently a significant long-term concern from San Antonio south. There is some mild aggradation upstream of San Antonio. These reaches are strongly influenced by the pool elevation of Elephant Butte Reservoir (Elephant Butte Dam was closed in 1916) as well as sediment and water discharge magnitude, duration, and frequency (Levish 2010). During wetter periods with a full reservoir, these reaches continue to experience high levels of aggradation, alternating with degradation influenced by recession of the reservoir during drier periods and lower incoming sediment load.

The aggradation of the active channel provides water to a broader area of riparian vegetation that is used by flycatchers and cuckoos, as well as lower velocity habitats for silvery minnow.

#### *4.5.1.8 Channel Plugging with Sediment (Sediment Transport Capacity Is Less than Sediment Supply)*

Channel plugging is likely the result of some combination of high sediment supply, increased bank stability, higher base level (e.g., Elephant Butte Reservoir pool elevation), increased floodplain lateral confinement, and increased floodplain connectivity. A higher base level and an increase in floodplain connectivity can reduce the sediment transport capacity of the river, which over time builds conditions that support the formation of sediment plugs. The particular combination of factors that lead to plugs is dependent on reach-specific conditions.

As sediment deposits in the main channel, flow from the top of the water column can go overbank at lower discharges. Because there is a lower concentration of sediment being transported at the top of the column, the overbank flow removes a higher percentage of water volume than sediment load. As a result, the main channel sediment transport capacity is reduced, but the sediment supply decreases by a smaller percentage. This results in additional deposition in the main channel. Continued overbank flows with sediment accumulation in the main channel further reduces main channel flow capacity. This process can continue until sediment completely fills the main channel. The RM 78 to RM 62 Reach has a history of sediment plug formation near RM 70, approximately 1.5 miles upstream of the San Marcial Railroad Bridge. Three plugs have formed at this location in the last 20 years, in 1991, 1995, and 2005. The 1991 plug caused a breach of the Tiffany Levee on the west side of the river. The 1995 plug grew to a length of approximately 5 miles, and the 2005 plug grew to a length of approximately 3 miles. During the 2008 spring runoff, a sediment plug formed in the main channel of the river within the San Antonio Bridge to RM 78 Reach, just downstream from RM 81. The main channel was completely plugged with sediment for a length of a half mile and partially plugged upstream of that for a distance of over 1 mile.

The plugging of the active channel provides water to a broader area of riparian vegetation that is used by flycatchers as well as lower velocity habitats for silvery minnow. A connected floodplain provides important larval and rearing habitats for silvery minnow as well as inundated riparian vegetation for flycatcher and cuckoo.

#### *4.5.1.9 Perched Channel Conditions (River Channel Higher than Adjoining Riparian Areas in the Floodway or Land Outside the Levee – Sediment Transport Capacity Is Less than Sediment Supply)*

Perched channel conditions are likely the result of some combination of high sediment supply, increased bank stability, higher base level (e.g., Elephant Butte Reservoir pool elevation), increased floodway lateral confinement, and increased floodplain connectivity.

As a riverbed raises and sediment-laden waters flow overbank into the riparian zone, flow velocity decreases, which causes sediment deposition that, in turn, raises the river bank height. Continued bed raising and overbank deposition results in a channel bed, bordered by natural levees, which is significantly higher than the adjoining areas between manmade levees or geologic formations. This condition is known as a perched channel. A river corridor also can become higher than land areas outside the levee when sediment deposition occurs across the entire floodplain between the levees. The historical valley floodplain accessible by the MRG has been significantly reduced by levees paralleling much of the river. Subsequent aggradation between the levees has rendered that area higher than the adjoining valley for most of the MRG between Angostura Diversion Dam and Elephant Butte Dam. This process is most pronounced on the Rio Grande downstream from San Antonio. Perched channel conditions can be a factor in channel plugging.

The perching of the active channel provides water at a larger variety of flows to a broader area of riparian vegetation that is used by flycatchers as well as lower-velocity habitats for silvery minnow. A connected floodplain provides important larval and rearing habitats for silvery minnow, as well as inundated riparian vegetation for flycatcher and cuckoo.

#### *4.5.1.10 Increased Channel Uniformity (Sediment Transport Capacity Can Be Either Greater or Lesser than Sediment Supply)*

On a reach scale in the MRG, morphological features (width, depth, velocity, floodplain connection, backwater features, etc.) that were once significantly variable are becoming more uniform. This increase in channel uniformity results primarily from a decreased variability in flows and sediment supply. This decreased variability is a result of flow control, which causes lower peaks and more constant low flows. Lower peaks mean less energy is available to rework the channel and floodplain and scour emergent vegetation. The channel banks and floodplain do not erode as much, and sediment remains stored in the banks. More constant low flow means vegetation can grow more easily (see vegetation encroachment section above) near and within the active channel, further reinforcing the existing bank line and perhaps storing even more sediment.

In the MRG, storage of sediment behind dams in both the main stem and tributaries, less watershed erosion due to land use changes and bank and bed stabilization have so reduced the sediment supply that, even with lower peaks, the sediment transport capacity is greater than the sediment supply for most of the MRG. SWCA (2010b) found that after the 1930s the channel dynamics in the Angostura to Isleta Reach of the MRG were diminished to the point that the riparian environment diversity became static and no longer changed as it once did.

Conditions in which the sediment transport capacity is greater than the sediment supply lead to river bed degradation or channel incision, as previously described. As the channel incises and narrows, the active channel planform moves from a wide braided channel with extensive mobile bars to a narrow single channel with few mobile bars. The wetted channel at higher flows changes from being wide and shallow with significant topographic and hydraulic variations, to narrow and deep with limited space for topography and hydraulic variations. These changes contribute to increased channel uniformity locally and also on a reach basis as the irregularities of the natural channel become more and more alike. The end result is a channel with more uniform slope and width, high, steep banks, lower suspended sediment load, and coarser bed material.

Conditions in which the sediment transport capacity is less than the sediment supply lead to channel aggradation, as previously described. Because the majority of the MRG has lateral constraints, as the channel aggrades, the space between the constraints becomes elevated. This, in turn, raises the bed elevation of the main channel, creating greater opportunities for flooding and diminishing the topographical elevation variations between the main channel and the floodplain. Vegetation growth near and within the active channel, as described in the section on vegetation encroachment, is encouraged by sustained low flows, the smaller in-channel forces created by lower peak flows,and the greater connectivity between the main channel and the floodplain due to aggradation. Bars often attach to the bank as the channels fill in, decreasing bar mobility. Under these conditions, the active channel planform moves towards a narrow active channel with a more consistent width and limited sediment mobility.

Figure I-55 illustrates one aspect of channel uniformity: the variability of the channel width within a reach. The narrowing of the gap between the maximum and minimum measured widths and the decrease in the standard deviation are an indication that widths are becoming increasingly uniform.

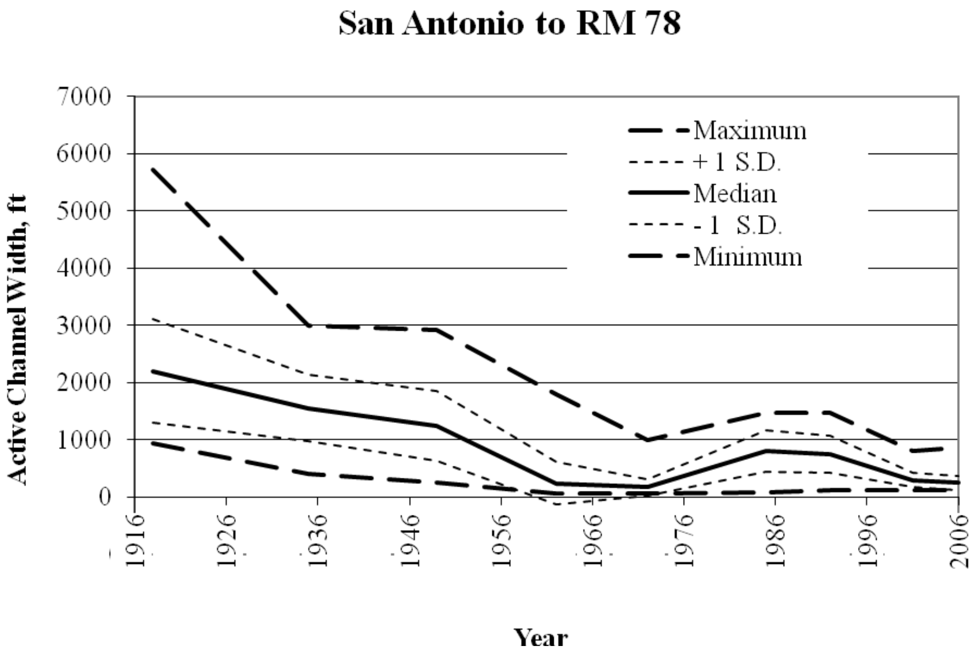



**Figure I-55. Channel mean width change over time with standard deviation for San Antonio (RM 87.1 to RM 78)**

## 4.6 Prior Actions to Avoid, Minimize, or Mitigate

This environmental baseline is also affected by many ongoing activities that the Service prescribed in biological opinions issued since 2001, as well as other activities that have had positive effects on the status and knowledge of the species. Many of these activities have been carried out by the Collaborative Program, which focuses on improving the status of the listed endangered species in the MRG including the silvery minnow and the flycatcher. These activities serve as a tool to conserve listed species, assist with species recovery, and help protect critical habitat.

The following is a brief discussion of the activities carried out, including elements in the RPA, RPM, and conservation recommendations in the 2003 BO as well as other measures that may improve the status and knowledge of the species.

### 4.6.1 Environmental Water Management

Over the past decade, federal, state, and local agencies have engaged in efforts to coordinate water and river operations to improve system operations and achieve ESA compliance. Environmental water operations were triggered by 2003 BO flow criteria. RPA Element C mandates that reconnaissance of portions of the MRG be performed to:

1. Provide current information on river flows that allow Reclamation and the other agencies to react quickly to rapidly changing conditions on the river.
2. Facilitate coordination among the agencies to prevent unexpected drying.
3. Prepare for silvery minnow rescues.

Daily coordination of water operations between federal and non-federal partners has been especially critical during periods of limited water availability and river drying. For example, coordination with the MRGCD allowed the maintenance of short lengths of wet river during extremely dry periods through small, targeted return flows from irrigation system drains, outfalls, and wasteways. Also, coordination of the RiverEyes program with the Service's minnow salvage program allowed targeting of salvage efforts to the locations at which they would be most effective. Information provided by the RiverEyes program also allowed optimal use of pumping from the LFCC to the river as needed to limit the extent of drying, manage recession, and avoid excessive stranding, and to support silvery minnow rescue operations.

Many of the RPA elements (A to O, RPMs 1.1, 3.1, and 3.2) involve water management thresholds, targets, and requirements. Element A calls for a spike release to induce silvery minnow spawning. A natural spike flow occurred in 2003 and was followed in 2009 by a spike flow resulting from an experimental deviation in the operation of Cochiti Reservoir. A deviation of Cochiti Reservoir operations also occurred in 2010, but that deviation resulted in a rapid decrease in flows following the flow spike, which may have disrupted the development of silvery minnow eggs and larvae.

Supplemental Water releases have aided in maintaining the flow targets and slowing the rate of recession, which helps both minnow and flycatcher habitat (Elements A to O, RPM 3.1, 3.2). Supplemental Water generally has only been used to manage the recession of spring runoff and not to augment spring peaks. The flow requirement increases between average and wet years in the 2003 BO may not significantly change the condition of the river but can result in a significant increase in the required water.

As part of the Supplemental Water Program (Element O, RPM 4.1), in the San Acacia Reach, pumping from the LFCC to the river is done at four locations. The use of this water to manage river recession has been successful and has allowed many of the fish to move with the receding river. Pumping for flycatchers has not been done directly and should be assessed on a case-by-case basis where appropriate; during very dry years, it is theorized that pumping may attract predators to areas where flycatchers are nesting. In recent years, pumps have run continuously at the southern boundary of BDA during low-flow conditions though not required by the 2003 BO. There has been no assessment of the effectiveness of pumping to benefit the species or how effective the pumped water is at maintaining river connectivity.

#### *4.6.1.1 Reclamation's Supplemental Water Program*

Reclamation initiated its Supplemental Water Program in 1996 to support water needs of the ESA-listed species in the MRG. The program originally included acquisition, storage in upstream reservoirs, and release of water to support river flows. Since 2001, it also has included operation of a pumping network in the San Acacia Reach to pump water from the LFCC to the river. Reclamation has enhanced the flexibility of its program of leases of annual allotments of SJC Project water with a program of waivers of release dates from Heron Reservoir of contracted water. This program of release waivers has served to further enhance water releases for environmental and recreational purposes on the Rio Chama.

Through these methods, Reclamation has acquired a supply of Supplemental Water over the past decade and used this water to support river flows and manage recession to meet the needs of the endangered species and the terms of the BOs. Since 2003, Reclamation has released an average of 28,568 AFY of Supplemental Water in the manner deemed to provide the most benefit to the listed species. An updated NEPA analysis of the current Program was completed in 2011, and a finding of no significant impact was issued.

The Program has included the following elements:

- Lease from contractors and storage of SJC Project water
- Heron Reservoir release waiver
- Acquisition and storage of relinquished credit water from the State
- Release of Supplemental Water to meet the needs of listed species
- Pumping of water from the LFCC to the San Acacia Reach of the Rio Grande

These elements of the program are described in more detail in the following subsections.

##### *4.6.1.1.1 San Juan-Chama Project Water Acquisition and Storage*

Since 1997, Reclamation has acquired most of its Supplemental Water Program water by entering into temporary lease agreements with SJC Project contractors. The amounts and sources of these leases each year are summarized in Table I-18. Since 2003, Reclamation has leased an average of 24,664 AF of water from SJC Project contractors annually.

Figure I-56 summarizes the water obtained for Reclamation's Supplemental Water Program from willing SJC Project contractors since 2001. The primary source of SJC Project water to the program has been the ABCWUA. However, as previously described, ABCWUA has brought online its drinking water diversion, through which it plans to use its allocation of SJC Project water for urban supply. Therefore, the availability of this water to Reclamation's Supplemental Water Program has been significantly reduced.

**Table I-18. Leased supplemental San Juan-Chama Project water (1997–2011)**

| CONTRACTOR | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Albuquerque | 10,000 | 10,000 | 10,000 | 64,500 | | 40,000 | | | | 48,200 | | | | 10,000 | 10,000 | 202,700 |
| City of Belen | | | 800 | 700 | 400 | 470 | 504 | 354 | 242 | 450 | 470 | 470 | 400 | 450 | 450 | 6,160 |
| City of Bernalillo | | | | | | 300 | | | | 400 | 320 | 400 | 400 | 400 | 400 | 2,620 |
| City of Espanola | | 2,000 | 2,000 | 5,000 | | 1,687 | | 1,650 | 1,000 | 800 | 856 | 850 | 850 | 850 | 900 | 18,443 |
| Jicarilla Apache Nation | | | 6,500 | 6,500 | 6,500 | 6,500 | 6,500 | 6,500 | 6,500 | 6,000 | 2,948 | 3,000 | 3,000 | 3,500 | 3,000 | 66,948 |
| County of Los Alamos | | 3,650 | 3,600 | 5,000 | 1,200 | 1,529 | 1,200 | 1,200 | 1,200 | 1,200 | 1,200 | 1,200 | 1,200 | 1,200 | 1,200 | 25,779 |
| Village of Los Lunas | | 500 | 500 | 300 | 200 | 500 | 100 | | | 256 | 293 | 331 | 200 | 200 | | 3,380 |
| MRGCD | | | | | | | 3,132 | | | | | | | | | 3,132 |
| Ohkay Owingeh | | | | | | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 | 20,000 |
| City of Santa Fe | | 10,000 | 10,000 | 10,000 | | | 2,500 | | | 5,500 | | 2,500 | 2,500 | | 375 | 43,375 |
| County of Santa Fe | | | | | | | | | | 375 | 375 | 375 | 375 | 175 | | 1,675 |
| Town of Red River | | | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 780 |
| Town of Taos | | | 400 | 400 | | 937 | 419 | 400 | 400 | 400 | 400 | 400 | 200 | 245 | 225 | 4,826 |
| Taos Ski Valley | | | 50 | 50 | | 53 | | | | | 15 | 15 | 15 | 8 | 8 | 214 |
| Uncontracted | | 4,990 | 4,990 | 4,990 | 4,990 | 2,990 | 2,990 | 2,990 | 2,990 | 2,990 | 2,990 | 2,990 | 2,990 | 2,990 | 2,990 | 49,860 |
| Total | 10,000 | 31,140 | 38,900 | 97,500 | 13,350 | 57,026 | 19,405 | 15,154 | 14,392 | 68,631 | 11,927 | 14,591 | 14,190 | 22,078 | 21,608 | **449,892** |

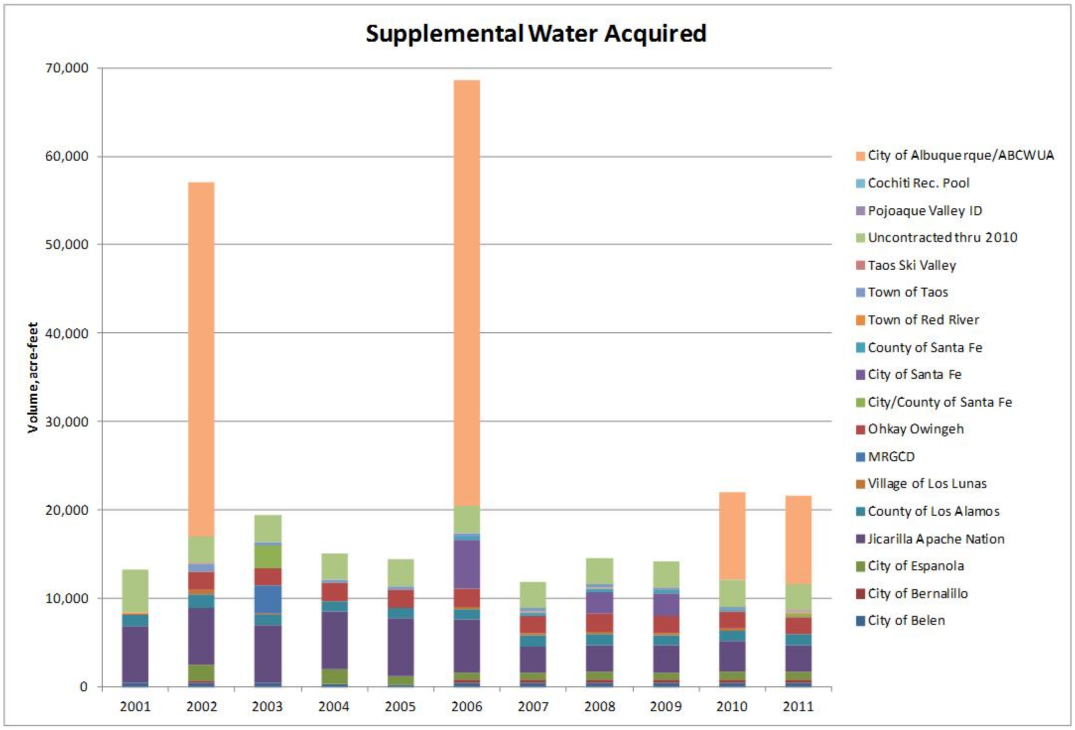



**Figure I-56. Summary of San Juan-Chama Project water leased to Reclamation's Supplemental Water Program**

Reclamation has entered into agreements with the MRGCD and ABCWUA to store the leased SJC Project water that Reclamation acquires for the Program. Under an MRGCD storage agreement, which expired at the end of 2009, Reclamation stored up to 30,000 AF of SJC Project water in El Vado Reservoir. The ABCWUA storage agreement authorizes Reclamation to store 10,000 AFY of SJC Project water in Abiquiu Reservoir through 2012, with options to extend.

#### *4.6.1.1.2 Heron Reservoir Release Waivers*

As discussed above, SJC Project contractors must take delivery of their annual allocation of SJC Project water prior to December 31 of each year; otherwise, their water reverts to the SJC Project pool at Heron Reservoir. However, Reclamation regularly authorizes extension of that date in cases for which such an extension benefits the United States. Waivers generally allow SJC Project water to remain in Heron Reservoir through April 30 of the year following the one in which the water was allocated to the contractor. Reclamation has authorized waivers even later in the year, but only under unusual circumstances.

Reclamation has authorized waivers at times when maintaining water in Heron will allow use of such water at a later date to facilitate downstream storage or when changes to the timing of deliveries help maintain fishery flows and support recreation on the Rio Chama. Reclamation also has authorized waivers to contractors who have agreed to lease their allocated water to Reclamation's Supplemental Water Program.

From 2003–2011, Reclamation acquired over 201,601 AF of San Juan-Chama Supplemental Water at a cost of approximately $17,679,696.

##### *4.6.1.1.3 Conservation Water Agreement and Emergency Drought Water Agreement*

Reclamation also includes in its Supplemental Water supplies water leased from the State of water obtained through relinquishment of New Mexico credits under the Rio Grande Compact. Lease of this water to Reclamation's Supplemental Water Program was made possible through the Emergency Drought Water Agreement[20] and the CWA with the State. CWA and EDWA water has been stored and made available to Reclamation, consistent with the relevant interstate compacts and with state and federal law as a conservation pool upstream of Elephant Butte Reservoir. Pursuant to the amended EDWA agreement (2003–2013), Reclamation may release up to 20,000 AF of its allocated water in any one calendar year. This water is authorized for storage while Article VII storage restrictions under the Compact are in effect; therefore, this supply has significantly contributed to the availability of Supplemental Water during low-water years.

In 2003, New Mexico offered to relinquish up to 217,500 AF of accrued credit waters in Elephant Butte Reservoir. In April 2003, New Mexico relinquished 122,500 AF of credit water held in Elephant Butte Reservoir, and Texas accepted that water in project storage. It was further agreed that Texas would accept the balance of 95,000 AF if available. In 2004, Texas accepted an additional 53,000 AF. These agreements allowed Reclamation to store in El Vado Reservoir a maximum of 169,448 of the 175,500 AF relinquished to date while under Article VII restrictions. Approximately one-third of the relinquishment storage could be used by Reclamation on behalf of federally listed endangered species, while two-thirds of the relinquishment was assigned to the MRGCD supplies. Releases related to the EDWA storage for endangered species compliance averaged 7,620 AF over the 6-year period from 2003–2008. Credit relinquishments for 125,000 AF in 2008 enabled Article VII restrictions to be lifted. Approximately 62,500 AF of water was allocated for species needs, but EDWA waters were not actually stored in 2008. An unallocated balance of 62,500 AF of water was reserved for future as yet undefined needs. As of the end of 2011, there was 19,196 AF of EDWA water in storage at El Vado, and Reclamation has an additional unused allocation of 19,500 AF.

Reclamation also sought to maximize storage for Supplemental Water obtained either from EDWA or SJC Project water leases. Storage agreements for conservation water storage at Abiquiu Reservoir were secured, contingent on the availability of space. In 2005 and 2006, 20,000 AF of storage at Abiquiu was designated for conservation storage. A new agreement

[20] In 2003, Reclamation, the MRGCD, the Service, BIA, and the Corps entered into the Emergency Drought Water Management Agreement to coordinate the use of EDWA water, to provide an additional source of stored water for routine MRGCD operations, and to manage EDWA water in a manner that optimizes operations for meeting needs of both irrigators and species as set out in the 2003 BO.

signed in 2007 identified 10,000 AF of conservation storage space. Since ABCWUA has brought its SJC Drinking Water Project online, the amount of potentially available conservation storage space available at Abiquiu is increasing and is expected to ultimately increase to about 30,000 AF.

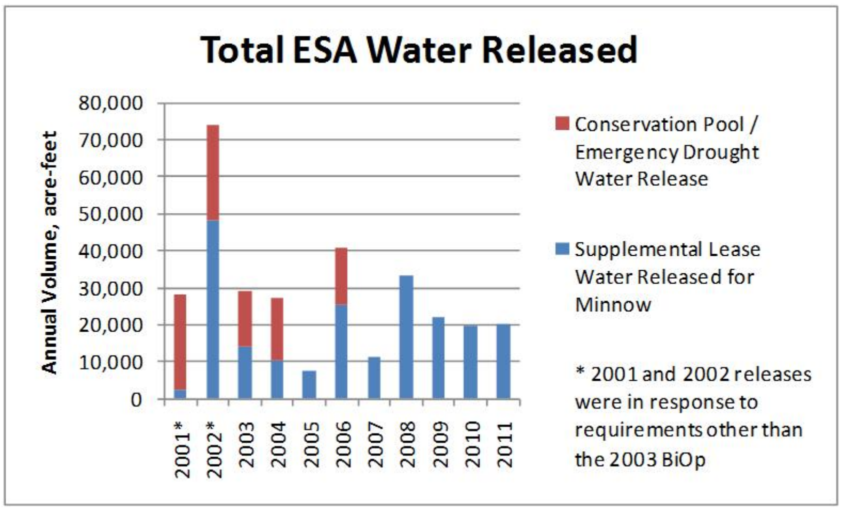
From 2003–2011, Reclamation acquired over 64,509 AF of Supplemental Water under the Emergency Drought Water Agreement at a cost of approximately $6,450,900.

#### *4.6.1.1.4 Release of Supplemental Water*

Supplemental water acquired as described in the sections above has been released from storage by Reclamation as needed to meet the needs of listed species. Because SJC Project waters are not authorized to be used for delivery compliance under the Compact, Reclamation has exchanged the leased SJC Project water with MRGCD for native Rio Grande flows. The SJC Project water leased each year by Reclamation has therefore been used beneficially in New Mexico for irrigation, while native waters have augmented stream flow and provided benefits to the listed species. The MRGCD has used the exchanged Supplemental Water for irrigation once it has passed the downstream-most flow target.

Figure I-57 shows the total water released under the Supplemental Water Program for ESA purposes over the past decade. It is evident from this figure that CWA and EDWA water were a significant source of water released to benefit listed species during the drought years of the early part of the past decade.

**Figure I-57. Summary of water released annually to meet the needs of listed species under**




**Reclamation's Supplemental Water Program**

Please note that in 2001 and 2002, water was released according to different criteria and flow targets than in the years covered by the 2003 BO. In 2000, 171,000 AF was released that was related to a court order to keep the Rio Grande wet pending re-consultation with the Service over the minnow.  This process resulted in the 2001 BO.  In 2002, 73,000 AF was released under the 2001 BO.

A new BO was implemented as of March 13, 2003, and the remaining releases were made to meet the requirements of that BO.  The annual average release of water for ESA purposes under the 2003 BO was 28.568 AF, of which 19,593 AF was leased SJC water and 8,975 AF was conservation pool/emergency drought water.

About one-third of Supplemental Water released was used to support continuous flow requirements, spring spawning and recruitment flows, and to manage recession (March–June) while the remaining two-thirds of Supplemental Water supplies were released to meet late season flow targets (July–October) or manage recession after rewetting.

The date of first release of Supplemental Water has varied widely, from early March to early August.  These variations, which are graphed in Figures I-54 and I-55, are dependent on hydrologic conditions (the earliest dates are from the drought years of 2002–2004) and BO requirements for a given year.  The last release date for Supplemental Water each year was in October, the last month of the irrigation season for non-Pueblo irrigators, except in 2006, in which it was in early November, during the final period of Pueblo irrigation.  In Figures I-58 and I-59, these dates of ESA water release are compared to the dates of reported river drying in the Isleta Reach and the San Acacia Reach.  As can be seen on these graphs, ESA water release typically has been initiated in anticipation of river drying in these reaches.

The data presented demonstrate that Reclamation has met the flow requirements of the 2001 and 2003 BOs over the past decade, but that Reclamation's ability to do so was dependent on the following conditions and events:

- The availability of water to be leased to Reclamation's Supplemental Water Program, including both SJC Project water leased from willing sellers and water relinquished and leased to Reclamation by the State.
- Conservations measures and other helpful water management actions performed by Reclamation's water management partners, including the Corps, the Service/BDA, the State, and the MRGCD.
- No years with small, early snowmelt runoffs, such that Supplemental Water is required to maintain continuous flow throughout the MRG.

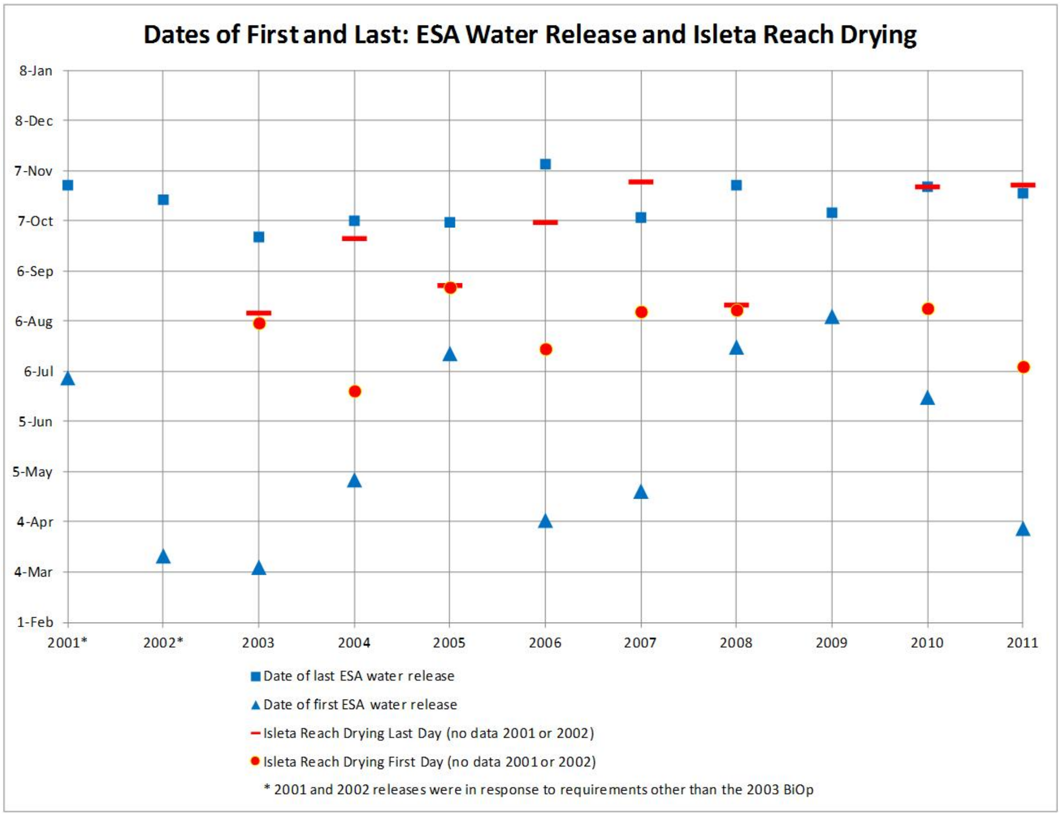



**Figure I-58. Comparison of dates of first and last release of water from Reclamation's Supplemental Water Program to dates of reported river drying in the Isleta Reach, 2001–2011**

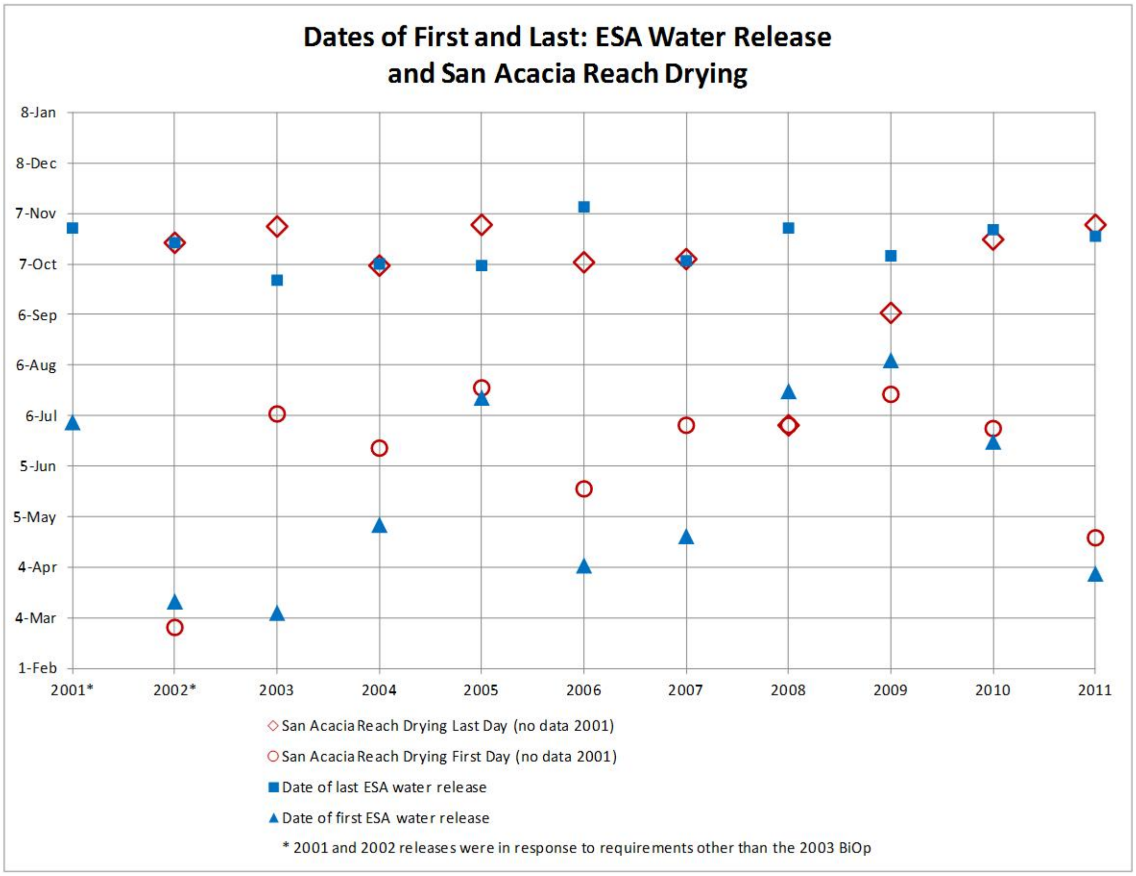



**Figure I-59. Comparison of dates of first and last release of water from Reclamation's Supplemental Water Program to dates of reported river drying in the San Acacia Reach, 2001–2011**

### *4.6.1.1.5 Pumping from the Low Flow Conveyance Channel*

Due to the long travel times for Supplemental Water stored in Rio Chama reservoirs, various types of diversion and river losses, and difficulties in meeting downstream flow targets during dry periods, Reclamation implemented a local water management alternative in the reach below San Acacia Diversion Dam, in which water collected from seepage into the LFCC is pumped from LFCC to the river. From 2001–2010, pumping of water from the LFCC to the river in the San Acacia Reach has been used to limit the extent of river drying from Neil Cupp south to Fort Craig and to assist in managing river recession and silvery minnow rescue. LFCC pumping was identified in the 2003 BO as a beneficial action that helps sustain habitat for both the silvery minnow and Southwestern willow flycatcher. Accordingly, Reclamation has performed this action as part of its Supplemental Water Program. As such, it does not preclude river drying when drying is allowed under the 2003 BO.

In 2000, Reclamation installed and operated temporary pumps at Neil Cupp, Mid-Bosque, South Boundary, and Ft. Craig to alleviate drying in the Rio Grande to benefit the silvery minnow and flycatcher. Subsequently, Reclamation relocated the Mid-Bosque pumps to North Boundary. In

June 2005 Reclamation produced an appraisal design study on installing permanent, electrically operated pumps at the four historical sites. Due to monetary concerns, the permanent-pump alternative was not pursued. At present, sites are located at both the northern and southern boundaries of BDA (North Boundary, South Boundary), Neil Cupp, and Fort Craig.

Although not required by the 2003 BO, Reclamation has continuously pumped water from the LFCC to the river at South Boundary during each of the summer drying seasons, except 2008, to maintain river flows south of BDA for the benefit of the silvery minnow. Other stations are used as needed, and as water is available, to assist in managing river recession (generally before the end of June) and to support silvery minnow salvage and rescue operations. The pumps at North Boundary and at Neil Cupp have been operated intermittently, primarily due to the need to balance the use of the available water in the LFCC between the Supplemental Water Program, the MRGCD (which has an LFCC diversion structure at Neil Cupp) and the BDA (which has an LFCC diversion structure at the north boundary of the refuge).

Figure I-60 shows the total amount of pumping from all of the LFCC pump stations since 2001 on an annual basis. LFCC pumping volumes ranged from 30 AFY (2008) to 32,481 AFY (2002). As this figure shows, total pumping was highest during the early 21st century drought years and has declined considerably since. A typical distribution of volume pumped at each site is given in Figure I-61, which was representative of the 2006 pumping season.

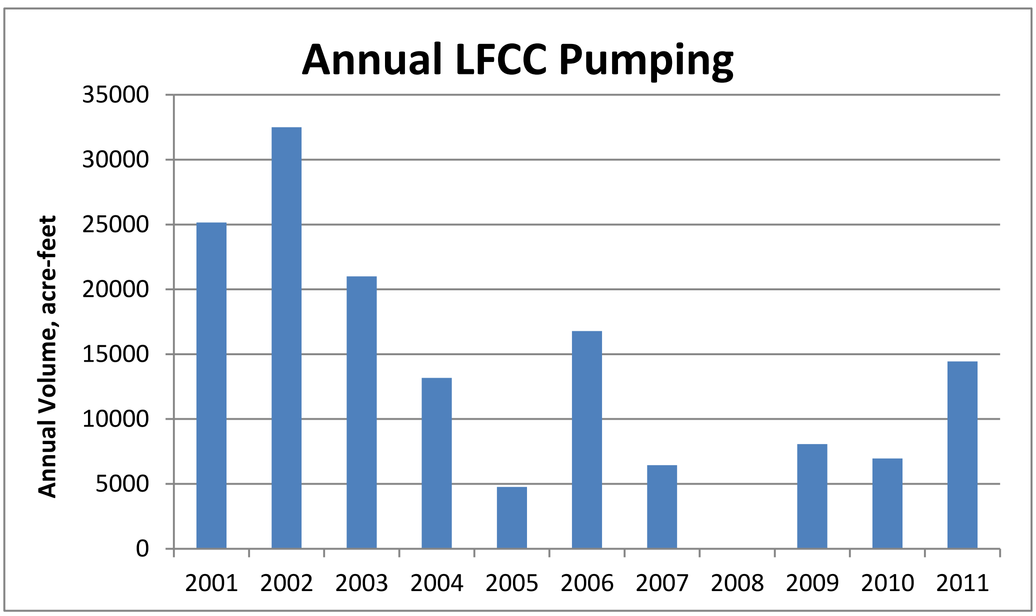



**Figure I-60. Summary of water pumped annually from the LFCC to the San Acacia Reach of the Rio Grande, as part of Reclamation's Supplemental Water Program**

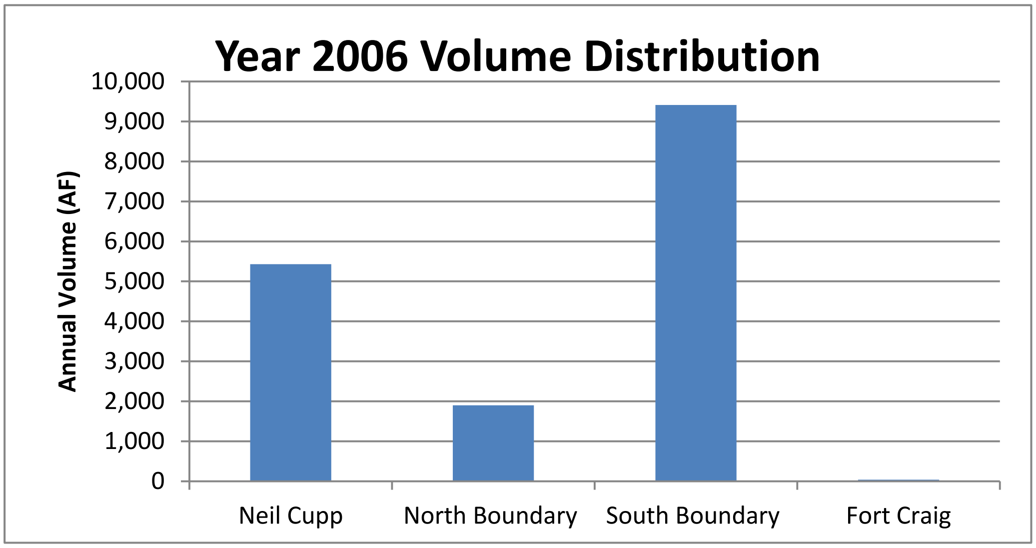



**Figure I-61. 2006 distribution of annual volume pumped from the LFCC across the four pumping sites used during the baseline period**

Figure I-62 provides a comparison of the time period during each calendar year in which Reclamation has pumped water from the LFCC to the San Acacia Reach of the river to the time period in which drying was reported in this reach. In most of these years, pumping has been initiated in anticipation of river drying and has helped to ameliorate the effects of that drying on the species by providing refugial wetted habitat at key locations.

#### *4.6.1.2 MRGCD's Conservation Activities.*

The MRGCD takes the below-described measures to support listed species. Additionally, the MRGCD participates in and shares the cost of the Collaborative Program, and has funded PVA model development (full funding for one of the two models under development).

##### *4.6.1.2.1 MRGCD's Enhanced Coordination for Environmental Water Operations*

The MRGCD's enhanced coordination for environmental water operations have included the following timeframe:

- Participation in the regular management of water operations throughout the MRG, in conjunction with Reclamation, the Corps, NMISC, the ABCWUA, and the Service with the goal of providing efficient water management, meeting the needs of all State permitted water uses, remaining in compliance with the Compact, and benefitting the species to the greatest extent practical.

- Provision of access to MRGCD managed lands for operational and scientific purposes involving species (including guides, keys, etc.), including activities related to habitat restoration projects, fish monitoring, and fish salvage.

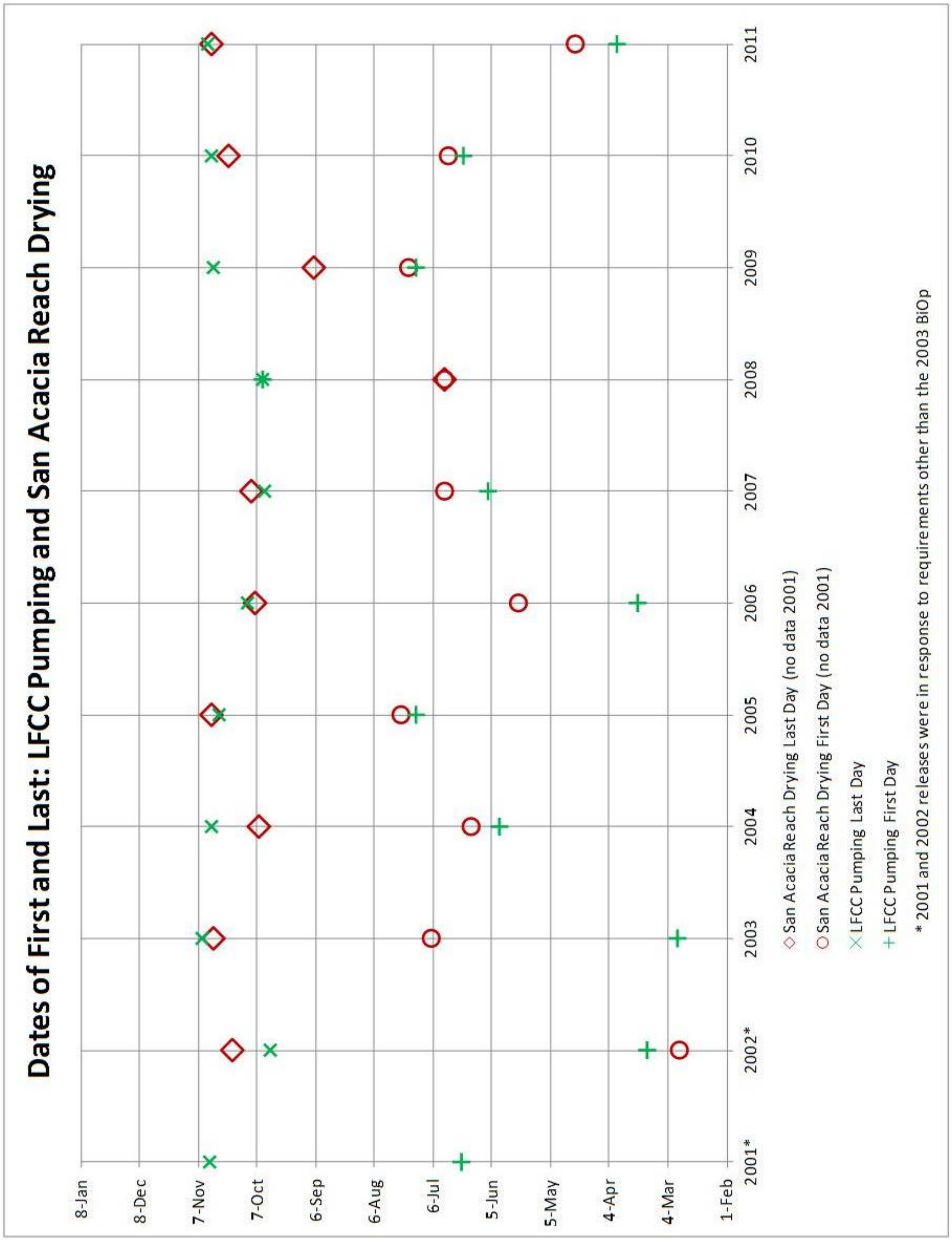



**Figure I-62. Comparison of the calendar days of supplemental water release to the calendar days of pumping from the Low Flow Conveyance Channel**

- Operation and maintenance of measurement stations, telemetry equipment, computer processing, and data exchange networks to collect and distribute information on MRGCD water operations to other water management entities and the general public.

- Expansion and refinement, with funding and cooperation from the State, Reclamation, and the Program, of the network of MRGCD measurement stations to contribute to a more thorough scientific understanding of water movement, distribution, and use throughout the MRG.

- Support for efforts by Reclamation and NMISC to fully understand Rio Grande depletions from all sources through participation in river measurements made by various entities.

- Support for management of Supplemental Water by Reclamation, and species salvage by the Service, through participation in river measurements during critical periods.

##### *4.6.1.2.2 MRGCD Operations to Support Instream Habitat and Flow Management*

The primary purpose of the MRGCD's operational measures described below has been to benefit listed species.

- MRGCD requested that Reclamation release from El Vado only the amount of irrigation water necessary to sufficiently augment native supplies to meet agricultural demands. This operational efficiency has the goal of increasing annual carryover of stored water, minimizing both Reclamation's need for Supplemental Water for the species and impacts of subsequent storage operations on flows. This allowed the MRGCD to minimize the rate of diversion at the Diversion Dams during critical times, most significantly Angostura Diversion Dam, and to continue to use the layout of the four MRGCD divisions to efficiently reuse return flows.

- The MRGCD has managed releases of return flows from drain outfalls and wasteways to better meet the needs of silvery minnow. These releases, which have been coordinated with Reclamation's Supplemental Water Program, have increased the consistency of return flows and have provided discrete wetted sections that have served as refugia for silvery minnow, with possible flycatcher benefit. On occasion, the MRGCD managed these releases to assist the Service with its silvery minnow rescue efforts.

- The MRGCD has exchanged Reclamation's Supplemental Water, as necessary, for an equal amount of native water. This exchange has ensured that all SJC Project water that was released under the Supplemental Water Program was beneficially consumed within the MRG.

- The MRGCD has borne all losses to Reclamation Supplemental Water through Cochiti and Albuquerque Reaches. As a result, Supplemental Water has been conveyed through the Cochiti and Albuquerque Reaches without incurring any loss. In exchange, the MRGCD has diverted the remaining Supplemental Water once it has passed the downsteam-most flow target specified in the 2003 BO.

- During periods with a continuous flow requirement through the MRG, the MRGCD has borne a variable portion of losses to Reclamation's Supplemental Water, to ensure that 50% of the Supplemental Water arriving at Isleta Diversion Dam is passed through the Isleta Reach to the San Acacia Diversion Dam.

- During its shortage/conservation operations in the fall of 2011, the MRGCD reduced diversions at Angostura Diversion Dam to the minimum practical rate of flow required to meet irrigation demand within the Albuquerque division.

- The MRGCD has exchanged water with Reclamation's Supplemental Water Program to allow the program to achieve intended rates of flow below diversion dams without accounting for travel time between the reservoir from which the water was released and the river reach of concern (that is, when Reclamation has begun releasing Supplemental Water, the MRGCD has bypassed water through its diversion dams to support critical reaches downstream, even though the Supplemental Water had not yet reached the diversion dam). The MRGCD has taken actions to avoid the sealing of gates in the Isleta Diversion Dam, such that the normal gate leakage of approximately 8 cfs is maintained throughout the irrigation season. This water has provided critical refugial habitat for the silvery minnow downstream from the dam.

- The MRGCD has taken actions to avoid the sealing of gates in the San Acacia Diversion Dam, such that the normal gate leakage of approximately 8 cfs is maintained throughout the irrigation season. This water has provided critical refugial habitat for the silvery minnow downstream from the dam.

###### *4.6.1.2.3 The MRGCD's Operation to Support Spring Peak Flows*

- The MRGCD has minimized or temporarily suspended diversions during periods of peak silvery minnow egg production to minimize incidental entrainment of eggs and larvae into irrigation canals; this action has been subject to rates of flow, agricultural needs, and coordination with the Service.

- The MRGCD has coordinated its storage requests with Reclamation, NMISC, and the Corps with the goal of maximizing peak discharge and/or duration of the spring runoff through the MRG to benefit the species.

### 4.6.2 Habitat Improvement

Habitat restoration elements in the 2003 BO include various components meant to benefit the species. Some elements are basically coordination efforts to utilize the best available methods to minimize take. For example, any project that may potentially affect flycatcher or silvery minnow habitat is coordinated with the Service including maintenance of LFCC pumps (Element P). This includes vegetation clearing and other activities that surround the pump sites. Water is a key element within the Rio Grande, and many gages in the river and within MRGCD (Element Q) have helped to ascertain the accurate accounting of water use. Other elements are more specific to improving conditions for endangered species and may be specifically tied to the recovery plan.

#### *4.6.2.1 Fish Passage*

Fish passage (Element R) has been delayed due to needed additional assessments. An external peer review process, initiated through the Collaborative Program, was completed in 2011. This peer review of the science surrounding the need for fish passage found that there was much uncertainty surrounding what the goals for fish passage are, and how many silvery minnow would need to use it to accomplish these goals (PBS&J 2011). The peer review panel recommended that more research into the relationship between genetic diversity and dam fragmentation as well as the influence of habitat mitigation within reaches on movement, growth, survival, and reproductive success of the silvery minnow be conducted before fish passage at San Acacia Diversion Dam is attempted.

#### *4.6.2.2 Habitat Restoration*

Habitat improvement projects (Elements S, T, and X) and efforts by other parties in coordination with the Collaborative Program, yielded over 2,500 acres of habitat restoration work in the MRG at a cost of $16,487,092. This amount includes Reclamation and Collaborative Program amounts for actual construction. Additional funding was provided for planning, design, and monitoring costs (not included in the $16.4 million).

The initial focus of these restoration efforts was in the more degraded upstream reaches between Cochiti Dam and Isleta Diversion Dam. However, more recently the emphasis has expanded to include significant restoration efforts in the Isleta Reach. Funded through the Collaborative Program, the Corps, Reclamation, the Service's Management of Exotics for Recovery of Endangered Species program, ABCWUA, the Pueblos, City of Albuquerque, and others have provided localized changes to improve riverine and riparian conditions along the MRG.

The projects have used techniques including creating/opening secondary high-flow channels, lowering/clearing bank lines, islands, and adjacent bars, creating overbank flooded habitat, clearing non-native vegetation, planting native vegetation, building gradient reduction facilities, widening the river channel, placing large woody debris, building embayments and backwater areas, and removing lateral constraints. Further descriptions of the methods, the most likely geomorphic and biological response, as well as habitat characteristics of the habitat restoration techniques commonly used on the MRG over the last decade is included in Appendix B. Because the MRG is actively self-regulating to balance its sediment transport capacity and sediment supply, exact geomorphic and biological responses to a particular method after implementation are more difficult than for rivers that are closer to a sediment balance. Caveats on the use of the geomorphic responses are described in the Channel Conditions and Dynamics section.

The objective of many of the projects has been to provide additional low-velocity habitats during high flows and increase retention of eggs and larvae within the upper reaches of the river when inundation targets are met for these projects. Habitat restoration techniques that have been used for improving habitat at lower-flow conditions include creation of refugial habitat at drains and placement of cottonwood snags or large woody debris that create pool habitat. Specific projects for flycatchers also have been completed, which replace monotypic stands of saltcedar with dense native vegetation and provide greater floodplain connectivity.

Monitoring is ongoing to evaluate if restoration is producing positive results for silvery minnow and flycatchers and to evaluate effectiveness of techniques used. Generally, most projects have had positive results and use by silvery minnow. For silvery minnow, it is considered to be a success if more low-velocity habitat is available at the sites than was available prior to restoration. Large numbers of silvery minnow have been collected on inundated sites (Collaborative Program 2011, SWCA 2010a, 2010b). Creation of suitable flycatcher habitat is predicted to take several years post-construction for mature vegetation to establish. No suitable habitat was identified in the 2008 flycatcher habitat suitability model. At this time, no flycatcher nesting has been verified on any program habitat restoration sites.

Hydrologic monitoring on NMISC restoration sites indicates that these sites provide fish habitat that is lower velocity and shallower than the adjacent river channel. Monitoring efforts also have been analyzed to understand the potential differences in hydrological conditions produced by different general restoration techniques. For this effort, four broad categories of habitat restoration techniques were used: high-flow channels, backwaters, and lowering of bank shelves and islands (Table I-19). While all techniques produced hydrologic habitat conditions that fall within the suitable habitat range, backwaters generally produced the lowest velocity and the second highest depths. High-flow channels resulted in both the highest depth and highest velocity conditions. Shelves and islands were the only two techniques that had conditions within the suitable habitat range recorded in each measured transect (NMISC 2011).

**Table I-19. Average depth and velocity conditions on categorized habitat restoration sites (ISC 2011 Draft)**

| Technique Categories | Sample Number (n) | Mean Depth (ft) | Mean Velocity (ft/s) |
|---|---|---|---|
| High-flow Channels | 24 | 1.23 | 1.24 |
| Backwaters | 15 | 1.18 | 0.23 |
| Bank Shelves | 33 | 0.76 | 0.35 |
| Island | 24 | 0.67 | 0.32 |

The amount of restored habitats that inundate annually varies depending on discharge. Most features have been designed to inundate at flows between 1,500 and 3,500 cfs at the site location. The amount of restored acreage that inundates annually increases with the amount of flow, though all features do not function equally at flows greater than their designed inundation level. For example, a feature designed to inundate at 1,500 cfs may not provide low-velocity habitat at 3,500 cfs. Since 2000, 4 years had spring discharge levels that fully inundated restored sites in the Albuquerque Reach (> 3,500 cfs) for more than 10 days, while 5 years failed to inundate any sites designed for 1,500 cfs or more for at least 10 days (Table I-20). Available data for the Bosque Farms and 346 Bridge Gage show that the inundation targets for restoration sites in the Isleta Reach are met less often.

**Table I-20. Maximum consecutive days of discharge exceeding habitat restoration inundation targets at Albuquerque Gage from 2000–2011 (USGS8330000), Bosque Farms Gage from 2006–2011 (USGS 08331160), and Highway 346 Gage from 2006–2011 (USGS 08331510). Dark shading indicates no days with average discharge greater than inundation targets. Lighter shading indicates inundation less than 10 consecutive days.**

| Albuquerque Reach | | | |
|---|---|---|---|
| **Albuquerque Gage** | **Inundation Target (cfs)** | | |
| *Year* | *3,500* | *2,500* | *1,500* |
| 2000 | | | |
| 2001 | 2 | 6 | 37 |
| 2002 | | | |
| 2003 | | | |
| 2004 | | 1 | 13 |
| 2005 | 71 | 78 | 88 |
| 2006 | | | 1 |
| 2007 | 3 | 15 | 37 |
| 2008 | 22 | 92 | 103 |
| 2009 | 20 | 34 | 47 |
| 2010 | 12 | 31 | 62 |
| 2011 | | | |

| Isleta Reach | | | |
|---|---|---|---|
| **Bosque Farms Gage** | **Inundation Target (cfs)** | | |
| *Year* | *3,500* | *2,500* | *1,500* |
| 2006 | | 1 | 2 |
| 2007 | | 4 | 28 |
| 2008 | 11 | 27 | 92 |
| 2009 | 13 | 28 | 35 |
| 2010 | 4 | 6 | 31 |
| 2011 | | | |
| **346 Bridge** | | | |
| 2006 | | | |
| 2007 | | 4 | 27 |
| 2008 | 12 | 26 | 93 |
| 2009 | 15 | 33 | 35 |
| 2010 | 5 | 7 | 32 |
| 2011 | | | |

Table I-21 provides a brief description of habitat restoration projects and the listed acreage of that work. Information was compiled from the Collaborative Program's annual reports and Reclamation's annual Biological Opinion Accomplishment Reports sent to the Service.

**Table I-21. Summary of habitat restoration activity on the Rio Grande, sorted by geomorphic reach**

| Year | Type of Work | Project Lead/ Project Name | Total Work Done |
|---|---|---|---|
| | ***Rio Chama to Otowi Bridge*** | | |
| 2004 | Non-native vegetation removal and native vegetation planting | Ohkay Owingeh Pueblo | 40 acres vegetative removal, 75 acres native planted |
| | Removal of approximately 40 acres of Russian olive and other exotic vegetation. In addition, willows and native wetland plants were planted in two areas. | Ohkay Owingeh Pueblo | 75 acres |
| 2005 | Flycatcher habitat created at Ohkay Owingeh Pueblo creation of high-flow channels, removal of non-native trees, and planting of native tree species | Ohkay Owingeh Pueblo | 10 acres |
| 2007 | Ohkay Owingeh Pueblo installed habitat within restored bosque, also included exotic vegetation removal | Ohkay Owingeh Pueblo | 10 acres |
| 2007 | Buried Bendway weirs at San Ildefonso | Reclamation | |
| 2008 | Ohkay Owingeh Pueblo installed habitat within restored bosque, also included exotic vegetation removal | Ohkay Owingeh Pueblo | 38 acres removed, replanted |
| 2010 | Ohkay Owingeh Pueblo invasive species removal and native vegetation planting: 15,000 herbaceous wetland plants, 3,500 coyote and Gooding's willows, and 148 box elder. | Ohkay Owingeh Pueblo | 279 acres replanted |
| | Total Rio Chama to Otowi | | 487 acres of habitat work |
| | ***Cochiti Dam Reach*** | | |
| 2005 | Bank lowering at Santa Fe River confluence1.6 acres reconnected to river and planted with native vegetation | Reclamation | 1.6 acres reconnected |
| 2006 | Modification of side channel to connect with main stem, creation of embayments and backwater, non-native vegetation removal. | Santo Domingo | 114 acres non-native removed, 2 acres side channel, embayment |
| 2007 | Santo Domingo Pueblo reconnected an old oxbow to the main channel, created embayments, and installed large woody debris to the main channel | Santo Domingo | 23 acres, oxbow recreation |
| 2008 | Removal of non-native vegetation at San Felipe Pueblo | San Felipe Pueblo | 10 acres non-native removed |
| 2008 | Riparian and backwater area creation; bioengineering at the Pueblo de Cochiti | Reclamation | 7 acres backwater |
| 2009 | Santo Domingo Pueblo - removal of invasive species and channel restoration over three areas | Santo Domingo | 58 acres combined non-native removal and channel |
| 2010 | Santo Domingo Endangered Species Habitat Improvement Project Phase IV– reconstruction of a historical side channel | Santo Domingo | 9 acres historical side channel |
| 2011 | Revegetation and construction at two Santo Domingo sites | Santo Domingo | 30 acres |

**Table I-21. Summary of habitat restoration activity on the Rio Grande, sorted by geomorphic reach**

| Year | Type of Work | Project Lead/ Project Name | Total Work Done |
|---|---|---|---|
| 2011 | Vegetation clearing, riparian and backwater area creation, bioengineering at the Pueblo of San Felipe | Reclamation | 18 acres of non-native vegetation removal, 5 acres of habitat restoration; bioengineering planted with native vegetation |
| | **Total Cochiti to Angostura** | | **272.6 acres habitat work** |
| | ***Angostura Reach*** | | |
| 2003 | Habitat restoration at the Pueblo of Sandia | Sandia Pueblo | 40 acres restored |
| 2003 | Clearing non-native vegetation, installation of willow swales and Gradient Restoration Facilities. | Santa Ana | Cleared 500 acres of bosque, 100 acres of willow swale, 4 GRFs |
| 2003–2004 | Perennial pools created using cottonwood large woody debris through Albuquerque Reach | MRGCD | 3 cottonwood snags |
| 2004 | Willow swale installation at Santa Ana Pueblo | Santa Ana Pueblo | 10 acres willow swale |
| 2004 | Wetland creation and bosque restoration at Tingley Beach | City of Albuquerque | 48 acres restoration, wetland creation (Tingley) |
| 2005 | Island and bank destabilization through the Albuquerque Reach | ISC/Reclamation | 12 acres bar destabilization |
| 2005 | Pond reconstruction, bosque restoration, and wetland creation at Tingley Beach | City of Albuquerque | 9 acres wetlands construction, 15 acres pond reconstruction |
| 2005 | Removal of non-native vegetation throughout the Albuquerque Reach | | 200 acres non-native removal and replanting |
| 2006 | ISC performed bank lowering, island lowering, and ephemeral channel excavation north of Alameda bridge through the Albuquerque Reach | ISC | 74 acres, bank, island lowering |
| 2006 | Habitat creation at the Rio Grande Nature Center | Corps/Rio Grande Nature Center | 15 acres various riparian |
| 2006 | Floodplain lowering and formation of riparian habitat near Bernalillo | ISC | 6 acres high-flow channel |
| 2007 | Excavation of ephemeral channels and removed non-native vegetation at the Rio Bravo south site | City of Albuquerque | 26 acres non-native removal near channel |
| 2007 | U.S. Highway 550, Paseo del Norte to Montano Road, in the vicinity of the I-40 bridge and in the vicinity of the South Diversion Channel. Restoration techniques included vegetated island modification, bar habitat modification, placement of large woody debris, bank scouring, bank lowering, and the establishment of ephemeral channels. | ISC | 87 acres, various methods |
| 2007 | Riparian and variable flow aquatic habitat created on the Pueblo of Sandia , construction of bendway weirs and placement of rootwads | Reclamation | 35 acres, mostly riparian near aquatic |
| 2008 | Habitat restoration at north Rio Bravo site | City of Albuquerque | 1.3 acre Rio Bravo |
| 2008 | Rio Grande Nature Center bosque reconnection with the Rio Grande | Corps/Rio Grande Nature Center | 10 acres non-native, 3 acres high-flow channel |

**Table I-21. Summary of habitat restoration activity on the Rio Grande, sorted by geomorphic reach**

| Year | Type of Work | Project Lead/ Project Name | Total Work Done |
|---|---|---|---|
| 2009 | Bank lowering project/habitat restoration | Corps | 27 acres of habitat restored, 62 acres of banks and islands were lowered |
| 2009 | Construction of backwater and other bank lowering activities | City of Albuquerque | 20 acres of bank and bar lowering; 5 acres of habitat was created by the backwater construction |
| 2009 | Removal of jetty jacks and created habitat north of Rio Bravo by reshaping of the bank | City of Albuquerque | 140 jetty jacks, re-treated 20 acres of resprouting non-native vegetation, and planted 40 cottonwoods, 250 black willows, and 4,000 sedges and rushes. 58.3 acres of habitat were created. |
| 2009 | Route 66 bosque restoration, 121 acres of riparian restoration, 5 willow swales, and 3 high-flow channels | Corps | 121 acres of habitat restored |
| 2009 | Sediment spoil pile removal | Santa Ana/ Reclamation | 20 acres of overbank improved |
| 2009 | Construction of a 5-acre backwater and refugial habitat at an old irrigation diversion structure, named the Atrisco Diversion. Also, 20 acres of river bankline, islands, and bank-attached bars were modified by lowering and sculpting to create new floodplain habitats that inundate during spring runoff | ISC | 25 acres |
| 2009 | Re-connection of floodplain at the Pueblo of Santa Ana | Pueblo of Santa Ana/Corps | 62 acres of bank-lowering to increase the extent and frequency of inundation in the Pueblo's reach of the Rio Grande |
| 2010 | Project features include island and bar vegetation removal and destabilization, bank lowering, and backwater embayments | Sandia Pueblo | 24 acres bar lowering, backwater |
| 2011 | Project features include island and bar vegetation removal and destabilization, bank lowering, and backwater embayments | Sandia Pueblo | 30 acres, backwaters, destabilization |
| | Total Angostura Diversion Dam to Isleta Diversion Dam | | 1,530 acres habitat work |
| | ***Isleta Reach*** | | |
| 2003 | Riverbank was lowered and bank features constructed at Los Lunas Habitat Restoration Project | Reclamation | 50 acres bank lowering, etc. |
| 2005 | Pole planting of native vegetation at 2002 Los Lunas restoration site | Reclamation | 16 acres replanted |
| 2007 | MRGCD, Reclamation, and Habitech collaborated in the anchoring of enhancement structures comprised of large cottonwood snags in the MRG channel at the outfalls of the three drains located upstream of Highway 308 near Belen, New Mexico in the Isleta Reach | MRGCD | Structures installed on three drains. |
| 2008 | Isleta Pueblo – Island destabilization project funded by New Mexico Water Trust Board. | Isleta Pueblo | |

**Table I-21. Summary of habitat restoration activity on the Rio Grande, sorted by geomorphic reach**

| Year | Type of Work | Project Lead/ Project Name | Total Work Done |
|---|---|---|---|
| 2009 | Modification along banklines, islands, and bank-attached bars to create new floodplain habitat. The new habitat features include a large off-channel backwater in a low-lying area of the Bosque. | ISC/Isleta Phase I | 24 acres, island modification and bank lowering, 5.8 acre backwater |
| 2010 | Habitat modification includes nonnative species removal, high-flow channels, and bank lowering. | ISC-Reclamation/ Isleta Phase II | 56 acres, various techniques |
| 2011 | Habitat modification includes nonnative species removal, high-flow channels, and bank lowering. | ISC-Reclamation/ Isleta Phase II | 45 acres, various |
| | Total Isleta Reach | | 196.8 acres habitat work |
| | ***San Acacia Reach*** | | |
| 2003 | Helicopter spraying of dense saltcedar groves south of Socorro. | | 230 acres sprayed, vegetation control |
| 2005 | Setback of lateral constraints around RM 113/114 | Reclamation | 187 acres to readjust |
| 2005 | Removal of monotypic saltcedar and the mechanical control of non-native vegetation river bars and jetty jacks removal. | BDA | 51 acres non-native removal |
| 2006 | Removal of monotypic saltcedar and the mechanical control of non-native vegetation river bars and jetty jacks removal. | BDA | 76 acres non-native removal |
| 2009 | Setback of lateral constraints around RM 111, additional space provided for river to self adjust | Reclamation | 59 acres setback |
| | Total San Acacia Reach | | 603 acres habitat work |
| | **Total habitat work (all reaches)** | | **3,089 acres** |

#### *4.6.2.3 Railroad Bridge Relocation*

The relocation of the railroad bridge at San Marcial (Element U) has not been implemented due to cost and lack of agency authorization. With the steady lowering of Elephant Butte Reservoir levels since 2001, the headcut that has resulted has contributed to increasing the flow capability under the bridge, which was the original reason for the relocation.

#### *4.6.2.4 Overbank Flooding and Sediment Transport*

The Corps has stored and later released floodwater to increase the number of days of floodplain inundation downstream from Cochiti Dam. With a degraded river channel and the very established vegetation along much of the river, the maximum flow allowed from Cochiti Dam (7,000 cfs) has limited ability to create new backwater habitats for silvery minnow and flycatcher within the upper reaches (Element V). Habitat restoration projects have increased the area that inundates at lower discharge levels. Increased sediment transport out of Cochiti, Jemez, and Galisteo Dams (Element W) has not fully been implemented but is ongoing. In addition to this possible source of sediment into the overall sediment starved MRG, and indirect benefit from all the ongoing habitat restoration work is that approximately 2–3 million cubic yards of sediment have been reintroduced into the river. This number is derived from a summation of Clean Water Act 404 permits and environmental assessments submitted for the projects.

### 4.6.3 Salvage and Captive Propagation and Actions to Minimize Take of Silvery Minnow

Propagation of silvery minnow has been very successful; in most years, there are more silvery minnow available at propagation facilities than are needed for MRG augmentation activities (Element Y, Z, AA). Dexter National Fish Hatchery and Technology Center has been able to supply more than enough silvery minnow than are required annually for the MRG. Hatchery fish also are maintained in two other facilities (Albuquerque Biopark and NMISC Los Lunas Refugium). Silvery minnow also were held at the New Mexico State University A-Mountain Facility for research purposes. That program was discontinued in 2009. Genetic testing so far indicates that the captive fish are representative of the wild population, and augmentation has aided in maintaining genetic diversity between reaches (Osborne et al. 2012). A fourth recently constructed silvery minnow sanctuary within the Angostura Reach will also eventually contribute towards minnow management. If negative impacts to minnow population occur in the river, these propagation facilities can provide minnow back to the river. Reclamation and the Collaborative Program exceeded the monetary support requirements for these propagation facilities with a total of $6,644,970 provided to the Service, the Albuquerque Biopark, the ISC Refugium, and the Minnow Sanctuary for expansion (at Dexter) and O&M to date.

The 10j experimental population in the Big Bend area (Element BB) is now in its third year, and recruitment has occurred. Hatchery produced silvery minnow were provided for this reintroduction from MRG propagation facilities. The population needs to be monitored for several more years, but the results are encouraging. Lessons learned from this activity can be used when the next population is established (Element CC). Reclamation and the Collaborative Program exceeded the monetary support requirements for this activity with a total of $1,362,276.00 provided to the Service.

Silvery minnow have been salvaged from drying reaches each year except 2008 (RPM 1.2, 1.3). To determine the extent of drying and facilitate salvage of silvery minnow, RiverEyes contractors monitor the river daily (Element C). It has been difficult to determine how salvage benefits (RPM 1.3) the silvery minnow population, as it likely depends on the duration and magnitude of drying; however, relocating fish into flowing habitat does reduce the amount of mortality due to drying. Protocols for salvage were adjusted in 2007 in an effort to increase the likelihood that salvaged fish are fit enough to survive when released (Remshardt 2010b, Caldwell et al. 2010). River flows are ramped down slowly using Supplemental Water in coordination with the Service. Pumping from the LFCC aids the rampdown process.

During the spawning period for the silvery minnow, egg monitoring in irrigation canals and entrainment have been assessed, and egg monitoring and collection occurs within the river channel (RPM 2.1 and 2.2). Egg monitoring has occurred each year except 2005. The Service monitors eggs within the canals and more in-depth analysis of the egg entrainment data is underway by the Service. ABCWUA also conduct egg monitoring activities upstream of the Paseo del Norte diversion, near the water intake point, to estimate and reduce the amount of silvery minnow eggs entrained in the diversion structure. Egg collection activities are coordinated between the City of Albuquerque and the Service.

### 4.6.4 Water Quality

Since 2001, there are many general water quality assessments and specific studies that have been completed or are in process (Element DD, EE). Much of the data collected by these studies have not been clear and definitive on the effects of various water quality parameters on the silvery minnow population. The current status of information is presented in Section 3.1.2.4.4.

### 4.6.5 Monitor Cowbird Parasitism

A cowbird control program was conducted along the MRG from 1996–2001. This program involved trapping and removing cowbirds in an effort to reduce brood parasitism on flycatchers. In 1998, a telemetry study was initiated to determine the daily and seasonal movements of cowbirds to evaluate the effectiveness of localized cowbird trapping efforts (Sechrist and Ahlers 2003). *An Assessment of the Brown-Headed Cowbird Control Program in the Middle Rio Grande, New Mexico* was prepared in 2003 by Moore and Ahlers to monitor the success of the cowbird trapping and removal effort. To complete this assessment, a nest monitoring and point count study was conducted targeting neotropical avian species. The end result concluded that, although cowbird trapping was effective on a local level by reducing cowbird abundance and parasitism rates, it is an ineffective method for increasing overall nesting success.

In 2006, a report titled *Riparian Obligate Nesting Success as Related to Cowbird Abundance and Vegetation Characteristics Along the Middle Rio Grande, New Mexico* by Dave Moore concluded that habitat quality is the most important factor to neotropical migrant nesting success. Similar to the report from 2003, it was found that when parasitism rates were locally reduced, other factors (e.g., predation) came into play that inevitably kept nesting success at the same level.

In addition to studies focused on cowbird parasitism, all nests monitored since 1999 have indicated whether or not parasitism was present. Further analysis on nest parasitism versus nesting substrate, territory dominance, and hydrology immediately under the nest is completed annually.

### 4.6.6 2003 BO Conservation Recommendations

Many of the 25 conservation recommendations in the 2003 BO have been implemented and/or are ongoing studies. Results from some of the studies indicate the need for additional work or refinements of the original hypothesis. Table I-22 is a list of the conservation recommendations with their current status.

**Table I-22. Synopsis of activities for conservation recommendations as defined in the 2003 BO**

| | Conservation Recommendations and Studies | Studies to Date |
|---|---|---|
| 1 | Effects of turbidity and suspended sediment on silvery minnow | The Service was funded by the Collaborative Program to investigate fish health including effects of suspended sediment. This project is still ongoing; initial findings indicate that high suspended sediment may affect the amount of food available to silvery minnow (Lusk PowerPoint 2011), which concurs with findings by Magana (2009) and Bixby and Burdett (2011). |
| 2 | Effects of sediment toxicity on silvery minnow | NMED 2009 review of current information found that chemical concentrations in sediment may have some impacts to fish and aquatic life. Based on the data collected in 2006–2007, the concentrations are not at levels where fish kills would be expected due to any one chemical; however, several chemicals were found above levels where adverse effects are expected to occur only rarely. |
| 3 | Silvery minnow diet and sediment ingestion | Diet studies have been conducted on hatchery fish (Magana 2009, Watson et al. 2009) that indicate that silvery minnow are primarily algavores but may use other food items such as macroinvertebrates depending on their availability. There are upcoming projects to determine diet and habitat use of larval fish. |
| 4 | How effluents from waste water treatment plants mix with Rio Grande at various discharges | Not completed. |
| 5 | Water pollution education; effects and prevention | Not completed specifically for MRG. |
| 6 | Voluntary water quality monitoring by citizens | Not completed. |
| 7 | Agricultural water forbearance program | A water management decision support system was developed in 2007 by NMISC. MRGCD would be the lead agency to implement a forbearance program. |
| 8 | Program for conversion of high to low water use crops | ISC's MRG Water Plan www.waterassembly.org/waterplan.htm describes the benefits and tradeoffs associated with converting to low water use crops. Further development of these ideas would need to be developed with MRGCD, NMDA, and others. |
| 9 | Monitor/study silvery minnow spawning | Ongoing activity, spawning mentoring in the river and canals is funded each year by Reclamation. Studies indicate few eggs are currently entrained in canals (Service Data). River monitoring provides information on the timing and conditions surrounding spawning events in the river. |
| 10 | Develop and implement long-term plan | Ongoing in Collaborative Program |

**Table I-22. Synopsis of activities for conservation recommendations as defined in the 2003 BO**

| | Conservation Recommendations and Studies | Studies to Date |
|---|---|---|
| 11 | Annually survey and report flycatcher habitats to the Service | Surveys began in 1994 in a more concentrated area but have expanded to the southern boundary of Isleta Pueblo to Elephant Butte Reservoir since 2002. Areas near Velarde and Frijoles Canyon also have been surveyed periodically. |
| 12 | Fund flycatcher habitat requirements study | A nest monitoring effort supplies information on habitat requirements (i.e., distance to water, nest substrate species, major plant community, etc.) and compares nesting components to nest success. A nest quantification study from 2004–2006 provided insight to habitat requirements such as stem densities and percent canopy cover for example. A mapping effort and subsequent habitat suitability model was completed in 2008 from Bernardo to Elephant Butte. Previous mapping efforts took place using the modified Hink and Ohmart approach in 2002 and 2005. |
| 13 | Contingency plan for fire in flycatcher habitat | Not formally completed. In a recent fire within the Elephant Butte Reservoir pool, coordination among fire crew and Reclamation and Bureau of Land Management staff took place to focus on protecting occupied flycatcher habitat from destruction. |
| 14 | Study groundwater/surface water relationship | This study is very site-specific and dependent on soil composition, vegetation composition, and other factors. A groundwater model was developed by USGS. Also, a study using dataloggers to document the groundwater levels and comparing that information to flows in the river was initiated in BDA in 2010. |
| 15 | Implement water efficiencies and apply savings to silvery minnow and flycatcher conservation | There are many informal water conservation contributions that MRGCD has implemented. ABCWUA routinely evaluates and improves/ monitors the water conservation program. |
| 16 | Encourage adaptive management of flows and conservation of water for ESA species | A formal Adaptive Management Program is being developed for the MRG (see Part V). |
| 17 | Secure storage rights and water for ESA species | Not completed; studies needed |
| 18 | Fund habitat preference studies for silvery minnow | Habitat use studies were done by Platania in 1997 based on the population monitoring information. Studies to understand habitat availability at various flow conditions were completed at several sites by Bovee et al. 2008. Their model indicated that greater amounts of suitable habitat (as defined by the recovery plan) at discharges between 100 and 200 cfs. Additionally, the Corps is currently funding USGS to conduct a habitat availability study. |

**Table I-22. Synopsis of activities for conservation recommendations as defined in the 2003 BO**

| | Conservation Recommendations and Studies | Studies to Date |
|---|---|---|
| 19 | Study saltcedar control and ensure no impacts to willow flycatcher and seek funding for habitat restoration | A study was initiated in 2002 to analyze revegetation strategies and restoration of saltcedar infested sites. This study used mechanical treatments, growth amendments, herbicide applications, and seeding mixtures in an effort to restore the site. A final report was not completed; but upon visiting the site, it appeared that not many native species developed. Young saltcedar and kochia revegetated the area instead.<br>Goats were released within a study plot in 2004 to study their impacts on saltcedar resprouts. After 2 years of treatment, less than 10% of saltcedar plants were killed. However, duff and leaf area index was reduced by 27% and plants were damaged/stressed.<br>Saltcedar leaf beetles have been recently detected within the MRG. Monitoring is underway to determine the effects of this species on the MRG bosque. |
| 20 | Prevent unauthorized use of silvery minnow water | River discharge is monitored at several locations. The MRGCD has an ongoing process to identify water rights and leases within their district boundaries. |
| 21 | Assess flycatcher population at Elephant Butte Reservoir | Multiple studies on hydrologic and vegetation parameters as well as annual surveys and nest monitoring have taken place within the Elephant Butte Reservoir and associated population of flycatchers. A flycatcher management plan is currently in place to focusing on developing suitable habitat outside of the reservoir pool. |
| 22 | Use drains for silvery minnow refugia | Low densities of silvery minnow likely persist within the permanently watered canals such as the LFCC and drains (Cowley et al. 2007, Lang and Altenbach 1994, Reclamation 2010). Buhl 2011 conducted in situ studies in drains to inform refugia development. Woody structures were installed at the outflow of several drains to provide habitat. Results of these projects have been mixed. |
| 23 | NMDGF monitor silvery minnow at Angostura Reach | Not conducted routinely; Angostura monitoring is covered in Population Monitoring Program. |
| 24 | Limit human encroachment into 10,000 cfs floodplain | Houses build adjacent to the bankline have already restricted flows below the Highway 550 Bridge near Bernalillo to 7,000 cfs. Isleta Reach has very limited encroachment between the levees on both sides of the river. The Collaborative Program San Acacia Reach group has proposed a reach assessment be accomplished in 2013. |

**Table I-22. Synopsis of activities for conservation recommendations as defined in the 2003 BO**

| | Conservation Recommendations and Studies | Studies to Date |
|---|---|---|
| 25 | Investigate effects of predation and competition on silvery minnow | There is little information on the effects of predation and competition on silvery minnow within the MRG. Discussions of extirpation of silvery minnow within the Pecos watershed cite competition with introduced plains minnow as a primary factor (Hoagstrom et al. 2010). |

# 4.7 Summary of Baseline Conditions for Listed Species

There has been a multitude of recent activities in the MRG aimed at improving the status of the currently listed species, especially the silvery minnow and flycatcher. Flycatcher population levels have increased since the initiation of the 2003 BO. The silvery minnow population has fluctuated substantially since 2003, with peak densities in 2005 and extremely low densities since 2012. The following evaluates the status of baseline conditions for the listed species in each reach. In addition, tables are developed for each major period in the life history of the silvery minnow, flycatcher, cuckoo, and mouse presenting the current knowledge of the status of each critical habitat PCE.

## 4.7.1 Summary of Habitat Condition, Species Status, and Restoration by Reach

The following information is a short summary of habitat conditions and habitat restoration projects on the Rio Grande, sorted by geomorphic reach, as well as information on silvery minnow, flycatcher, cuckoo, jumping mouse, and Pecos sunflower status in the area.

### *4.7.1.1 Rio Grande above Cochiti Dam and Rio Chama*

#### *4.7.1.1.1 State Line to Otowi (State Line–RM 258)*

For the silvery minnow, although there are historical records of the species from this reach, it was likely never abundant (Bestgen and Platania 1991). Silvery minnow have not been documented in this reach for over 30 years; the last silvery minnow was captured near Velarde in 1978, five years after the closing of Cochiti Dam in 1973 (Bestgen and Platania 1991).

Along the Rio Grande from the Colorado state line to Otowi, 18 flycatcher territories were documented in 2000. In 2004 and 2005, 12 territories were detected (Service 2014b). In 2009, the population increased to 34 territories. A total of 23 territories were identified in 2011, which was the last year on record with a disclosed number of territories submitted to the Service (Service 2014b). As of 2011, 452 acres of habitat restoration was funded for habitat restoration within this reach. The goal of these projects was to improve the health of the river for flycatchers, and the reach continues to be occupied by flycatchers. Flycatcher critical habitat exists in this reach from Taos Junction Bridge to the upstream boundary of Ohkay Owingeh Pueblo, as well as a section of critical habitat located near Española, New Mexico between Ohkay Owingeh and Santa Clara Pueblos.

Cuckoo critical habitat for this reach has been proposed and is mostly eligible for exclusion based on Pueblo Management Plans. It is largely unknown how many breeding territories may be located in this reach.

For the jumping mouse, although historically the species was found at Ohkay Owingeh Pueblo, no jumping mice were found during surveys performed in 2012 (Service 2014e). Because this area has suitable habitat and previously was confirmed to be occupied by jumping mice, the Ohkay Owingeh Subunit is being considered for listing as critical habitat. There are two segments within this subunit for a total of 51 ha (125 acres) along 4.8 km (3.0 miles) of ditches, canals, and marshes. The first segment begins at the junction of New Mexico Highway 291 and immediately west of the middle Rio Grande, generally follows riparian areas, and terminates about 0.6 km (0.4 mi) southeast of Guique, New Mexico. The second segment begins near San Juan Lakes, east of the Rio Grande 0.08 km (0.05 mi) east of Fishpond Road and extends about 0.4 km (0.25 mi) southeast, where it heads northwest about 0.9 km (0.6 mi) through a series of ponds and marshes, paralleling the eastern edge of the fishing pond (Service 2014e). This habitat is important as an area for possible reintroduction of jumping mice.

##### *4.7.1.1.2 Chama River (Willow Creek Confluence to Confluence with Rio Grande)*

For the silvery minnow, there are few early fish sampling records in the Rio Chama. There is some historical information from tribal sources that silvery minnow may have occupied the Chama up to approximately Abiquiu (Parametrix 2010). There is no critical habitat designated in this reach of the river. No habitat restoration projects have been done on this reach for silvery minnow or flycatchers.

Along the Rio Chama to the confluence of the Rio Grande, flycatcher surveys have been recorded in the NM Rangewide Database since 1993 (Service 2014b). In 1993, two flycatcher territories were observed. The largest population detected in this reach was in 1994, 1997, and 2001 with four territories. In 2006, the last surveys were completed and submitted to the Service for this reach showing that no flycatcher territories were detected.

Formal cuckoo surveys have not been conducted along the Chama River. Cuckoos have been reported from the area of the Chama River between the town of Abiquiu and the Rio Chama–Rio Grande confluence. Upstream of the town of Abiquiu, no cuckoo detections have been reported along the Rio Chama (eBird 2012).

There are no known jumping mouse populations in this reach.

##### *4.7.1.1.3 Otowi Bridge to Cochiti Dam (RM 258–RM 233)*

The specimens of silvery minnow from this reach were likely collected near Otowi Bridge (Bestgen and Platania 1991). Silvery minnow have not been collected in this reach for over 40 years. The current potential to support silvery minnow in this reach (if they were reintroduced) is limited by the entrenched channel and loss of floodplain connectivity, cold water temperatures, channel fragmentation, substrate size, and competition with non-native fish species. The lack of low-velocity habitats for larvae and young-of-year and the lack of contiguous sections of river to allow silvery minnow to complete its life cycle within the reach would limit the ability for the species to survive (Buntjer and Remshardt 2005). There is no critical habitat designated in this reach of the river. No habitat restoration projects have been done on this reach for silvery minnow or flycatchers.

Formal surveys for flycatcher were not conducted within this reach until 2008. Since that time, territory totals have ranged between one and two territories mainly in an area just south of Frijoles Canyon.

Cuckoo critical habitat for this reach has been proposed and is mostly eligible for exclusion based on Pueblo Management Plans. It is largely unknown how many breeding territories may be located in this reach.

There are no known jumping mouse populations in this reach.

#### *4.7.1.2 Cochiti Reach: Cochiti Dam to Angostura Diversion Dam (RM 233–RM 210)*

Silvery minnow egg monitoring was conducted in the Angostura Canal immediately downstream from this reach in the early 2000s. During this time, only three eggs were reported (in 2003), and those were not preserved for confirmation. The lack of eggs in the Angostura Canal suggests that silvery minnow density upstream of Angostura Diversion Dam is extremely low if present (Service 2009). No publicly available silvery minnow surveys have been conducted in the last two decades. Limiting factors in this reach for silvery minnow are likely cool water conditions from the operations of Cochiti Dam, lack of low-velocity habitat, and a generally degrading river channel (Service 2008a). The land base encompassing the Cochiti Reach is primarily tribal-owned and requires partnership with the Pueblos for any monitoring or restoration activities. Funding has been provided to Cochiti, Santo Domingo, and San Felipe Pueblos through the Collaborative Program since 2002 for habitat restoration and maintenance projects including nonnative vegetation control, bank lowering, and side channel formation. In total, over 277 acres have been restored to date.

This reach has not been formally surveyed for flycatcher and is not known to have any suitable habitat.

Cuckoo critical habitat is proposed within this reach. Suitable habitat within this reach for the cuckoo is minimal at best, and it is largely unknown how many breeding territories may be located in this reach.

There are no known jumping mouse populations in this reach.

#### *4.7.1.3 Angostura Reach: Angostura Diversion Dam to Isleta Diversion Dam (RM 210–RM 169)*

Silvery minnow have been collected throughout this reach since 2004. Silvery minnow densities in this reach are the lowest when compared with downstream reaches, based on recent population monitoring in 2013 and 2014 (Dudley and Platania 2014, Dudley et al. 2015). This reach has not dried in recent years; however, this reach did dry historically. Floodplain connectivity is minimal in many portions of this reach. Lack of habitat diversity and amount of low-velocity habitats above Highway 550 likely are limiting factors for silvery minnow (SWCA 2008).

Several projects have taken place on the Sandia Pueblo and around the City of Albuquerque to improve riparian conditions with the assistance of Collaborative Program funding (e.g., projects conducted by Reclamation, the Corps, Santa Ana Pueblo, NMISC, and Albuquerque Open Space). To date, over 1,000 acres have been restored. Many of the restoration projects have concentrated on features that provide a greater connectivity with the river at lower discharge levels than previous conditions. Other strategies have included creating side channels and installing woody vegetation to create pools during low flows. Initial results of monitoring silvery minnow at these sites indicated that large numbers of silvery minnow use the created overbank habitats during inundation (Collaborative Program 2011, SWCA 2010a). Initial monitoring of the installed large woody debris found that silvery minnow were present both during winter and summer sampling but higher numbers were collected during the summer (Wesche et al. 2006).

A total of 3–4 flycatcher territories were known to occur in a small area in 1994 and 1995 within this reach (Mund et al. 1994, Mehlman et al. 1995). In 2000, surveys in all suitable nesting habitats within this reach found 14 territories (Johnson and Smith 2000). In 2003, only 4 territories were found (Smith and Johnson 2005). A total of 7 territories were located in 2004 (Smith and Johnson 2005), 6 territories were identified in 2005 (Smith and Johnson 2006), and 16 territories were identified in 2008 (Service 2014b). In 2009 through 2013, there were no territories located in this reach (Service 2014b).

Cuckoo critical habitat is proposed within this reach. Suitable habitat within this reach for the cuckoo is marginal, and it is largely unknown how many breeding territories may be located in this reach.

There are no known jumping mouse populations in this reach.

#### *4.7.1.4 Isleta Reach: Isleta Diversion Dam to San Acacia Dam (RM 169–RM 116.2)*

##### *4.7.1.4.1 Isleta Diversion Dam to Rio Puerco (RM 169–RM 127)*

Silvery minnow abundance is highly variable in this reach (Dudley and Platania 2010, Reclamation 2010). Prior to 2004, recruitment was low in this reach. Silvery minnow distribution and abundance patterns show the importance of base flows within the reach to maintain population numbers (Parametrix 2008). This reach has both flycatcher and silvery minnow critical habitat.

Habitat restoration work throughout this reach includes large acreage projects by Reclamation and the NMISC, which have cleared vegetation and increased the potential for channel movement. Techniques include creation of backwaters, secondary channels, as well as bankline benches and terracing. Monitoring of these habitats indicates use of these habitats during inundation by adult silvery minnow and larval fishes as well as egg retention (SWCA 2010a, Collaborative Program 2011). Cottonwood snags also were installed at drain outfalls in this reach. Initial monitoring showed use by silvery minnow during inundation, but the intended purpose of scouring and maintaining wetted pools over a range of flow conditions had mixed results due to sedimentation issues (Wesche et al. 2010).

The majority of flycatchers detected within this reach were typically migratory flycatchers, late migrants, or occasional lone male territories. The first nesting pair was located just north of the Rio Puerco in 2005. Over the last several years, this same area typically has about one to four territories detected. In 2010, this area supported four territories composed of three pairs and one additional pair about ¾ mile upstream. In 2011, the population expanded to 10 territories, mainly near the Rio Puerco, but also farther north in the area from Los Lunas to Bernardo. In 2013, territories near the Rio Puerco declined to a total of 4 territories; however, territories near Belen and Los Lunas have increased to a total of 23 in the general area (Moore and Ahlers 2014).

This reach, in its entirety, is proposed critical habitat for the cuckoo. Formal cuckoo surveys started in the southern portion of this reach in 2009 with 1 detection and 0 estimated territories (Ahlers and Moore 2014). The greatest number of detections/territories within this reach was in 2012, when there were 44 detections making up approximately 15 territories (Ahlers and Moore 2014).

For the jumping mouse, while it is unknown if the species currently occupies habitat in the Isleta Pueblo Subunit, two segments within this subunit are proposed as designated critical habitat. One segment begins at the confluence of the Isleta Return Channel and the Rio Grande and extends north about 0.5 km (0.3 mi), then heads west about 30 m (100 ft), and finally heads south about 1.6 km (1 mi) to the end of Isleta Marsh paralleling New Mexico Highway 314. The other segment begins about 0.8 km (0.5 mi) south of Highway 25 and extends about 1.6 km (1.0 mi) along the marsh where it terminates at the railroad crossing, just west of the Rio Grande (Service 2014e). Evaluation of these two segments show that if restored, the size of the suitable jumping mouse habitat would be increased and could provide habitat connectivity that is currently lacking (Service 2014e).

##### *4.7.1.4.2 Rio Puerco to San Acacia Diversion Dam (RM 127–RM 116.2)*

This reach has lower propensity for drying than the upstream portions of Isleta Reach (Parametrix 2008). Increases in channel complexity could increase the habitat diversity required to maintain silvery minnow within the reach. There are some areas that have been perennially wet in this section due to return flow from the San Juan drain. This is likely important to silvery minnow within this reach. Habitat assessment of these flows was modeled by USGS (Bovee et al. 2008). No habitat restoration projects have been done on this reach for silvery minnow or flycatchers.

Flycatchers on the Sevilleta NWR and La Joya WMA were initially discovered in 1999 with four territories. All flycatchers within this reach have been found along the banks of the Rio Grande. Surveys have continued in this area since 1999, with 7 territories detected in 2000 and 11 territories in 2001 and 2002. The highest numbers to date for this site, 31 territories, were detected in 2008. Over the last 3 years, there has been a decrease in territories. In 2009, there were 18 territories detected; 13 territories were detected in 2010 and 9 territories were detected in 2011. In 2013, territories in this section had decreased to a total of 4.

This reach, in its entirety, is proposed critical habitat for the cuckoo. Formal cuckoo surveys started in this reach in 2009 with 4 detections and 2 estimated territories (Ahlers and Moore 2014). The greatest number of detections/territories within this reach was in 2012, when there were 36 detections making up approximately 12 territories (Ahlers and Moore 2014).

There are no known jumping mouse populations in this reach.

#### *4.7.1.5 San Acacia Reach: San Acacia Diversion Dam to River Mile 62 (RM 116.2–RM 62)*

##### *4.7.1.5.1 San Acacia Diversion Dam to Arroyo de las Cañas (RM 116.2–RM 95)*

Silvery minnow in this reach are seasonally concentrated in the spring and summer below the diversion dam where water is generally perennial (Dudley and Platania 2010). It is unknown if there is seasonal upstream movement behavior that would cause silvery minnow to accumulate below the diversion dam that blocks upstream movement. Rescue operations rarely occurred in this reach. Salvaged fish from other portions of the San Acacia Reach are stocked here where water is perennial (Service 2002–2010). Little potential for overbank flooding exists in this reach (Parametrix 2008). There have been river maintenance projects within this reach, which have focused on moving back the levee and relocating the LFCC to allow the river greater area to migrate (Reclamation 2008a). There is both flycatcher and silvery minnow critical habitat within this reach.

This area has been surveyed for flycatchers since 1997 and has had intermittent territory establishment through the years. In 2012, the first nesting flycatcher was detected within this reach and in 2013 there were 4 total territories (2 of which were pairs with nests).

This reach, in its entirety, is proposed critical habitat for the cuckoo. Formal cuckoo surveys started in this reach in 2009 with 13 detections and 5 estimated territories. The greatest number of detections/territories within this reach was in 2013 when there were 50 detections making up approximately 13 territories.

There are no known jumping mouse populations in this reach.

##### *4.7.1.5.2 Arroyo de las Cañas to San Antonio Bridge (RM 95–RM 87.1)*

Silvery minnow densities in this reach are highly variable. October densities increased from 2006–2009 (Dudley and Platania 2010). Rescue efforts have occurred most years in portions of this reach. River pumps are installed in this reach to aid in slowing the rate of river drying using water supplied from the LFCC. No habitat restoration projects have been done on this reach for silvery minnow or flycatchers. Critical habitat for silvery minnow and flycatcher is present within this reach.

This reach is very similar to the San Acacia to Arroyo de las Cañas Reach and has been surveyed for flycatchers since 1998. Within the last 13 years, there have been minimal territories, with the exception of summer 2011. During the breeding season of 2011, a total of 7 territories were detected within this reach, most of which were detected within close proximity to BDA. In 2012, no territories were observed. In 2013, only one unpaired male territory was recorded.

This reach, in its entirety, is proposed critical habitat for the cuckoo. Formal cuckoo surveys started in this reach in 2009 with 5 detections and 1 estimated territory. The greatest number of detections/territories within this reach was in 2013, when there were 47 detections making up approximately 15 territories.

There are no known jumping mouse populations in this reach.

##### *4.7.1.5.3 San Antonio Bridge to River Mile 62 (RM 87.1–RM 62)*

Silvery minnow generally are collected in surveys within this reach, and densities are occasionally high. Reclamation surveys and population monitoring surveys found high winter densities in 2010 following high 2009 October numbers (Dudley and Platania 2010, Reclamation 2010). Generally, this reach is prone to river drying, and salvage generally occurs early in the year. River pumps from the LFCC supply water to the river from the northern and southern boundary of BDA and near Fort Craig and aid in slowing the rate of river drying. Due to the perched condition of the channel, high-flow events may go out of the channel and into the lower elevation overbank areas. There have been sediment plugs that have formed within the channel. Critical habitat is present within this reach for both silvery minnow and flycatcher.

The upper portion of this reach within the active floodplain in BDA has been surveyed for flycatchers annually since 1998. From 1998–2008, there were fewer than 5 territories detected annually. In 2009, there was a large population increase to 20 territories. A total of 34 territories were detected in 2010, and there was another large increase in 2011 to 49 territories. In 2012, the largest population in this section was recorded with a total of 51 territories. In 2013 and 2014, territories in this section had decreased to 27 and 23, respectively.

In lower portions of the reach, from 1994–1996, the majority of detections within this reach were located between the southern boundary of BDA to the railroad trestle near Black Mesa. Since 1994, the population within this entire reach has increased and decreased responding to vegetation and hydrological changes. Peak years within this section include 1994 with 11 territories, 2004 with 16 territories, and 2006 with 14 territories. Since 2006, territory numbers range from 7–11, with 14 territories detected in 2013.

This reach, in its entirety, is proposed critical habitat for the cuckoo. Formal cuckoo surveys started in portions of this reach in 2006 with 40 detections and 16 estimated territories (Ahlers and Moore 2014). The greatest number of detections/territories within this reach was in 2009, when there were 107 detections making up approximately 28 territories.

For the jumping mouse, the BDA Subunit, which includes parts of a ditch system associated with irrigation of BDA management units, is proposed as critical habitat for this species. This subunit begins in the northern part of the refuge and generally follows the Riverside Canal to the southern end. The BDA encompasses over 23,000 ha (56,834 acres), with approximately 3,600 ha (8,895 acres) of wetland and irrigated farmland within the historical floodplain (Service 2014e). Currently, the jumping mouse was found on only 2.7 km (1.7 miles) of the Riverside Canal (Frey and Wright 2012).

Areas of the BDA Subunit have high potential of being restored to suitable habitat. Proposed critical habitat included 21.1 km (13.1 mi) to increase the current size and connectivity of suitable habitat, increasing the potential distribution of the jumping mouse into historically occupied habitat (Service 2014e). Careful management should be considered along irrigation canals and ditches to address the reduction or clearing of riparian herbaceous vegetation, making the habitat too sparse for use by the jumping mouse. Periodic thinning and mowing could reduce shading and facilitate the development of dense riparian herbaceous vegetation of suitable habitat (Service 2014c).

### 4.7.2 Baseline Conditions for Listed Species and Critical Habitat

#### *4.7.2.1 Silvery Minnow*

In this section, baseline biological information and status of critical habitat elements (PCEs) are described in Table I-23. For the silvery minnow, life history is subdivided into spawning, egg, larval, juvenile, and adult stages; current information on how those stages are functioning is included. Even though there is some uncertainty surrounding the preferential spawning locations for the silvery minnow, it is evident that the minnow likely will spawn in the spring with any slight increase in discharge in whatever habitat is available.

**Table I-23. Status and information of life history elements and critical habitat PCEs for silvery minnow. Gray cells indicate that life history stage is generally not present during that season or affected by the PCE.**

| Life History Element | Spawning | Eggs | Larval | Juvenile | Adult |
|---|---|---|---|---|---|
| Spring (April–June) | Spawning has been detected each year. Very small flow spikes are necessary for fish to spawn, with greater spawning output at higher magnitude spring peak flows. | The carrying capacity of recruitment is set by spring flows, and duration and characteristics of the ramp down of spring peak flows to summer levels. Eggs and larvae that are retained upstream in low-velocity habitats are more likely to recruit into the adult population. Higher spring flows allow more overbank habitats to be inundated. Recruitment success is likely the driver for genetic diversity, effective size of the population, and October census densities.<br>Habitat restoration has increased available habitat at lower discharge levels in Angostura Reach. | | | Large numbers of adult silvery minnow have been collected on overbank habitats during spring flows. It appears that population levels must be very low before the number of adult spawners would have a detectable effect on number of offspring measured the next fall. |
| Summer (June–September) | | | Delayed onset of low-flow conditions and increased summer flow correlates with higher October densities. Increased turbidity from various flow events may decrease the available food base. Refugial habitats may decrease mortality of silvery minnow and maintain higher numbers of silvery minnow during dry periods. Refugial habitats have been maintained at some return drain outfall sites and may reduce the impact of drying on the population by keeping those areas wet. Studies on the water quality of those sites are in their initial stages and will help determine suitability of this habitat. | | |
| Fall (September–November) | | | | Generally steady base flows during this time period are positive for October population densities. Drying has occurred within this timeframe, however, and may have effects on recruitment of young-of-year to the October census. | |

**Table I-23. Status and information of life history elements and critical habitat PCEs for silvery minnow. Gray cells indicate that life history stage is generally not present during that season or affected by the PCE.**

| Life History Element | Spawning | Eggs | Larval | Juvenile | Adult |
|---|---|---|---|---|---|
| Winter (December–March) | | | | | Silvery minnow are known to use habitats with some type of cover, particularly woody debris piles. Relatively constant winter flows are positive; however, this season is marked by reduced food availability to meet energetic demands. Habitat restoration activities have installed large woody debris in both the Angostura and Isleta Reach. |
| Summary of baseline population trend and indicators. | The silvery minnow population has experienced a declining trend in recent years. The majority of silvery minnow that are collected during monitoring efforts are hatchery-reared individuals (i.e., wild-caught eggs supplemented with captively spawned individuals reared in hatchery facilities and released back to the river), and there has been a downward trend in the number of young-of-year collected (Dudley and Platania 2013, 2014; Dudley et al. 2014, 2015). Since 2012, October census data have indicated poor recruitment and survival of silvery minnow. The overall declining population trend coupled with critically low numbers of wild fish and little evidence of recruitment, indicates that current river conditions and management efforts have not been successful in buffering the silvery minnow population against substantial declines, and that the silvery minnow population is currently dependent upon augmentation.<br><br>Silvery minnow abundance is closely related to the timing, magnitude, and duration of spring and summer flows. With prolonged and elevated flows, there is a higher probability of silvery minnow recruitment as measured in the October census (Dudley et al. 2015). | | | | |
| ***Critical Habitat PCEs*** | | | | | |
| ***Hydrologic Regime*** | | | | | |
| Low to moderate currents | Determined by sediment transport, reach slope, sinuosity, which all contribute to habitat complexity. Current trend is toward channel simplification. Habitat restoration has improved condition in Angostura Reach and Isleta Reach. | | | | |

**Table I-23. Status and information of life history elements and critical habitat PCEs for silvery minnow. Gray cells indicate that life history stage is generally not present during that season or affected by the PCE.**

| Life History Element | Spawning | Eggs | Larval | Juvenile | Adult |
|---|---|---|---|---|---|
| Diversity of habitats for all life history stages | | The amount of egg and larval development habitat increases when overbank areas are inundated. Depending on the reach, this occurs when spring flows are greater than 1,500 cfs. With the exception of 2015, flows at the Albuquerque gage did not reach this level for more than 10 consecutive days since 2010. Between 2003 and 2010, flows met this level each year except 2003 and 2006. Habitat restoration activities have created more low-velocity areas that inundate in the 1,500- to 3,500-cfs range. | | Juvenile and adult silvery minnow use wetted habitats with moderate depths and low velocity during non-winter times. Winter habitat use is also associated with low-velocity areas but also concentrated in deeper areas with available cover (instream debris piles, tumbleweeds). | |
| Spawning trigger | Spawning has occurred each year of baseline, even in years with minimal spring flow spike. | | | | |
| No increased low flow | River drying is predicted when flows drop below 100 cfs at San Acacia gage. Number of low-flow days at San Acacia gage is significantly different in baseline timeframe (2003–2011) and listing timeframe (1993–2002) (t= [2.1], p<0.05). Mean # days <100 cfs 1993–2002=17 (SE 10), 2003–2011=52 (SE 12). | | | | |
| Constant winter flow | | | | Irrigation season ends in October and other water deliveries are often made in November and December, which may increase base flows. | |
| ***Unimpounded stretches of river with a diversity of habitats and low-velocity refuge areas*** | | | | | |
| River reach length | Reach length in MRG has not changed since time of listing. The only new cross channel structure is the ABCWUA diversion that was mitigated with a fish passage structure. The multi-year PIT tag study conducted by the Service showed that silvery minnow use the passage in both upstream and downstream directions. | | | | |
| Habitat "Quality" in each reach and refugial habitats. | Each reach has positive and negative habitat attributes. Channel trends throughout the MRG are toward a more simplified channel due to vegetation encroachment. Cochiti Dam and Angostura Reaches are not as susceptible to drying but have limited connection with overbank areas. Isleta Diversion Dam and San Acacia Reaches are prone to drying in areas but have low overbank thresholds and a greater diversity of mesohabitats than the upper reaches due to the more dynamic nature of the channel than the upper reaches. Habitat restoration activities in upper reaches have provided more low-velocity habitats in the 1,500- to 3,500-cfs range. Low-velocity refuge areas are important during summer drying and for overwinter habitat. | | | | |
| ***Substrate of sand or silt*** | | | | | |
| Substrate size | | Substrate size is dependent on water velocity and sediment transport within the reach. The lower reaches of the river are dominated by sand/silt substrates. Reaches that have a low sediment supply (Cochiti and Angostura) are trending towards larger substrates. | | | |

**Table I-23. Status and information of life history elements and critical habitat PCEs for silvery minnow. Gray cells indicate that life history stage is generally not present during that season or affected by the PCE.**

<table>
<tr><th>Life History Element</th><th>Spawning</th><th>Eggs</th><th>Larval</th><th>Juvenile</th><th>Adult</th></tr>
<tr><td colspan="6">Water quality</td></tr>
<tr><td>Temp >1°C and <30°C.</td><td colspan="2">Warmer temperatures speed the rate of egg development and larval growth. This is generally considered positive for fish because it means they spend less time in this vulnerable stage.<br><br>A notable difference between water temperatures in high-flow years versus low-flow years is the minimization of diel variation in high-flow years, and thus a more constant temperature.<br><br>Overbank habitat has been shown to provide warmer daytime temperatures but may also experience greater fluctuations corresponding to air temperatures then main channel habitats.</td><td colspan="3">NMED monitoring has shown little evidence of temperature exceedances within the main channel of the river.<br><br>Isolated pools often exceed 30°C. Pools >34°C are not salvaged due to the poor condition of fish within the pools.<br><br>Low temperatures have not been a concern within the occupied portion of the MRG except in extreme weather events. Ice flows were present within the channel in February 2011 following extreme low temperatures.</td></tr>
<tr><td>DO > 5 mg/L</td><td colspan="5">There have been records of low dissolved oxygen within the main stem of the MRG. Many of these are associated with rain events and stormwater entering the system. The duration of these low DO events are generally less than a few hours. There were localized conditions that deviated from the main stem conditions due to low-flow conditions and isolated pools. From salvage data, it appears that many isolated pools have DO that falls below the optimal level. These pools are not considered for salvage. Additionally, low DO was detected in 2005 on inundated floodplain areas that have high levels of organic materials.</td></tr>
<tr><td>pH (6.6–9.0)</td><td colspan="5">No exceedances of the pH criterion were documented from deployed dataloggers at any locations except for one sample in 2007 at NM Highway 550 Bridge. Isolated pools may experience high pH levels. Pools greater than 9.0 are not considered for salvage.</td></tr>
<tr><td>Other Contaminants</td><td colspan="5">Short-term water quality issues due to chlorine releases from wastewater quality treatment plants have occurred infrequently in the MRG. Initial studies of fish tissue indicate elevated levels of zinc in some samples. Other studies have not indicated specific water quality issues that may be affecting silvery minnow.</td></tr>
</table>

It appears that the spring hydrograph has an influence on recruitment of silvery minnow into the population (Section 3.1.2.4.2). This is indicated by the correlative relationship of fall catch rates with the spring hydrograph. It is hypothesized that spring flows that inundate the floodplain create large amounts of low-velocity habitat that aids in the retention of eggs and larvae in upstream reaches and provides an area of highly productive low-velocity habitat, which promotes larval survival and development. The lack of recruitment in 2010 provides some indication that management of flow recession may be an important management consideration. Although there is a correlation between the spring hydrograph and the fall CPUE, the mechanisms that drive this relationship are not fully known.

The current measure of the population is based on October catch rates, which gives an indication of annual recruitment into the population. October catch rates of silvery minnow have varied widely since the inception of the monitoring program in 1993; this variability is influenced by a number of factors, including population variability, sampling variability, food availability, habitat availability, and flow condition at sampling. This variation is similar to abundance measures of many species of fish that have high reproductive potential. Though there is large variation, mean catch rates from 2004–2011 are over 10 times higher than the lowest recorded catch rates in 2002 and 2003. Mean catch rates in 2005 were roughly 1,000 times the mean catch rate recorded in 2003.

Juvenile silvery minnow utilize low-velocity habitats, similar to larval stages; however, they are able to actively swim at this stage. Little is known about the full range of factors that influence survival of juvenile and adult silvery minnow. Food availability is varied due to hydrology and storm events. Studies indicate that the main source of periphyton, which is one of the main foods of silvery minnow, exists in a "bathtub ring" in the shallow, more productive sections of the river. Storm events or other flow changes may affect periphyton availability by scour events, inundation which places existing colonies out of optimal light areas, or desiccation.

Drying also causes direct take of silvery minnow. Drying has occurred each year since 2003 except for 2008 in some portion of critical habitat. There is some evidence that a portion of silvery minnow are able to move with the water as the river begins to dry, and some fish can survive for long periods in the isolated pools that may persist in disconnected sections of the river. However, there is documented take of silvery minnow that has occurred each year associated with drying. Other unquantified sources of take that occur with river drying include predation from birds and other species, as well as mortality due to poor water quality and disease that is exacerbated when fish are isolated in pools.

At least some amount of river drying is predicted when San Acacia flows drop below 100 cfs. On average, from 2003–2011, there were 52 days annually when San Acacia was below 100 cfs compared to the previous timeframe (1993–2002) when the annual average was 17 days. There is a significant negative correlation to October catch rates and the number of days with low-flow conditions at the San Marcial gage (Figure I-17).

There is little known about winter survival of silvery minnow. Studies indicate that they are most often found in backwaters and other habitats with cover in the winter (Dudley and Platania 1996, 1997). As with other fish species, they seek out low-velocity habitats that limit the amount of energy they must expend during cold water temperatures. It is hypothesized that stable water levels may be positive because stability of individual habitats is related to stability of water levels in the MRG. Generally, flow is higher early in the winter when letter water is being released as well as other activities to move stored water. Winter storm flows occur periodically.

With the current condition of the river, mechanical means are needed to substantially change geomorphology. Water management alone cannot provide flows of high enough discharge and duration to remove established vegetation and reset river banks. Habitat restoration activities since 2003 have increased the amount of habitat that inundates at lower flow levels, especially in the Angostura Reach. These areas show use by silvery minnow each year of inundation (Gonzales et al. 2012).

#### *4.7.2.2 Flycatcher*

The flycatcher population within the MRG has increased over the last decade (Table I-24). Habitat availability appears to not be a limiting factor, as not all suitable habitat is occupied. High-flow events and overbank flooding conditions tend to attract flycatchers and lead to new territory establishment. These localized events aid in providing the successional aged structure in riparian stands that flycatchers depend on. Suitable habitat areas are temporary because vegetation senescence occurs relatively quickly.

**Table I-24. Status and information of life history elements and critical habitat PCEs for willow flycatcher. Gray cells indicate that life history stage is generally not present during that season or affected by the PCE.**

| Life History Element | Migration (April–June and July–September) | Arrival to Territories/ Territory Establishment/ Nest Building (May–July) | Egg Laying/Incubation/ Nestling/Fledgling (June–August) |
|---|---|---|---|
| Breeding Season (April–September) | Flycatchers may use less suitable habitat as stopover locations (i.e., narrow vegetated areas such as LFCC or areas a greater distance from water). | Flycatchers are attracted to areas within 50 m of slow moving water, particularly flooded areas, or areas with saturated soils and dense vegetative canopy cover.<br>Higher spring flows allow more overbank habitats to be inundated, thus attracting flycatchers, improving vegetative health, and likely increasing abundance in prey. | At this point, flycatchers are more invested in their established territories and less likely to abandon nests should conditions dry or decline in value. However, if vegetation does not have adequate water resources, canopy cover will likely decrease, and predation and/or parasitism would likely be more prevalent. Prey abundance may decrease with decreased water availability. |
| Summary of baseline population trend and indicators. | Baseline conditions since 1993 have indicated mainly positive population growth. The most recent increase in territory numbers within the project area can be attributed to an event within BDA in which overbank flows increased in combination with the large population within Elephant Butte Reservoir beginning to disperse and defend territories in other locations. | | |
| ***Critical Habitat PCEs*** | | | |
| Riparian Vegetation | | Riparian habitat in a dynamic successional environment to be used for nesting, foraging, migration, dispersal, and shelter. Dense tree or shrub vegetation in close proximity to open water or marsh areas. The 2008 habitat suitability study mapped out suitable habitat in Isleta Diversion Dam and San Acacia Reaches. Habitat mapping occurs every 2–4 years and documents changes within the riparian area. Currently, flycatchers only occupy a portion of suitable habitats; thus, amount of habitat is not considered to be limiting factor. | |

**Table I-24. Status and information of life history elements and critical habitat PCEs for willow flycatcher. Gray cells indicate that life history stage is generally not present during that season or affected by the PCE.**

| Life History Element | Migration (April–June and July–September) | Arrival to Territories/ Territory Establishment/ Nest Building (May–July) | Egg Laying/Incubation/ Nestling/Fledgling (June–August) |
|---|---|---|---|
| Insect Prey Populations | The abundance of insect prey populations in a given habitat patch is likely related to the proximity of the patch to riparian floodplains or moist environments. There are no data indicating that insect prey is a limiting factor within suitable habitat areas. | | |

Temporary overbank flooding or close proximity to water also contribute to vegetation health and insect prey base abundance. This is particularly important during territory establishment to attract and retain territories. As flycatchers move through the chronology of the season and put forth an increasing amount of energy towards nesting (first territory establishment, then pairing, nest building, egg laying, incubating, feeding nestlings, and taking care of fledglings), they are less and less likely to abandon a territory. Nest success is dependent on vegetative health to provide the canopy cover required for protection from predators and other environmental stressors such as weather. Conversely, prolonged flooding prohibits seed establishment and can have a long-term negative effect on vegetative health. Nest success has remained relatively high within the MRG over the last decade, until recent drought years. In 2014 nest success was at an all-time low with only 28.1% (Ahlers 2014).

The critical habitat designation for flycatchers (50 CFR 344) indicates riparian habitat in a dynamic successional environment is used for nesting, foraging, migration, dispersal, and shelter. This habitat can include trees and shrubs such as Goodding’s willow, coyote willow, tamarisk, or Russian. Vegetation must be dense, with a canopy cover of about 50–100%. Vegetation can range in height from about 6–98 feet tall depending on elevation (within the project area, vegetation height is typically about 9–26 feet tall [Moore 2007]). Patches also must include small openings of open water or marsh areas to create a variety of habitat that is not uniformly dense. Vegetation patch size can range from 0.25–175 acres.

A variety of insect prey populations are also essential for flycatchers. The abundance of insects typically associated with riparian floodplains or moist environments is likely related to the proximity of water to the habitat patch and density of vegetation within the canopy. Flooded sites provide for higher relative humidity and likely greater insect abundance (Reclamation 2009). No surveys have been done to estimate prey availability within various types of habitats within the MRG. Insects that are considered to be flycatcher prey include flying ants, wasps, and bees (Hymenoptera); dragonflies (Odonata); flies (Diptera); true bugs (Hemiptera); beetles (Coleoptera); butterflies, moths, and caterpillars (Lepidoptera); and spittlebugs (Homoptera).

#### *4.7.2.3 Cuckoo*

For the cuckoo (Table I-25), the population within the MRG has remained fairly consistent over the last several years and is potentially increasing slightly. Although there has not been a formal habitat suitability model created specifically for the cuckoo, habitat availability is hypothesized to not be a limiting factor because territories shift from one reach to another between years, presumably moving to other areas of suitable habitat when the insect prey base locally increases or hydrology conditions change.

**Table I-25. Status and information of life history elements and proposed critical habitat PCEs for cuckoo**

| Life History Element | Migration (April–June and August–November) | Arrival to Territories/ Territory Establishment/ Nest Building (June–July) | Egg Laying/Incubation/ Nestling/Fledgling (July–August) |
|---|---|---|---|
| Breeding Season (June–August) | Cuckoo may use less suitable habitat as stopover locations (i.e., narrow vegetated areas such as LFCC or areas a greater distance from water). | Cuckoos are attracted to large expanses of dense riparian vegetation with an adequate prey base.<br>Higher spring flows allow more overbank habitats to be inundated and/or increase groundwater levels, improving vegetative health, likely increasing abundance in prey, and therefore attracting cuckoos. | At this point, cuckoos would need to have humidity levels remain consistently adequate to ensure proper hatching and rearing of young. Canopy cover and prey base is largely important at this life history stage. |
| Summary of baseline population trend and indicators. | Baseline conditions since 2006 have indicated either consistent or slightly increasing population growth. Cuckoos are largely concentrated south of the project area and within the exposed portion of Elephant Butte Reservoir. | | |
| ***Critical Habitat PCEs*** | | | |
| Riparian Woodlands | Riparian woodlands with mixed willow cottonwood vegetation, mesquite-thorn forest vegetation, or a combination of these that contain habitat for nesting and foraging in contiguous or nearly contiguous patches that are greater than 325 ft (100 m) in width and 200 acres (81 ha) or more in extent. These habitat patches contain one or more nesting groves, which are generally willow dominated, have above average canopy closure (greater than 70%), and have a cooler, more humid environment than the surrounding riparian and upland habitats. | | |
| Adequate prey base | Presence of a prey base consisting of large insect fauna (for example, cicadas, caterpillars, katydids, grasshoppers, large beetles, dragonflies) and tree frogs for adults and young in breeding areas during the nesting season and in post-breeding dispersal areas. | | |
| Dynamic riverine processes | River systems that are dynamic and provide hydrologic processes that encourage sediment movement and deposits that allow seedling germination and promote plant growth, maintenance, health, and vigor (e.g., lower gradient streams and broad floodplains, elevated subsurface groundwater table, and perennial rivers and streams). This allows habitat to regenerate at regular intervals, leading to riparian vegetation with variously aged patches from young to old. | | |

The critical habitat proposal for cuckoos (79 Fed Reg 48548) indicates they need large expanses (preferably 200 acres or more) of riparian habitat with a dense canopy closure and high foliage volume. This habitat can include trees and shrubs such as Goodding's willow, coyote willow, and cottonwood.

A variety of insect and small vertebrate prey populations are also essential for cuckoos. The availability of food is largely influenced by the health, density, and species of vegetation (79 Fed Reg 60038). Water availability and humidity are important habitat characteristics for the cuckoo in regard to prey base, canopy cover, and vegetative health, and for hatching and rearing of young (79 Fed Reg 60038). Cuckoo prey includes sphinx moth larvae (Family Sphingidae), katydids (Family Tettigoniidae), and tree frogs (*Hyla* spp. *and Pseudacris* spp.*)* (79 Fed Reg 60038).

#### *4.7.2.4 Jumping Mouse*

The distribution and number of populations of the jumping mouse has declined significantly rangewide (Table I-26). Most of the local extirpations have occurred since the late-1980s and early 1990s (Service 2014c). Habitat suitability is limited by habitat connectivity and patch size. As additional habitat losses have occurred, patches have become smaller and more isolated until the amount of unsuitable areas between the suitable habitat patches have exceeded movement or dispersal capability.

**Table I-26. Status and information of life history elements and proposed critical habitat PCEs for jumping mouse**

| Life History Element | Dormant Season | Active Season |
|---|---|---|
| Life History | Period of hibernation; typically lasts for 8 to 9 months. | Jumping mice are only active 3 or 4 months during the summer. Within this short timeframe, it must breed, birth and raise young, and store up sufficient fat reserves to survive the next year's hibernation period. |
| Summary of baseline population trend and indicators | The distribution and number of populations of the jumping mouse has declined significantly rangewide since the late 1980s and early 1990s due to habitat loss. | |
| ***Critical Habitat PCEs*** | | |
| Riparian Communities | Utilizes riparian area vegetation for food, cover, nesting materials, movement, and avoiding predation. | |
| Flowing Water/Dense, Tall Vegetation | Flowing water provides saturated soils throughout the jumping mouse's active season that supports tall (average stubble height of herbaceous vegetation of at least 69 cm (27 inches) and dense herbaceous riparian vegetation. | |
| Sufficient Area | Sufficient areas of 9 to 24 km (5.6 to 15 mi) along a stream, ditch, or canal that contain suitable or restorable habitat to support movements of individual jumping mice. Historically, these wetland habitats would have been in large patches to disperse to other habitat patches within stream segments located intermittently along long stretches of streams. | |
| Adjacent Upland | Necessary for hibernation and maternal nesting (birthing and rearing of young). Includes adjacent floodplain and upland areas extending approximately 100 m (330 ft) outward from the water's edge | |

The critical habitat proposal for jumping mice (Service 2013) indicates they need (1) riparian communities with herbaceous wetland vegetation or scrub shrub riparian areas, (2) flowing water that provides saturated soils that supports tall dense herbaceous vegetation, (3) sufficient areas (9 to 24 km) along a stream, ditch, or canal with habitat to support movements, and (4) adjacent floodplain/upland areas extending approximately 100 m (330 ft) from the water's edge.

#### *4.7.2.5 Sunflower*

Pecos sunflower (*Helianthus paradoxus)* is currently only located in two locations within the MRG action area – on the La Joya WMA and the Rhodes population on private property. There is no designated Pecos sunflower critical habitat for the species within the action area. *Helianthus paradoxus* is an annual species that must reestablish populations of adult plants each year from seed produced during previous years' reproductive efforts. Populations tend to grow in crowded patches of dozens or even thousands of individuals. Solitary individuals may be found around the periphery of the wetland, but dense, well-defined stands within suitable habitats are more typical. NMDGF developed a habitat conservation plan to support conservation of the species on the La Joya WMA by:

1. Annually controlling invasive species.
2. Protecting the natural spring in Unit 5 from motorized vehicles and heavy equipment.
3. Monitoring core populations by digitizing these areas annually.
4. Conserving *H. paradoxus* by adjusting invasive species treatment area boundaries.
5. Restoring native habitat through revegetation.

The acreage of Pecos sunflower on La Joya WMA has varied, but has remained greater than 200 acres since 2008. Water supply for this population is provided through existing drains that supply La Joya WMA.

# 5. Cumulative Effects Analysis

Cumulative effects are effects of future non-federal (state, local governments, or private) activities on endangered and threatened species or critical habitat that are reasonably certain to occur within the action area of the actions subject to consultation. This cumulative effects analysis considers those non-federal activities that may occur in the foreseeable future. The effects of non-federal actions included in this BA as proposed actions and analyzed in the direct and indirect effects sections are not included in the cumulative effects analysis.

Cumulative effects in the MRG include the impact of natural events (i.e., climate, hydrology, wildfires, and introduced species) and urban development (i.e., floodplain development, future water use, and regional water planning).

## 5.1 Projected Impacts of Natural Events

Natural phenomena such as climate change and wildfire, or very distantly caused human activities such as the release and unintended spread of saltcedar leaf beetle, are expected to impact the MRG basin and its listed species and habitats.

### 5.1.1 Future Changes in Climate and Hydrology

In future years, more pronounced changes are anticipated in the climate of the MRG Basin, including greater increases in average temperature, earlier snowmelt runoff, and even greater hydrologic variability with nearly all projections showing an overall decrease in streamflows. Projected changes in the climate and hydrology of this region were summarized in the Secure Water Report (Reclamation 2011), and discussed in detail in Chapter 4, Environmental Baseline of this BA.

The results of the Secure Water Report suggest that average temperatures throughout the Rio Grande Basin may increase steadily during the 21$^{st}$ century. The basin-average mean-annual temperature is projected to increase by 5–6°F during the 21$^{st}$ century (Figure I-63). Change in annual precipitation over the region from numerous projections suggests that mean annual precipitation, averaged over the MRG Basin, may gradually decrease during the 21$^{st}$ century. The projections also suggest that annual precipitation in the MRG Basin will remain quite variable over the next century (Figure I-63). The character of precipitation within the MRG Basin is expected to change in such a way that there are more frequent rainfall events and less frequent snowfall events.

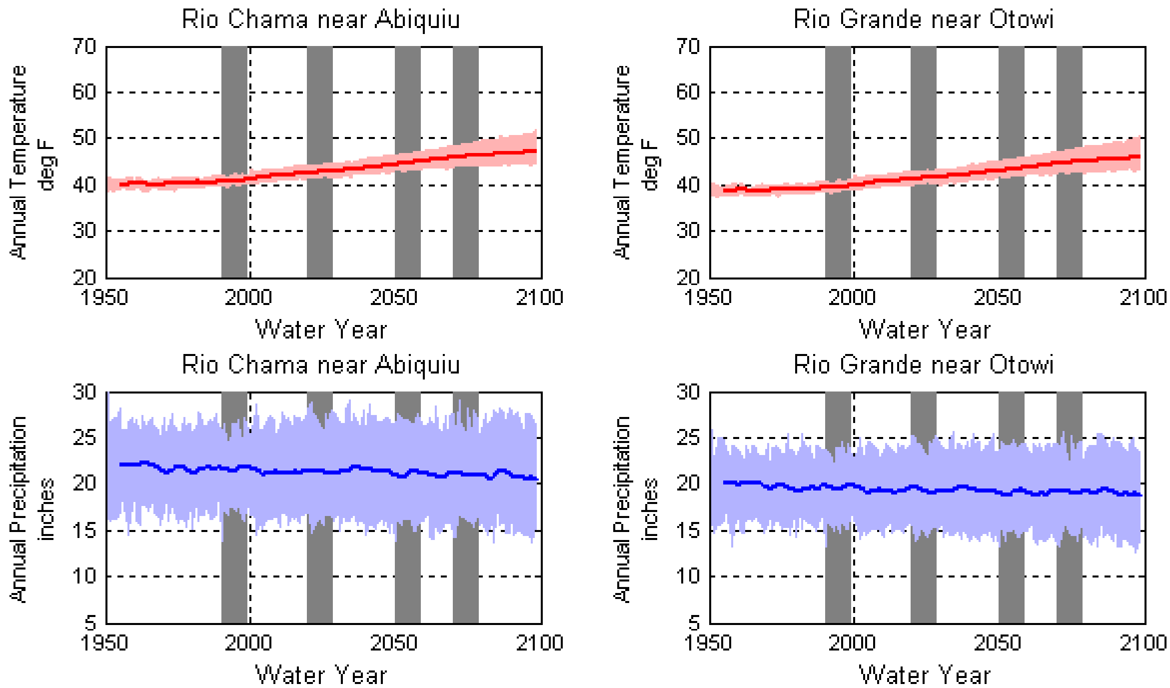



**Figure I-63. Simulated annual climate averaged over Rio Grande sub-basins**

Warming is expected to diminish the accumulation of snow during the cool season (i.e., late autumn through early spring) and the availability of snowmelt to sustain runoff to the MRG during the warm season (i.e., spring through early summer). Although increases or decreases in cool season precipitation could offset or amplify changes in snowpack, it is apparent that the projected warming in the Rio Grande Basin tends to dominate projected effects. Snowpack decreases are expected to be more substantial over the lower-lying portions of the basin, where baseline cool season temperatures are generally closer to freezing thresholds and more sensitive to projected warming. Changes in climate and snowpack within the MRG Basin will change the availability of natural water supplies. These changes may be to annual runoff or to runoff seasonality. Results suggest that annual runoff changes generally are consistent throughout the basin, although local variations associated with elevation and baseline climate are evident. At all locations, decade-mean annual runoff is projected to steadily decline through the 21st century, responding to both slight decreases in precipitation and warming over the region (Figure I-64).

The seasonality of runoff also is projected to change in the MRG in such a manner that, over time, winter flows increase and spring flows decrease. Warming would be expected to lead to more rainfall and runoff, rather than snowpack accumulation, during the winter. Conceptually, this change would lead to increases in the December–March runoff and decreases in the April–July runoff. As can be seen on Figure I-64, this concept is supported by results for the December–March seasonal runoff in the Rio Chama at Abiquiu, as projected mean winter runoff increases for the 2020s, 2050s, and 2070s.

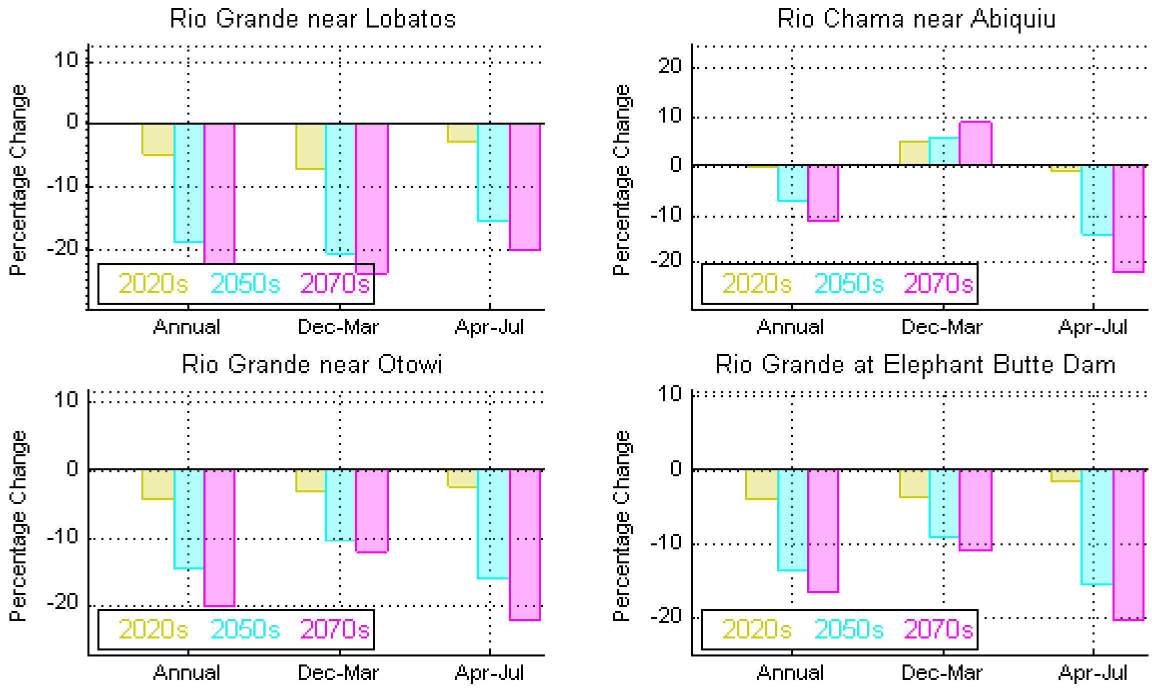



**Figure I-64. Simulated changes in decade-mean runoff for several sub-basins in the Rio Grande Basin**

Changes in the magnitude of flood peaks also are expected in the MRG (Table I-27), although there is less certainty in the analysis of these types of acute events than there is for changes in annual or seasonal runoff. Annual maximum weekly runoff (the maximum weekly average flow rate) and minimum weekly runoff (the minimum weekly average flow rate), as metrics of acute runoff events (Figure I-65), indicate that annual maximum weekly runoff may gradually decline during the 21st century. Results are generally consistent across the sub-basins shown. These results suggest that future flood events in the Rio Grande may be smaller in magnitude than those experienced in the 1990s, although the streamflow variability is expected to continue to be large. These changes have implications for water storage, flood control, and ecosystem management. However, it is important to note that there is a high degree of variability among model simulations, suggesting that there is a high degree of uncertainty in this flood metric.

Annual minimum weekly streamflows also are projected to decline during the 21st century (Figure I-65). These results suggest that future low-flow periods in the Rio Grande may be even drier than present day. However, there is a high degree of variability among model simulations, suggesting a high degree of uncertainty in the magnitude of this trend. Nevertheless, nearly all projections show an overall decrease in low streamflow values.

**Table I-27. Summary of simulated changes in decadal hydroclimate for several sub-basins in the MRG Basin**

| Hydroclimate Metric (change from 1990s) | 2020s | 2050s | 2070s |
|---|---|---|---|
| ***Rio Chama near Abiquiu*** | | | |
| Mean Annual Temperature (°F) | 1.9 | 3.8 | 5.3 |
| Mean Annual Precipitation (%) | –1.1 | –2.3 | –2.5 |
| Mean April 1 Snow Water Equivalent (%) | –47.6 | –61.4 | –68.2 |
| Mean Annual Runoff (%) | –0.2 | –7.3 | –11.0 |
| Mean December–March Runoff (%) | 4.8 | 5.5 | 8.6 |
| Mean April–July Runoff (%) | –1.3 | –13.9 | –21.7 |
| Mean Annual Maximum Week Runoff (%) | –4.3 | –9.5 | –14.9 |
| Mean Annual Minimum Week Runoff (%) | –12.1 | –19.2 | –23.9 |
| ***Rio Grande near Otowi*** | | | |
| Mean Annual Temperature (°F) | 1.9 | 3.7 | 5.2 |
| Mean Annual Precipitation (%) | –1.5 | –2.5 | –2.4 |
| Mean April 1 Snow Water Equivalent (%) | –48.5 | –63.8 | –72.9 |
| Mean Annual Runoff (%) | –4.4 | –14.4 | –19.9 |
| Mean December–March Runoff (%) | –3.1 | –10.4 | –12.0 |
| Mean April–July Runoff (%) | –2.5 | –15.9 | –21.8 |
| Mean Annual Maximum Week Runoff (%) | –9.3 | –20.3 | –25.3 |
| Mean Annual Minimum Week Runoff (%) | –11.7 | –21.6 | –26.3 |
| ***Rio Grande below Elephant Butte Dam*** | | | |
| Mean Annual Temperature (°F) | 1.9 | 3.7 | 5.1 |
| Mean Annual Precipitation (%) | –0.9 | –2.3 | –1.9 |
| Mean April 1 Snow Water Equivalent (%) | –72.4 | –80.7 | –85.3 |
| Mean Annual Runoff (%) | –4.1 | –13.5 | –16.4 |
| Mean December–March Runoff (%) | –3.6 | –8.9 | –10.9 |
| Mean April–July Runoff (%) | –1.6 | –15.4 | –20.0 |
| Mean Annual Maximum Week Runoff (%) | –6.1 | –15.7 | –18.8 |
| Mean Annual Minimum Week Runoff (%) | –9.6 | –18.2 | –22.4 |

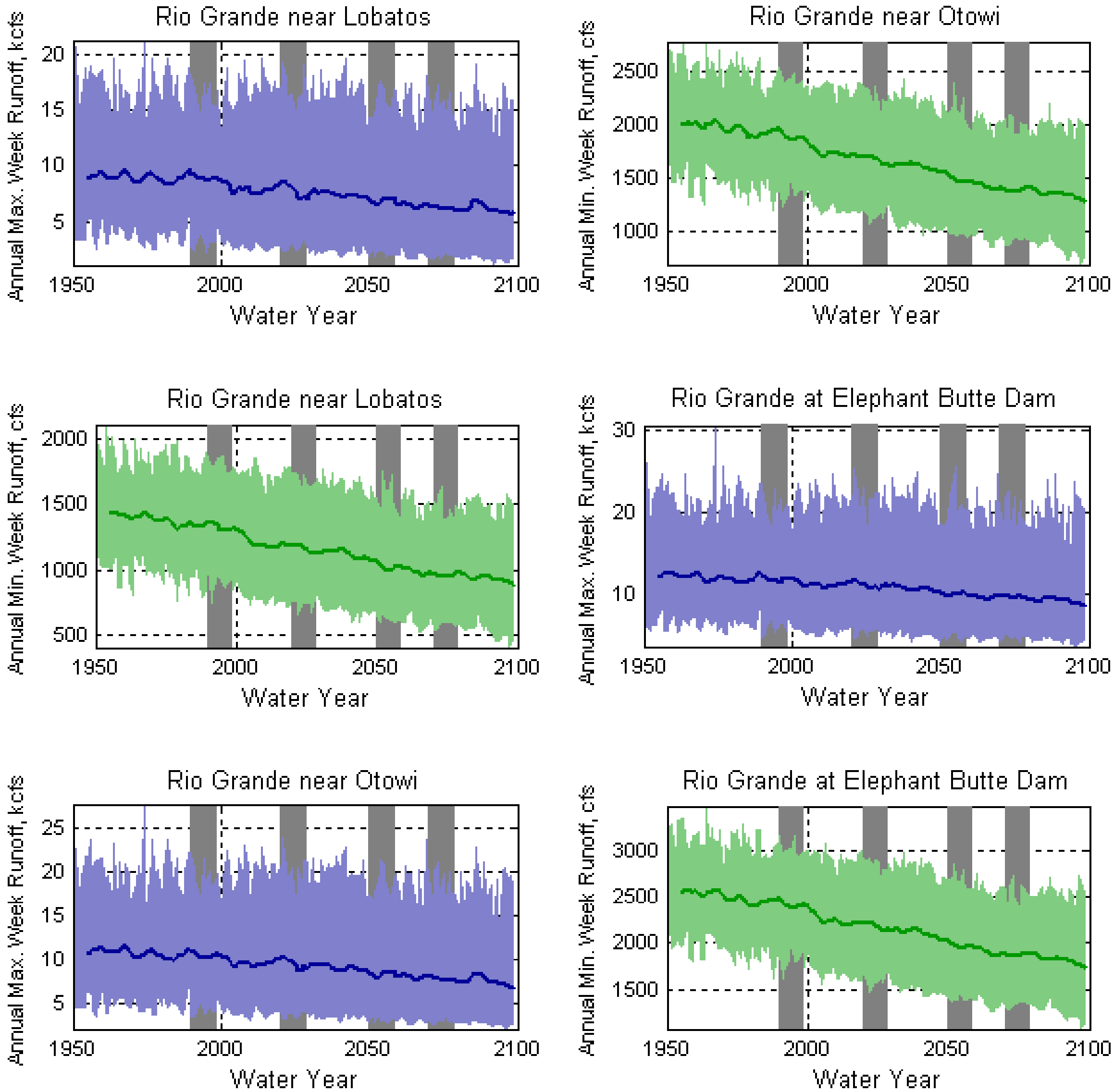



**Figure I-65. Simulated annual maximum and minimum week runoff for several sub-basins in the MRG Basin.**

### 5.1.2 Wildfire

Reclamation anticipates that natural disasters, such as wildfire, are reasonably likely to occur in the future, and large-scale, intense fires have the potential to directly impact listed species and significantly destroy or degrade their habitat in the MRG. Increased wildfire frequency and intensity is expected as a result of active fire suppression and the accumulation of high fuel loads in areas adjacent to riparian habitat (Allen et al. 2002). The lack of vegetation following intense wildfires can expose soils to surface erosion during monsoon storms, causing sedimentation and erosion in downstream drainages. Severe wildfires can also trigger flooding events, which can significantly inundate and destroy riparian areas. Flooding shortly after moderate- to high-intensity fires has been shown to increase stream bank erosion and damage recovering vegetation (Pettit and Naiman 2007). High-severity fires also destroy vegetation that aids in bank stability, leading to eroded banks, further loss of shrubs, channel widening, and input of additional sediment into streams. Though severe wildfire events are rare by their nature, the future effects of climate change may act to increase the current magnitude of their potential impacts. Wildfire also has the potential to negatively impact water quality if fire products such as ash, charcoal, and soil make their way from a burn site into the river. The release of these products can cause significant dissolved oxygen sags and anoxic conditions, which can significantly impact the biota in the river (Dahm and Candelaria-Ley 2012).

### 5.1.3 Saltcedar Leaf Beetle

As discussed in Chapter 4, Environmental Baseline, it is anticipated that the expansion of saltcedar leaf beetle within the MRG will likely continue into the future. The presence of saltcedar leaf beetle in the MRG and the associated defoliation of saltcedar trees will likely result in reduced canopy cover, reduced nesting substrate, and a reduced food source for flycatchers. Reduced nesting success and loss of breeding populations could occur into the future without the replacement of affected saltcedar with native vegetation.

## 5.2 Projected Impacts of Urban Development

The increasing human population within the MRG basin is expected to lead to expansions in urban development. Future residential, industrial, and municipal development and their associated activities and infrastructure can result in various impacts to aquatic and riparian ecosystems.

### 5.2.1 Floodplain Development

Future development within the historical and active floodplain of the MRG has the potential to impact water management and endangered species and their habitats. In certain regions of the MRG, particularly the San Acacia Reach, the active floodplain is currently unprotected from development and other land use practices that could negatively impact federal, state, and local land and water management programs (Collaborative Program 2013). Due to the threats from flooding, the ability to transport large volumes of water that would cause overbanking inundation is constrained; however, this overbank inundation promotes habitat conditions favorable to listed and other wildlife species. In addition, increased development within the floodplain encroaches on endangered species habitat and physically removes developed areas from endangered species occupancy or future colonization.

### 5.2.2 Future Water Usage

Historically, land use in the MRG region depended primarily on surface water; however, the shift from a dominantly rural population to a dominantly urban population has resulted in increased groundwater consumption and reduced aquifer recharge. The continued growth of human population and water-based industry in the MRG affects the availability of all water supplies, both groundwater and surface water—native and imported. In New Mexico, the surface waters of the Rio Grande have been considered fully appropriated since the Compact was signed, and the NMOSE does not allow new Rio Grande surface water appropriations (NMOSE 2000). As discussed in Chapter 4, Environmental Baseline, the NMOSE conjunctively manages surface and groundwater resources within the Rio Grande Basin because groundwater diversions from aquifers hydrologically connected to the Rio Grande affect the fully appropriated surface flow (NMOSE 2000). Increased urban development is associated with increased urban water use, including municipal and private uses. Further usage of surface water, or increased groundwater withdrawals that reduce surface water flow, will decrease the available wetted and moist habitats required by listed species.

### 5.2.3 Regional Water Planning

The New Mexico Subdivision Act requires that the NMOSE advise whether, in its opinion, an adequate water supply exists for new larger subdivisions that are outside of municipal jurisdictions (NM Stat. § 47-6-1 et seq.). In 1987, the New Mexico Legislature[21] recognized the State's need for water planning and created the State's regional water planning program to balance current and future water needs for a region. Just upstream of the MRG and within the action area of this BA is the Jemez y Sangre Planning Region, and the MRG is contained in two of the State's 16 water planning regions: the Middle Rio Grande Planning Region and the Socorro and Sierra Planning Region. Unfortunately, Land and Water (2011) reported a finding that the water supply is not adequate, does not prevent county government approval of the subdivision, and reported water plans are not commonly implemented because they are not supported by appropriate regulations, development decisions, or in conformity with the plans, and they become outdated.

#### *5.2.3.1 The Jemez y Sangre Planning Region*

The 2003 Jemez y Sangre Regional Water Plan (JyS Plan) includes the Rio Arriba, Los Alamos, and Santa Fe Counties and all or part of eight Pueblos. The JyS Plan states that demand for water may exceed available supply during years of average precipitation and that demand exceeds supply during drought years.

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[21] In 2003, the New Mexico Legislature mandated that the State develop a State Water Plan to provide a blueprint for the State to move forward into the 21st century with 21st century techniques and technologies applied to conserve and to increase the supply of water. NM Stat. § 72-14-3.1 (2011).

The region's surface water supply for agricultural use comes primarily from the Rio Grande and the Rio Chama. The city of Santa Fe receives approximately 40% of its supply from dams in the Santa Fe River watershed above the city (JyS Plan). As discussed in Chapter 4, the City of Santa Fe and Santa Fe County have initiated, under the Buckman Project, direct use of their 5,605 AFY allocation of SJC Project and native Rio Grande water to supplement their other water supplies and have been diverting water from the Rio Grande since January 2011. Groundwater is the primary supply for municipal and industrial uses and provides a small amount for agricultural use (JyS Plan).

The City of Santa Fe and areas of Santa Fe County close to the city are among the fastest growing areas in the State. The population of the region nearly doubled from 1970 to 2000; however, population growth is projected to slow during the first half of this century. The population is projected to increase from about 160,000 in 2000 to about 360,000 by 2060, and nonagricultural demand for water in 2060 is projected to be 31,500 AFY greater than current demand. Agricultural use is on a decline in the region; therefore, the increased demand for nonagricultural use potentially could be met. However, the amount of wet water currently in agricultural use is uncertain because water diverted for agricultural use is not measured or monitored, and the water rights in the region have not been adjudicated (JyS Plan).

The JyS Plan found that the projected supply and demand gap cannot be entirely eliminated through conservation or growth management. Moreover, the available SJC Project water would only meet 40% of the projected gap in the best case scenario. Additionally, reductions in agricultural uses and the elimination of all outdoor watering may be detrimental to public welfare. Some of the JyS Plan recommendations for remedying the supply shortfall are as follow:

- Create advisory boards.
- Adjudicate water right.
- Restore watershed.
- Manage stormwater to enhance recharge.
- Conduct pilot cloud seeding project.
- Evaluate establishing critical management areas to protect groundwater resources.
- Develop conjunctive use strategies.
- Appropriate flood flows.
- Require wastewater reuse.
- Encourage rainwater collection.
- Line ditches.
- Remove sediment in Santa Cruz Reservoir and investigate Nambe Reservoir.

- Repair leaks in water systems.
- Consider aquifer storage and recovery of excess water.
- Pursue increased storage capacity in Abiquiu Reservoir.
- Pursue water conservation.
- Pursue growth management to reduce demand.
- Limited use of domestic wells (JyS Plan).

#### *5.2.3.2 The Middle Rio Grande Planning Region*

The 2004 MRG Regional Water Plan (MRG Plan) comprises Sandoval, Bernalillo, and Valencia Counties, and the Six MRG Pueblos—and an area covering more than 5,000 square miles. More than half of New Mexico's population makes its home in the MRG planning region, and it is the largest urban water user in the State. The MRG region averages just 9 inches of rain per year and relies on surface water and groundwater to supply the industry, agriculture, environment, and people of the region. Surface water supplies include the Rio Grande, Rio Jemez, Rio Puerco, and the SJC Project. Surface flows are augmented by pumped groundwater in the form of 'return flows' of treated sewage, and there is an ongoing exchange between surface water and the shallow aquifer. As discussed in Chapter 4, until 2008, the City of Albuquerque's and Bernalillo County's potable water supplies were provided exclusively from groundwater. Population in the region had grown by 21% since 1993 and continues to expand by about 15% each decade, which will result in even greater deficits in the future unless some conservation actions are taken (MRG Plan).

On average, water use in the region exceeds its renewable supply by approximately 55,000 AFY, which was being supplied by nonrenewable groundwater. If no remedial actions are taken, the consumptive use by the region could result in a 150,000 AFY deficit by 2050 (Figure I-66) (MRG Plan).

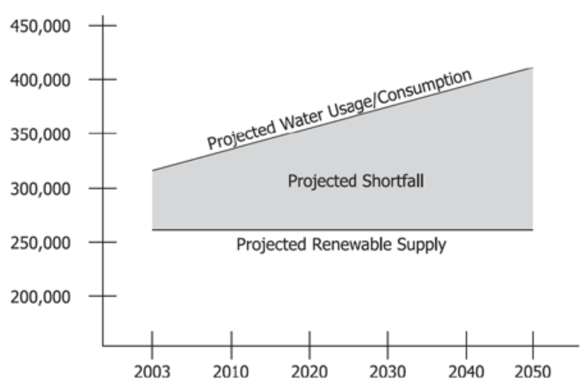


**Figure I-66. Projected MRG water supply shortfall (MRG Plan)**

The following are some of the MRG Plan recommendations for remedying the supply shortfall:

- Establish a domestic well policy.
- Outdoor conservation programs.
- Rainwater harvesting.
- Conversion to low-flow appliances.
- Urban water pricing.
- Graywater reuse.
- Treated effluent reuse.
- Growth of parks and golf courses.
- Watershed management plans.
- Water banking.
- Land use management and planning.
- Measure all water uses.
- Upgrade agricultural conveyance systems.
- Level irrigated fields.
- Implement upstream surface water storage.
- Implement upstream aquifer water storage.
- Implement aquifer storage and recovery for drought.
- Develop new water supplies through desalination.
- Investigate the potential for importing water (MRG Plan).

#### *5.2.3.3 The Soccoro-Sierra Planning Region*

The 2004 Soccoro-Sierra Regional Water Plan (SS Plan) includes Socorro and Sierra Counties, the latter of which is outside the action area for this BA. The population in the Soccoro-Sierra region doubled over the last 30 years to 31,400 and is expected to increase 70%, reaching 60,000 in 2040. Surface water supply for this region includes the Rio Puerco, Rio Salado, and ungaged tributaries east and west of the Rio Grande; and the region has significant supplies of groundwater. The SS Plan determined that demands from both human and natural processes deplete scarce water supplies, and demand outstrips supply by approximately 77,900 AFY. Results of modeling indicate that, in a low-flow year, the supply falls short of meeting demand by 194,000 AF (SS Plan). The following are some of the SS Plan recommendations for remedying the supply shortfall:

- Improve the efficiency of surface water irrigation conveyance systems.
- Improve on-farm efficiency.

- Control brush and weeds along water distribution systems and drains.
- Control non-reservoir surface water evaporation by reducing surface water in engineered and natural locations.
- Require proof of sustainable water supply for approval of new developments.
- Encourage retention of water within the planning region.
- Remove exotic vegetation (i.e., salt cedar, Russian olive) on a wide scale.
- Manage watersheds to increase yield and improve water quality.
- Develop economic potential for non-native species removal, harvest, and product output by local industries.
- Make water rights a non-condemnable resource.
- Improve reservoir management for better coordination of flows with demand.
- Identify and protect areas vulnerable to contamination.
- Adopt and implement local water conservation plans and programs, including drought contingency plans.
- Facilitate interregional water management decisions, public participation, and funding (SS Plan).

### 5.2.4 Local Government Water Conservation Efforts

Local governments, specifically the County and City of Santa Fe, the City of Albuquerque, and the County of Bernalillo, have undertaken substantial efforts to reduce use of and conserve water, with these water conservation and drought management programs expected to continue into the future. Santa Fe’s longstanding water conservation and drought management programs have been successful in decreasing total annual water diversions by 29% to serve a growing number of customers (14%) since 1995. The annual water diversions shrunk to 9,226 acre-feet in 2010, compared to 12,737 acre-feet in 1995, while the number of customers served increased to approximately 79,244 in 2010, from an estimated 67,839 in 1995. Santa Fe’s water customers reduced their water use by 38 percent from 1995 to 2010. Usage dropped from 168 gallons per capita per day (gpcd) in 1995 to 104 gpcd by the end of 2010. Santa Fe has reduced its per capita water demand by implementing a comprehensive set of ordinances that require its citizens and businesses to comply with water conservation requirements. Santa Fe’s low per capita per day water production statistics are among the lowest in New Mexico and the Southwestern United States (Santa Fe Conservation Plan, 2010). Santa Fe has implemented many of the recommended water conservation measures contained in the Jemez y Sangre Regional Water Plan, and Santa Fe’s water conservation successes, and the construction of the Buckman Direct Diversion project has significantly contributed to the closing of the 40-year supply shortfall ‘gap’ in the Santa Fe subregion (Santa Fe Conservation Plan 2010).

The ABCWUA has also implemented various measures to reduce use of and conserve water, and is proposing to continue their efforts toward future water conservation. The ABCWUA has also proposed new conservation measures to include the additional storage of native water, conservation storage agreements with environmental groups, leasing water to Reclamation's Supplemental Water Program, all of which have the potential to benefit endangered species.

### 5.2.5 Urban Water Discharges and Spills

Contamination of water as a result of urban runoff, effluents from sewage treatment plants, and residential, industrial, and commercial development is expected to occur into the future. Although rare, incidents involving the release of pollutants into the Rio Grande from point and non-point sources are also expected to increase with urban development. Decreases in water quality and gradual changes in floodplain vegetation can be expected as a result of surface and groundwater contamination, leading to reductions in the quality of aquatic and riparian habitat upon which listed species depend.

## 5.3 Pueblo Water Rights

The Pueblos hold water rights that are recognized and protected under Federal law, including but not limited to aboriginal time-immemorial water rights. With respect to the Six MRG Pueblos, a certain portion of their water rights are statutorily recognized under the Acts of 1928 and 1935. However, these Acts of Congress may not establish the full extent of the water to which these Pueblos may be entitled. Chapter 4 includes the junior, unadjudicated uses of water by non-Pueblo water users and recognizes the existence of unquantified, aboriginal water rights held by the Six MRG Pueblos. At such time when the full extent of the Pueblos' water rights are quantified, through water rights settlement or otherwise, and used, junior water uses may be curtailed pursuant to New Mexico water law.

## 5.4 Conclusion

In summary, the climate of the MRG basin may become warmer and drier with consequent reduction in snowpack, and urban population growth within the MRG is also projected to increase driving increased demand for water, which is already beyond the variable supply. Therefore, water management in the MRG will only become more challenging with less and less water available for the MRG basin and the species that depend on it (Reclamation 2013).