DEPARTMENT OF THE ARMY
ALBUQUERQUE DISTRICT, CORPS OF ENGINEERS
4101 JEFFERSON PLAZA NE
ALBUQUERQUE NM 87109-3435

February 15, 2013

Planning, Projects and Program Management Division
Planning Branch

SUBJECT: Final Biological Assessment and Request for Reinitiation of Consultation, Corps of Engineers Reservoir Operations

Mr. Wally Murphy
Field Supervisor, New Mexico Ecological Services Field Office
U.S. Fish and Wildlife Service
2105 Osuna NE
Albuquerque, NM 87113

Dear Mr. Murphy:

Pursuant to Section 7 of the Endangered Species Act, the U. S. Army Corps of Engineers (Corps) is hereby requesting reinitiation of consultation with the U.S. Fish and Wildlife Service (Service) for its reservoir operations in the middle Rio Grande basin of New Mexico. The Corps originally submitted its Biological Assessment (BA) on October 31, 2011. The Service requested additional information in a letter dated August 1, 2012. On January 31, 2013, the Corps provided the requested information, fully responding to the Service's concerns. The BA has been revised accordingly, and is hereby submitted. With this submittal, the Corps has met the requirements for a completed BA as described in 50 CFR §402.12, and has satisfied the requirements to initiate formal consultation with the Service as described in 50 CFR §402.14(c).

The Corps has made a final determination that the proposed action may affect, and would likely adversely affect, the endangered Rio Grande silvery minnow (*Hybognathus amarus*), and would likely adversely modify its designated critical habitat. Additionally, the proposed action may affect, and would likely adversely affect the endangered Southwestern Willow Flycatcher; but would not likely adversely modify designated critical habitat. Lastly, the proposed action would not affect the endangered Interior Least Tern (*Sternula antillarum athalassos*) or the threatened Pecos sunflower (*Helianthus paradoxus*).

The Bureau of Reclamation (Reclamation) is separately and simultaneously consulting on their water management actions along the middle Rio Grande. Because of this, the Corps understands that the Service needs to comprehensively evaluate the proposed actions of both agencies, along with environmental baseline and cumulative effects, in their determination of jeopardy. Notwithstanding, on January 23, 2013, the Service agreed to issue a Corps-specific Biological Opinion (BiOp) with reasonable and prudent alternatives and/or measures based on

SUBJECT: Final Biological Assessment and Request for Reinitiation of Consultation, Corps of Engineers Reservoir Operations

the effects of the Corps' proposed action. At that time, the Service acknowledged that an agency-specific BiOp facilitates the Corps' ability to secure funding and support for its Section 7 responsibilities. Further, a framework was established for partitioning the responsibilities of the Corps from the responsibilities of Reclamation and other state and local entities on the middle Rio Grande. Finally, the Corps agreed to the inclusion of specific conservation measures, including participation in the Middle Rio Grande Endangered Species Collaborative Program, which are reflected in the completed BA. This agreement has been incorporated in the BA, and appears as Appendix H. The Corps' request for reinitiation is wholly contingent on adherence to the terms of this agreement. Any deviations from these terms will result in the Corps' withdrawal from consultation until such deviations are remedied.

The Corps anticipates that, following evaluation of the submitted BA, the Service will issue a draft BiOp for review and comment. We look forward to working with the Service to finalize the terms and conditions to be incorporated in that draft BiOp. In the interim, the Corps understands that reinitiation of consultation provides continued compliance under Section 7 of the Endangered Species Act.

Please direct any questions or comments to me at (505) 342-3201 or Mr. William DeRagon at (505) 342-3356.

Sincerely,

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SUBJECT: Final Biological Assessment and Request for Reinitiation of Consultation, Corps of Engineers Reservoir Operations

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US Army Corps
Of Engineers
Albuquerque District

BIOLOGICAL ASSESSMENT
OF
U.S. ARMY CORPS OF ENGINEERS
RESERVOIR OPERATION ON THE
MIDDLE RIO GRANDE OF NEW MEXICO

October 31, 2011
Amended February 15, 2013

Prepared by
U.S. Army Corps of Engineers
Albuquerque District
4101 Jefferson Plaza NE
Albuquerque, New Mexico 87109

CONVERSION FACTORS

	From	Multiplier	To
Distance:	inches (in)	25.4	millimeters (mm)
	feet (ft)	0.3048	meters (m)
	miles (mi)	1.6093	kilometers (km)
Area:	acres (ac)	0.0407	hectares (ha)
	square miles (mi^2)	2.590	square kilometers (km^2)
Volume:	cubic yards (CY)	0.7646	cubic meters (m^2)
	acre-feet (ac-ft)	1,233.5	cubic meters (m^2)
	acre-feet (ac-ft)	325,851	gallons (gal)
Discharge:	cubic feet/second (cfs)	0.0283	cubic meters/second (cms)
Mass (weight) :	tons [short]	0.9072	metric tons [long]
Velocity:	feet/second (fps)	0.3048	meters/second (cms)
Salinity:	µSiemens/cm or µmhos/cm	0.32379	parts/million NaCl or mg/liter NaCl
Temperature:	° Fahrenheit (°F)	(°F-32)/1.8	° Celsius (°C)

TABLE OF CONTENTS

Page

APPENDICES

1. INTRODUCTION

1.1 SCOPE OF THE BIOLOGICAL ASSESSMENT

The U.S. Army Corps of Engineers (Corps) is submitting this Biological Assessment (BA) to the U.S. Fish and Wildlife Service (Service) pursuant to Section 7(a)(2) of the Endangered Species Act (ESA). The BA evaluates the effects of the Corps' continuing, discretionary reservoir operation actions on Federally listed species, and designated critical habitat within the middle Rio Grande valley of New Mexico. The BA also addresses effects that are interrelated or interdependent (as defined in 50 CFR §402.02) with the Corps' proposed action.

The proposed action in this Section 7 consultation includes the Corps' discretionary flood risk operation (a.k.a., "flood control"), San Juan-Chama water storage, maintenance operations at Corps-managed reservoirs in the middle Rio Grande valley, and the conduct of deviation in the flood regulation schedule of Cochiti and Jemez Canyon dams through July 15, 2013. The proposed actions are described in detail in Chapter 3 of the BA.

Current ESA compliance for water management activities by the Corps, Bureau of Reclamation (Reclamation) and other entities is contained in a Biological Opinion and incidental take statement issued by the Service in March 2003 (USFWS 2003b; the "2003 BO"). The Corps is reinitiating Section 7 consultation because the 2003 Biological Opinion will expire on February 28, 2013. Reinitiation of consultation through the Corps' submittal of this BA provides continued compliance under the ESA.

In the interest of comprehensive evaluation of the cumulative effects of water management activities in the middle Rio Grande valley, the Corps is initiating Section 7 consultation at this time in order to be contemporaneous with ESA consultation conducted by Reclamation (Reclamation 2013). Concurrent with these consultations, the Corps and Reclamation, as signatory members of the Middle Rio Grande Endangered Species Collaborative Program (Collaborative Program), are working with other Federal and non-Federal stakeholders to protect and improve the status of endangered species, while protecting existing and future water uses and ensuring compliance with all applicable laws.

Notwithstanding the stated collaborative goals, the Corps is submitting an agency-specific BA and remains firm in its position that reinitiation of consultation is contingent upon the Corps' receipt of an agency-specific—rather than multi-agency—Biological Opinion, should a Biological Opinion ensue as a result of the Service's evaluation of the Corps' defined actions. Federal case law supports the position that a federal agency has discretion in defining the action on which to consult, and that a decision to produce one Biological Opinion or two ultimately lies with the action agencies.[1] The Service agreed to the provision of a Corps-specific Biological Opinion in a meeting held on January 23, 2013, which was summarized in a jointly signed memorandum (see Appendix H of this BA).

All Corps actions that were included in the 2003 consultation on Middle Rio Grande water operations are included in this, current BA; however, the present consultation is not a reinitiation of the 2003 BO *per se*. Consultation #2-22-03-F-0129 analyzed a different set of actions, within a different action area, than those that the Corps or Reclamation are currently proposing in their individual consultations (see Reclamation 2013). The 2003 BO evaluated all water depletions within the Middle Rio Grande, e.g.: "...this biological opinion analyzes the effects on the listed species from existing depletions that result from both Indian and non-Indian water uses within the action area, and extends incidental take coverage

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[1] *See* American Rivers v. NOAA Fisheries and U.S. Bureau of Reclamation, 2006 U.S. Dist. LEXIS 32391, 63 Env't Rep. Cas. 1009 (D. Or. May 23, 2006), reconsideration denied 2206 U.S. Dist. LEXIS 48195 (D. Or. July 14, 2006).

for all those uses." (2003 BO, p. 7). Currently, neither the Corps nor Reclamation is individually proposing actions that would include all water depletions, even when their agency-specific actions are considered cumulatively. The action area of the 2003 BO was defined (on page 6) as "the area of the Rio Chama watershed and the Rio Grande, including all tributaries, from the Colorado/New Mexico State line downstream to the headwaters of Elephant Butte Reservoir." The action areas of the Corps' and Reclamations' current consultations each entail a much smaller portion of the Middle Rio Grande basin than that considered in the 2003 BO.

This BA considers the effects of the Corps' proposed actions on Federally listed species and their designated critical habitat occurring from Abiquiu Reservoir downstream along the Rio Chama and Rio Grande to the headwaters of Elephant Butte Reservoir just south of San Marcial, New Mexico. A detailed description of the action area is provided in Section 3.1 of this document. The BA focuses on the endangered Rio Grande silvery minnow (*Hybognathus amarus*), the endangered Southwestern Willow Flycatcher (*Empidonax traillii extimus*), the threatened Pecos sunflower (*Helianthus paradoxus*), and the endangered Interior Least Tern (*Sternula antillarum athalassos*).

The remainder of this chapter summarizes the history of the Corps' Section 7 consultations on reservoir operations since 1995. Recent and ongoing projects that are part of the current environmental baseline are summarized in Chapter 4.

1.2 HISTORY OF CONSULTATION

The Corps has completed numerous ESA consultations since 1995, including individual and joint consultations for Federal water operations on the Middle Rio Grande (see Figure 2.1 for a map of this region). The Corps' water control plans and flood-control operation parameters have remained unchanged since 1996. The majority of the consultations summarized below were required for temporary alterations to water control plans, or for ongoing reservoir operations.

1.2.1 Release of Carryover Flood Water from Abiquiu Reservoir, 1995

In November 1995, the Corps completed informal consultation concerning potential impacts of winter releases of carryover flood-water from Abiquiu Dam on Federally-listed species. Key stakeholders, including the three Rio Grande Compact states (Colorado, New Mexico and Texas), were involved in the analysis process. The Corps determined that the action to release carryover storage water at a constant rate of 325 cubic feet per second (cfs) above the normal release from November 1, 1995, to March 31, 1996, would not likely adversely affect the silvery minnow or adversely modify its then-proposed critical habitat. In letters dated October 11 and October 31, 1995, the Corps also determined that the action would have no effect on the Southwestern Willow Flycatcher, Whooping Crane (*Grus americana*), and the then-listed Bald Eagle (*Haliaeetus leucocephalus*). In a letter dated November 8, 1995, the Service concurred with these determinations based, in part, on the Corps' commitment to assume lead responsibility for monitoring the effects of the action.

1.2.2 Increase in Safe Channel Capacity at Albuquerque to 7,000 cfs, 1996

In 1996, the Corps informally consulted on increasing the safe channel capacity at Albuquerque from 5,000 cfs to 7,000 cfs (USACE 1996c). Between 1979 and 1996, the 5,000-cfs channel capacity was experimentally exceeded in several years through a series of year-long deviations in flood-control operations. Water control manuals for Rio Grande basin flood-control reservoirs were modified in 1996 to reflect the formal increase in the operational channel capacity. In a letter dated February 9, 1996, the Service concurred with the Corps' determination that the action would have no effect on the endangered

Interior Least Tern, Whooping Crane, and American Peregrine Falcon (*Falco peregrinus anatum*); would not likely adversely affect the endangered Rio Grande silvery minnow and Southwestern Willow Flycatcher, and the threatened Bald Eagle; and was not likely to adversely modify proposed critical habitat for the minnow and flycatcher.

1.2.3 Programmatic On-going Water Operations, 1996 and 1997

Severe drought conditions in 1996 resulted in significant challenges for those responsible for water management in the Middle Rio Grande basin. Reclamation and the Corps closely coordinated their respective activities with other entities throughout the 1996-1997 irrigation seasons to minimize impacts to the silvery minnow and Willow Flycatcher. These activities, undertaken by the Corps and reclamation, included: leasing available water from the City of Albuquerque and other San Juan-Chama contractors in compliance with state law and managed in compliance with State and Federal law and Compact requirements; improving portions of Middle Rio Grande Conservancy District's (MRGCD) water conveyance system in partnership with the New Mexico Interstate Stream Commission (NMISC) and the MRGCD; conducting intensive water measurement and operations; regulating summer thunderstorm runoff for flood control; and increasing biological monitoring. Reclamation and the Corps, in consultation with the Service during 1996 and 1997, determined that these collective actions would have no effect on the Bald Eagle, would not likely adversely affect the Willow Flycatcher, and may affect the silvery minnow. Additional details on water operations and endangered species during 1996 and 1997 can be found in the associated Biological Assessments (Reclamation and USACE 1996, 1997).

1.2.4 Programmatic On-going Water Operations, 1998-1999

In December 1997, Reclamation and the Corps informed the Service by letter of their intent to initiate an informal programmatic consultation that would cover a multi-year period with a goal of developing approaches to water operations and river maintenance to avoid adverse affects on listed species (Consultation #2-22-01-F-137). Programmatic BAs were submitted to the Service jointly by Reclamation and the Corps in May 1998 and October 1999. Subsequent supplements were issued to clarify the description of action, time frame of the consultation, and Reclamation's title interest in MRGCD facilities.

1.2.5 Temporary Deviation for Partial Evacuation of the Sediment Retention Pool at Jemez Canyon Reservoir, 2000

In September 2000, the Corps informally consulted with the Service regarding a one-time deviation from the water control plan for Jemez Canyon Reservoir in order to prematurely release 12,000 acre-feet of water from the sediment-retention pool. The total evacuation of the approximately 24,000-acre-foot sediment retention pool was expected to occur after December 31, 2000, the date when the Corps-NMISC agreement that established and maintained the pool was to expire. However, a court-mediated Agreed Order in an ongoing lawsuit (*Rio Grande silvery minnow, et al., vs. Eluid L. Martinez, et al.*) included the release of 12,000 acre-feet from the sediment retention pool as part of a plan to reduce the risk of extinction for the silvery minnow during a drought period. To conduct this release prior to the start of 2001 required amending the Corps-NMISC agreement, and approval from the Corps' Southwestern Division to deviate from the existing water control plan. In a letter dated September 20, 2000, the Service concurred with the Corps' determination that the proposed action may affect, but not likely adversely affect the minnow, Southwestern Willow Flycatcher, and Bald Eagle; and would have no effect on designated critical habitat for the minnow (Cons. #2-22-00-I-474). The action was successfully implemented in October 2000.

1.2.6 Programmatic On-going Water Operations, 2001-2003

On June 6, 2001, Reclamation and the Corps jointly submitted to the Service a BA for proposed Federal actions related to water management operations and river management activities on the Middle Rio Grande and non-Federal depletions and related actions (Reclamation and USACE 2001). The Service issued a final Biological Opinion (BO) on June 29, 2001 (USFWS 2001; Consultation # 2-22-01-F-431). The BO found that the proposed actions were likely to jeopardize the continued existence of listed species and contained a Reasonable and Prudent Alternative and an Incidental Take Statement, which the Federal agencies and non-Federal actors implemented.

1.2.7 Temporary Deviation to Store Endangered Species Conservation Water at Abiquiu Reservoir and Jemez Canyon Reservoir, 2001-2003

In April 2001—in furtherance of litigation resolution and as an environmental commitment in the then-current ESA consultation—the New Mexico Attorney General's Office (NMAGO), NMISC, Reclamation, and Corps outlined a 2.5-year-long process whereby up to 100,000 acre-feet of New Mexico's credit water in Elephant Butte Reservoir could be relinquished to downstream users in return for the ability to store the same volume of Rio Grande basin water upstream. The subject water would be stored in Corps reservoirs, managed by Reclamation, and be used to benefit listed species. The Corps formalized a temporary deviation in their water control plans to store up to approximately 24,000 ac-ft in Jemez Canyon Reservoir and 45,000 ac-ft in Abiquiu Reservoir, at any given time within the 2.5-year period (USACE 2001a). The Corps conducted informal consultation with the Service (Cons. # 2-22-01-I-332) regarding the storage and subsequent beneficial release of this water. In a letter dated April 12, 2001, the Service concurred with the Corps' determination that this action may, but not likely adversely, affect the silvery minnow, flycatcher, and Bald Eagle; and would have no effect on the Interior Least Tern and Whooping Crane. The "Conservation Water Agreement" was formally signed by the NMAGO, NMISC, Reclamation, and Corps on June 29, 2001, concurrent with the issuance of the BO by the Service (discussed above).

The subject conservation water was successfully managed by the responsible agencies, until the Conservation Water Agreement was amended by the "Emergency Drought Water Agreement" in April 2003. Under the latter agreement, water would be stored by Reclamation in El Vado Reservoir, rather than in Corps facilities.

1.2.8 Reclamation Reinitiation, 2002

(Note: In 2002, only Reclamation reinitiated consultation. Although the Corps did not reconsult at that time, a summary of that consultation is included here because it explains the process between the 2001 and 2003 BOs.)

Although the June 2001 consultation was to be effective through December 31, 2003, in June 2002, Reclamation predicted it would not be possible to meet the 2001 BO flow requirements for the remainder of the water year because of extreme drought. On August 2, 2002, Reclamation requested reinitiation of Section 7 consultation (Consultation # 2-22-02-F-608). Reclamation's proposal for managing the extremely limited water supply was further amended by an August 30, 2002, letter. On September 12, 2002, the Service issued an amended BO addressing Reclamation's proposed water management through December 31, 2002. The new BO found that Reclamation's proposed action was likely to jeopardize the continued existence of the silvery minnow but that there was no Reasonable and Prudent Alternative to the proposed action. On September 23, 2002, Chief U.S. District Judge James Parker issued an opinion declaring the September 12, 2002, BO "arbitrary and capricious," which effectively voided the September 12 BO. Ultimately, late season rains enabled Reclamation to use its remaining supplemental water consistent with the June 2001 BO, including the Incidental Take Statement. The June 2001 BO remained in effect throughout the 2002 water year, and the Federal agencies were instructed by the court to reinitiate consultation in 2003.

1.2.9 Reconsultation on Programmatic Water Operations, 2003-2013

On February 19, 2003, Reclamation and the Corps jointly submitted a BA (Reclamation and USACE 2003) to the Service requesting formal consultation pursuant to Section 7 of the ESA for the proposed actions associated with all water depletions, river maintenance, and flood control in the middle Rio Grande basin upstream from the headwaters of Elephant Butte Reservoir (USBR River-mile 62). The BA and subsequent BO (Consultation #2-22-03-F-0129), issued March 17, 2003 (USFWS 2003b), addressed Federal and non-Federal entities' actions related to typical operations, including net depletions and withdrawals, water and river management activities, operation of the Middle Rio Grande Project, flood control, and other management actions on the Middle Rio Grande. The consultation focused on effects on the endangered silvery minnow and its designated critical habitat, the endangered flycatcher, threatened Bald Eagle and endangered Interior Least Tern.

Reclamation and the Corps determined that their continuing actions were not likely to adversely affect the Bald Eagle and the Interior Least Tern; would likely adversely affect the silvery minnow and flycatcher; and may adversely modify designated critical habitat of the minnow. The Service concurred with the determinations for the eagle and tern. The Service also concluded that water operations and river maintenance of the Middle Rio Grande, as proposed in the February 2003 BA, were likely to jeopardize the continued existence of the silvery minnow and the flycatcher and adversely modify critical habitat of the silvery minnow.

Environmental commitments associated with the 2003 BO included a Reasonable and Prudent Alternative (RPA) addressing water operations elements, habitat restoration elements, salvage and captive propagation elements, water quality elements, and reporting elements. Additional terms and conditions affiliated with Reasonable and Prudent Measures (RPMs) in the associated Incidental Take Statement included commitments to: 1) minimize silvery minnow take within the Rio Grande while performing water operations activities, flood-control activities, and river maintenance activities, and 2) minimizing the take of minnow and the reduction of flycatcher reproductive success due to river drying.

Federal and non-Federal entities have collectively implemented many improvements in water operations and management since the 2003 BO, such as a reduction in the volume of MRGCD river diversions; improvements in water operations (daily coordination conference calls, *etc*.); Rio Grande Compact relinquishment of credit water in 2003 and 2008; over 1,100 acres of habitat restoration; levee and Low-Flow Conveyance Channel setback work in the San Acacia Reach[2]; deviations to the normal operation schedule of Cochiti Lake to facilitate spawning and recruitment flow; and various efforts to improve channel morphology, all of which have undergone separate Section 7 consultation.

1.2.10 Programmatic Reconsultation on Designated Critical Habitat for the Southwestern Willow Flycatcher, 2006

In April 2006, Reclamation and the Corps subsequently reinitiated consultation (Consultation #2-22-03-F-0129-R1) to include effects on re-designated critical habitat for the flycatcher, and requesting amendment of Term and Condition 1.1 of RPM 1 to allow river drying to proceed at a maximum rate of 8

[2] The levee setbacks constructed at River-mile 111 and 113/114 provide areas for lateral channel migration and formation of new lotic and riparian areas. (USFWS Consultation #22420-2008-I-0067.)

(rather than 4) miles per day. The Service transmitted a letter that amended the 2003 BO by determining that the proposed action did not destroy or adversely modify flycatcher designated critical habitat, amending RPM 1. The letter also required a revision of the protocol for coordination among water management entities. The Service also determined that all other determinations included in the 2003 BO regarding the silvery minnow and its critical habitat and the flycatcher remained unchanged.

1.2.11 Temporary Deviation to Alter Operation Schedule at Cochiti Lake, 2007

In April 2007, the Corps consulted with the Service (Consultation # 22420-2007-I-057) regarding a temporary (one year) deviation in the operation of Cochiti Dam to alter its regulating schedule and, thereby, facilitate flows conducive to the spawning and recruitment of the Rio Grande silvery minnow (USACE 2007). In a letter dated April 23, 2007, the Service concurred with the Corps' determination that the proposed action may, but not adversely, affect the flycatcher and the minnow; and would not adversely affect critical habitat designated for these two species. Rather, the action was expected to directly benefit the minnow through an increased potential for spawning and recruitment; and it would have a short-term, positive impact on the critical habitat of both species as a result of the longer duration of higher flows. The action was successfully implemented and completed in May-June 2007.

1.2.12 Temporary Deviation to Alter Operation Schedule at Cochiti Lake and Jemez Canyon Reservoir, 2009-2013

In July 2008, the Corps informally consulted with the Service (Consultation #22420-2008-I-0141) for a similar deviation in the operation of Cochiti and Jemez Canyon dams for up to 5 years. Also proposed was an alteration in the regulating schedule that would facilitate a discharge of approximately 5,800 cfs at Albuquerque's Central Avenue Bridge, thereby increasing inundation of the riparian zone within the Rio Grande floodway downstream. In a letter dated July 17, 2008, the Service again concurred that the proposed action may, but not likely adversely, affect the flycatcher and the minnow; and would not adversely affect critical habitat designated for these two species. Rather, the action was expected to beneficially affect the minnow and critical habitat designated for the minnow and flycatcher.

1.2.13 Summary of Previous Consultations Regarding the San Marcial Railroad Bridge

Because the Burlington Northern Santa Fe railroad bridge that spans the Rio Grande at San Marcial has been the subject of previous Section 7 consultations, a summary of that history is presented is this section.

In May 1996, the Corps initiated formal consultation (Consultation #2-22-95-F-180) on the *Rio Grande Floodway, San Acacia to Bosque del Apache* project, which entailed the replacement of 42 miles of existing spoilbank levee with a superior and competent engineered levee. The Service issued a draft BO (USFWS 1996) in November 1996 that determined the proposed project would likely jeopardize the continued existence of both the Southwestern Willow Flycatcher and the Rio Grande silvery minnow, and would likely result in destruction and adverse modification of proposed critical habitat for the minnow. The attendant Reasonable and Prudent Alternative (RPA) included, in part, the "management of the Middle Rio Grande to mimic timing of the historic hydrograph with sufficient flows to provide adequate overbank flooding to meet flycatcher needs." The RPA was based on the assumption that the San Marcial railroad was, and would continue to be, a significant limiting factor for flood-control operation.

During continuing plan formulation for the *San Acacia to Bosque del Apache* project, hydraulic analyses indicated that the proposed levees would sufficiently increase water surface elevations in the Rio Grande to result in an increased probability and frequency of damage to the railroad bridge, and that the railroad bridge would sustain damages that it normally would not sustain under existing (pre-construction) conditions. The Corps does not have the authority to routinely improve or replace private property that can potentially be physically or economically damaged by regulated flood flows. However, the increased probability and frequency of damage to the San Marcial railroad bridge as a result of proposed levee construction was determined to represent a compensable taking under the Fifth Amendment of the Constitution. In such cases, the Federal Government has the responsibility and is authorized to provide compensation for actions which negatively affect private property rights. In this case, it was determined that the least expensive compensation alternative was to replace the bridge in-kind, at a height and location where it would no longer be subject to damage. The replacement and relocation of the railroad bridge was incorporated as a justified feature of the Corps reevaluation study for the San Acacia to Bosque del Apache flood protection project.

In 2003, the Corps consulted on the operation of its Middle Rio Grande reservoirs relative to the Endangered Species Act (Consultation # 2-22-03-F-0129). The Biological Opinion issued in March 2003 (USFWS 2003b) found that the proposed actions would likely jeopardize the continued existence of the endangered Rio Grande silvery minnow and the endangered Southwestern Willow Flycatcher, and would likely adversely modify designated critical habitat for the silvery minnow. The Corps proposed the replacement of the San Marcial railroad bridge as an environmental commitment that would facilitate increased discharges and subsequently benefit the listed species. Element U of the RPA of the 2003 BO therefore states, in part: "Action agencies … shall collaborate on the river realignment and proposed relocation of the San Marcial Railroad Bridge project, which is necessary to increase the safe channel capacity within the Middle Rio Grande." This inclusion in the 2003 BO was consistent with the scope of the Corps' legal authority and jurisdiction.

In 2004, the flood-flow hydrology for the *San Acacia to Bosque del Apache* study was updated. Analyses based on this updated hydro-meteorological data resulted in a significant (30%) decrease in the estimated magnitude of the 1%-chance (colloquially termed "100-year") flood event; that is, from 43,000 cfs to 30,000 cfs at San Acacia. Based on these new evaluations, construction of an engineered levee along the west bank of the Rio Grande would have minimal effect on the potential for damaging the San Marcial railroad bridge. In essence, the probability of damages to the bridge is the same for both the "with" and "without" levee-project condition. Therefore, there are no induced flood damages to the bridge that can be attributed to construction of the levees, which means there is no compensable taking under the Fifth Amendment. As a result, the Federal Government would bear no responsibility, nor would it be in the Federal interest to relocate the bridge under the auspices of the San Acacia to Bosque del Apache project (Corps letter to Service dated Jan. 22, 2007).

As explained in detail in Chapter 6 of this BA, the railroad bridge has not functioned to curtail the regulated flood releases from Corps reservoirs since 1997. High storage in Elephant Butte Reservoir — a few miles downstream from the railroad bridge—was a factor in the reduced channel capacity at the bridge during the mid-1980s to mid-1990s. Storage levels in Elephant Butte Reservoir have been declining since 2000 and have been very low for the past few years. As a result, channel capacity has increased at the headwaters area.

2. SYSTEM OVERVIEW

2.1 INTRODUCTION

The Corps is responsible for operation and maintenance of four flood risk management (flood control) dams on the Rio Grande and its tributaries: Abiquiu, Cochiti, Galisteo, and Jemez Canyon dams (Figure 2.1). The primary purposes of all four facilities are flood and sediment control. Secondary purposes that have been authorized by Congress at include water supply storage and hydropower generation (at Abiquiu Dam), and recreation and fish and wildlife resources (at Cochiti Dam). This chapter broadly describes these Corps projects and provides background on reservoir operations. This information is critical for understanding the nature and limitations of the Corps' discretionary actions with respect to river flow in the middle Rio Grande valley. The action area and the proposed action for this Section 7 consultation are described in detail in Chapter 3.

Figure 2.1. Map of the Rio Grande basin in New Mexico showing location of the four U.S. Army Corps of Engineers dams.

The Rio Grande originates in Colorado near Crede, and flows southeast through the San Luis Valley, before turning south into the Rio Grande Rift. The Rio Grande enters the area referred to in this BA as the "Middle Rio Grande" reach at Velarde, New Mexico, just north of the Rio Chama confluence. Three water development projects on the Rio Chama play important roles regulating tributary flow into the Rio Grande. These three projects include Reclamation-operated facilities at Heron Reservoir and El Vado Dam, and the Corps-operated Abiquiu Dam.

Cochiti Dam and Lake, the major Corps project on the Rio Grande mainstem, is located about 39 river-miles downstream from the Rio Chama-Rio Grande confluence. Approximately 8 river-miles south of Cochiti Dam is the confluence with Galisteo Creek. This ephemeral creek has an unregulated flow facility, Galisteo Dam. South of the confluence with Galisteo Creek, the ephemeral Jemez River enters the Rio Grande near Bernalillo. Flood flows on the Jemez River are controlled at Jemez Canyon Dam, close to the confluence with the Rio Grande. Finally, the southern end of the Middle Rio Grande (as defined here) is the headwaters of the Reclamation-operated Elephant Butte Reservoir, which is the principal facility regulating flows to downstream reaches of the Rio Grande.

2.2 ABIQUIU DAM AND RESERVOIR

2.2.1 Flood Regulation

The Abiquiu Dam and Reservoir project is situated on the Rio Chama about 32 river miles upstream from its confluence with the Rio Grande. The project was authorized for construction by the Flood Control Act of 1948, (Public Law [P.L.] 80-858) and the Flood Control Act of 1950 (P.L. 81-516). Construction of Abiquiu Dam was initiated by the Corps in 1956 and the project was completed and placed into operation in 1963. The dam is a rolled earthfill structure with a crest length of 1,800 feet, and the maximum height above the stream bed is approximately 341 feet. The drainage area contributing flow to Abiquiu Reservoir comprises 2,146 square miles. Inflow to Abiquiu Reservoir is, in part, regulated by Heron and El Vado dams, which are operated by the Bureau of Reclamation.

Abiquiu Dam was initially authorized to be operated solely for flood and sediment control. Subsequent legislation added authority for water supply storage (specifically, San Juan-Chama Project water storage). The reservoir's storage allocations include 502,000 ac-ft for flood control and 77,039 ac-ft for sediment retention. At the end of 2009, an estimated 40,616 ac-ft of the initial 77,039 ac-ft sediment reserve space remained unfilled. Storage of San Juan-Chama water occurs within the flood-control space and unused portion of the sediment reserve space.

Under current operating procedures, Rio Grande basin flow and releases from El Vado Reservoir upstream are passed through Abiquiu Reservoir without regulation. The only situation in which the Corps would take any action would be to maintain the safe channel capacity downstream. Due to reach-specific safe channel capacity constraints, releases from Abiquiu Reservoir are restricted to 1,800 cfs directly below the dam; 3,000 cfs at the Chamita gage for the Rio Chama downstream from the dam; and 10,000 cfs at the Otowi gage for the Rio Grande mainstem. At the Chamita and Otowi locations, the Rio Chama and Rio Grande channels carry flow from sources other than Abiquiu Dam. The Corps limits releases from Abiquiu Dam such that those releases, in combination with current instream flows, do not exceed any of the three safe channel capacity limits.

Operation of Abiquiu Dam for flood control is coordinated with Cochiti, Galisteo, and Jemez Canyon dams, which are jointly operated for a maximum safe channel capacity of 7,000 cfs at the Albuquerque gage (Central Avenue Bridge). Flood regulation is initiated at Abiquiu Dam when flows into the reservoir exceed the capacity of the Rio Chama downstream from the dam or when flows on the Rio Grande equal or exceed its channel capacity. Flood regulation at Abiquiu Reservoir can be expected from April through June. The maximum water storage to date has been 402,258 ac-ft (elevation 6,261.1 feet), which occurred in June 1987.

2.2.2 San Juan-Chama Water Storage

Reclamation's San Juan-Chama (SJ-C) Project diverts water from the Navajo, Little Navajo, and Blanco rivers, which are upper tributaries of the San Juan River (of the Colorado River basin), for use in the Rio Grande basin in New Mexico. After being diverted through the Azotea Tunnel, this water is stored at Heron Reservoir, upstream from Abiquiu Dam. Reclamation delivers SJ-C Project water to users in the upper Rio Grande basin based on contracts with various water-management entities. Delivery of SJ-C Project water is authorized for municipal, domestic, industrial, recreation, irrigation, and fish and wildlife purposes. The following statutory conditions must be met for use of SJ-C Project water:

- Must be consumptively and beneficially used in New Mexico.
- Must have a downstream destination.
- Must not harm native Rio Grande water.
- Is not subject to provisions of the Rio Grande Compact.

SJ-C Project water is released from Heron Reservoir by Reclamation to a specific user, who can use such water immediately or store it in other facilities for future use.

In 1981, P.L. 97-140 (see Appendix A of this BA) authorized the Secretary of the Army to enter into agreements with entities that have contracted with the Secretary of the Interior for water from the SJ-C Project. The authorization allows for up to 200,000 ac-ft of this water to be stored in Abiquiu Reservoir within the flood-control space and unused portion of the sediment reserve space. The Corps has entered into agreements with the Albuquerque-Bernalillo County Water Utility Authority (ABCWUA) and other entities for SJ-C water storage (Table 2.1). Up to 180,124 ac-ft (elevation 6,220 ft.) is currently stored pursuant to storage easements held by the ABCWUA[3]. When full, this pool creates a 4,100-surface-acre reservoir. The authorizing legislation stipulates that storage of this water shall not interfere with the authorized purposes of Abiquiu Reservoir (namely, flood and sediment control). When forecasts indicate that more than 302,000 ac-ft are required for flood control, all, or a portion of, stored SJ-C water would be evacuated.

Normal releases of SJ-C water from Abiquiu Reservoir represent individual decisions made by contractors to call for their water, without discretionary action by the Corps. The Corps does ensure that these releases are passed in a manner that does not threaten the safety or structural integrity of flood-control facilities. For example, concerns regarding structural integrity or functionality may cause the Corps to evacuate SJ-C water to facilitate repairs.

In 1988, P.L. 100-522 (see Appendix A of this BA) authorized the storage of up to 200,000 ac-ft of Rio Grande system water at Abiquiu Reservoir when space is no longer required for the storage of San Juan-Chama Project water as authorized by P.L. 97-140. Presently, all water supply storage at Abiquiu Reservoir consists of SJ-C Project water; there are no agreements for storage of Rio Grande system water.

[3] The upper limit of SJ-C storage is the 6,220-foot elevation, which corresponds to the vertical extent of ABCWUA's storage easements with surrounding landowners. The actual volume of allowable SJ-C storage decreases over time as sediment retention in the reservoir increases. The gross rate of sediment accumulation behind Abiquiu Dam since its closure in 1963 is 792 ac-ft per year. The actual rate of accumulation in a given year or period varies widely depending on the frequency and magnitude of inflow during that period.

Table 2.1. San Juan-Chama Project storage allocations at Abiquiu Reservoir, 2012.

San Juan-Chama Project contractor	Allocation (ac-ft)
Albuq.-Bernalillo Co. Water Utility Authority[1]	170,900
Middle Rio Grande Conservancy District	2,000
City of Santa Fe	4,596
City of Los Alamos	1,055
City of Española	879
Town of Bernalillo	352
County of Santa Fe	330
Twining Water & Sanitation District	13
Total	180,124

[1] Reclamation stores up to 20,000 ac-ft of Supplemental Water within ABCWUA's space.

2.2.3 Hydropower

Abiquiu Dam was modified in 1991 to include a hydroelectric power facility. The County of Los Alamos constructed and maintains the power plant. Effectively, all dam releases are currently diverted through the power plant for generation of electricity. However, a written agreement between the County and the Corps prior to constructing the plant stipulates that no releases will be made specifically for the benefit of the power plant (USACE 1995). The plant is a run-of-the-river facility and has no impact on reservoir storage or releases.

2.3 COCHITI DAM AND LAKE

The Cochiti Dam and Lake Project is located on the mainstem of the Rio Grande, about 25 miles southwest of Santa Fe and 50 river miles north of Albuquerque. Cochiti Dam also extends across the Cañada de Cochiti and the Santa Fe River, tributaries of the Rio Grande draining from the east. The dam is a 28,815-foot-long, rolled earthfill structure with a maximum height of 251 feet above the stream bed. The drainage area contributing inflow into the lake is 11,685 square miles.

The Flood Control Act of 1960 (P.L. 86-645; see Appendix A of this BA) authorized the construction of Cochiti Dam, to be operated solely for flood and sediment control. Construction of Cochiti Dam by the Corps began in 1965 and the project was fully operational in 1975. The reservoir's storage allocations include approximately 500,000 ac-ft for flood control and 105,000 ac-ft for sediment accumulation. At the end of 2009, approximately 73,517 ac-ft of the sediment reserve space remained unfilled.

During the planning phase for Cochiti Dam, public interests in New Mexico requested, through their congressional delegation, the establishment of a permanent pool. Subparagraph (e) of P.L. 86-645 specifically exempted the creation of a permanent pool unless the water to fill and maintain the pool came from outside the Rio Grande basin. P.L. 88-293 (see Appendix A of this BA), enacted on 26 March 1964, authorized the Secretary of Interior to make water available from the San Juan-Chama Project for a permanent pool at Cochiti Lake for the purposes of recreation and the conservation and development of fish and wildlife resources. The permanent pool was filled with San Juan-Chama Project water to a surface area of 1,200 acres (approximately 50,000 acre-feet) in 1975.

Two irrigation canals—the Sile Canal and Cochiti Main canals—originate from the upper stilling basin in the outlet of Cochiti Dam. The upper stilling basin includes two headgates that replaced those of the former Cochiti Diversion Dam, which was built by MRGCD *circa* 1935, and demolished during construction of Cochiti Dam. After completion of Cochiti Dam construction, the Corps transferred the rebuilt canals and headworks to the Bureau of Reclamation for all future operation and maintenance.

The Cochiti Dam and Lake Project is not authorized, nor does it operate, to store or otherwise control either irrigation or municipal/industrial water.

The dam and the majority of the permanent pool are situated on lands within the Pueblo de Cochiti's territorial jurisdiction, and parts of the flood-control pool are within Sandoval, Santa Fe, and Los Alamos Counties, New Mexico. The flood-control pool inundates lands managed by the Pueblo de Cochiti, the New Mexico State Land Office, the U.S. Forest Service (Santa Fe National Forest), the U.S. Park Service (Bandelier National Monument), and the Department of Energy (Los Alamos National Laboratory).

Operation of Cochiti Dam for flood control is coordinated with Jemez Canyon and Galisteo dams in order to regulate for the maximum safe channel capacity at the Albuquerque gage which is 7,000 cfs. Summer flood storage is generally the result of short-term, high-intensity thunderstorm events. The maximum water storage to date has been 396,167 ac-ft (elevation 5,434.5 feet), which occurred in 1987. This volume included the permanent and flood-control pools.

Water sufficient to replace annual evaporation from the permanent pool is also obtained through the San Juan-Chama Project. On average, the required annual volume has been about 4,200 ac-ft. Evaporation from Cochiti Lake is computed daily and Reclamation provides the water accounting and coordinates with the Corps on the schedule of releases of San Juan-Chama Project water sufficient to offset annual evaporation and maintain the permanent pool. The San Juan-Chama water for replacement of evaporation is normally delivered from Heron Reservoir at the end of spring runoff, and in several steps during fall and winter. This schedule was developed to optimize benefits to the riparian and wetland habitats in the delta area of Cochiti Lake and is based on recommendations from neighboring land management entities (Allen *et al*. 1993).

2.4 GALISTEO DAM

Galisteo Dam is on Galisteo Creek, about 12 miles upstream from its confluence with the Rio Grande. Galisteo Creek enters the Rio Grande about 8 miles downstream from Cochiti Dam. Galisteo Dam was authorized by the Flood Control Act of 1960 for flood and sediment control for the middle Rio Grande valley. The Corps completed Galisteo Dam in 1970. The dam and spillway were modified in 1998 to correct deficiencies in their ability to accommodate the Probable Maximum Flood without overtopping the dam. Specifically, the dam embankment was raised 4.5 feet, the spillway was widened to accommodate a maximum discharge of 321,200 cfs, and a fuse plug[4] was installed in the spillway.

The dam is an earth-fill embankment that is 2,820-feet long with a maximum height of 158 feet above the stream bed. The reservoir's storage allocations include 79,600 ac-ft for flood control and 10,200 ac-ft for

[4] A fuse plug's primary function is to restrict spillway outflow until flooding conditions make greater spillway capacity necessary. The Galisteo Dam spillway fuse plug consists of an erodible earthen embankment that extends approximately halfway across the emergency spillway cross-section. During a flood event, as stage and flow through the spillway increase, the fuse plug is designed to erode away, thereby increasing the capacity through the spillway.

sediment retention. Because the dam was constructed with an uncontrolled outlet works, the reservoir passes all inflow up to approximately 5,800 cfs. Galisteo Reservoir is normally dry, with most inflows occurring in the summer months as a result of thunderstorm activity. The drainage area above Galisteo Dam includes 596 square miles. The maximum detention to date was 2,870 ac-ft, which occurred in July 1971 (USACE 2001b).

Because of the uncontrolled outlet, most sediment passes through the dam unhindered. Sediment accumulation behind the dam has been minor; approximately 808 ac-ft of sediment deposition has occurred within the 10,200 ac-ft sediment reserve space since 1970. The invert of the outlet structure was constructed at the pre-dam channel-bed elevation; therefore, no downstream incision has occurred, or is expected to occur, in Galisteo Creek.

2.5 JEMEZ CANYON DAM AND RESERVOIR

The Jemez Canyon Dam and Reservoir project is on the Jemez River, 2.8 miles upstream from its confluence with the Rio Grande. It is situated in Sandoval County, about five miles northwest of Bernalillo and about 22 miles north of Albuquerque. The Jemez River enters the Rio Grande about 24 miles downstream from Cochiti Dam.

Congressional authority for the construction of Jemez Canyon Dam is contained in the Flood Control Acts of 1948 (P.L. 80-858) and 1950 (P.L. 81-516). Construction began in May 1950, and the dam was completed and placed into operation in October 1953. The dam is a rolled earth-fill structure with a crest length of 861 feet and a crest width of 23 feet. In 1987, the project was modified as the result of revised probable maximum precipitation data, and the modification raised the dam approximately 14 feet and widened the spillway 28 feet. The drainage area upstream from the dam includes 1,034 square miles.

The project regulates Jemez River flood flows and controls sediment in conformity with P.L. 86-645. The reservoir's initial storage allocations included 73,000 ac-ft for flood control and 40,213 ac-ft for sediment control. As of 1998, approximately 24,425 ac-ft of the sediment reserve space remains unfilled. The maximum flood storage to date has been 72,254 ac-ft (elevation 5,220.3 feet) that occurred in 1987.

The Jemez Canyon Dam and Reservoir Project is not authorized, nor does it operate, to store irrigation or municipal/industrial water.

All lands associated with the project—about 6,711 acres—are held in trust by the United States for the benefit and use of the Pueblo of Santa Ana. The Department of the Army and the Pueblo signed an agreement in 1952 (amended in 1978 by P.L. 95-498) which established a perpetual right and privilege for the construction, operation, and maintenance of the Jemez Canyon Dam and Reservoir project. The Pueblo of Santa Ana reserved the right to use all associated lands for any purposes not inconsistent with those expressly granted to the government for operation and maintenance of the facility.

Although there are no structures or protective works along the Jemez River downstream from the dam, Jemez Canyon Dam is operated in concert with Abiquiu, Cochiti, and Galisteo dams to regulate Rio Grande basin flood flows to the maximum safe channel capacity of 7,000 cfs at the Albuquerque gage.

2.5.1 Sediment Control

At the time of construction of Jemez Canyon Dam, the Rio Grande downstream from the Jemez River confluence was an aggrading channel; that is, sufficient sediment had accumulated within the channel through Albuquerque by 1960 to raise the river bed 6 to 8 feet above the typical valley floor elevation outside of the levee system (Lagasse 1980). Prior to 1979, sediment retention in Jemez Canyon Reservoir was facilitated by maintaining a 24-hour equivalent pool[5] when inflow exceeded 40 cfs. This was effective in trapping sand and larger particles, but let clay and most of the silt pass through the dam. Subsequent flows periodically remobilized deposited material and carried it through the conduit, thus reducing trap efficiency and the effectiveness of the project to prevent sediment accumulation in the Rio Grande channel downstream.

In the spring of 1979, a sediment retention pool of about 2,000 ac-ft was established by the New Mexico Interstate Stream Commission (NMISC) using San Juan-Chama Project water leased from the City of Albuquerque. This pool improved sediment retention and resulted in degradation of the downstream Jemez River channel. In January 1986, the sediment retention pool was expanded to include the entire unused capacity of the allocated sediment reserve space (approximately 27,500 ac-ft) to further improve trap efficiency of the pool. The water for this expansion was again leased by the NMISC from the City of Albuquerque. The pool was created and was maintained by capturing native water from the Jemez River in the reservoir and replacing that water to the Rio Grande by releasing San Juan-Chama water from Abiquiu Reservoir, usually during the spring runoff.

In the summer of 2000, 12,000 ac-ft was released from the sediment retention pool in accordance with an Agreed Order issued by the U.S. District Court, District of New Mexico, to prevent the Rio Grande from drying and to facilitate spawning of the silvery minnow (see Section 1.2.5). Independent of these legal proceedings, the Corps-NMISC storage agreement expired on December 31, 2000 (its original expiration date). The NMISC decided not to extend the agreement for sediment pool storage, citing significantly increased demands on available water in the region, its increasing cost, and the need for increased sediment loading to the currently degrading Rio Grande channel as factors in this decision. The remaining pool was released in early 2001 (USACE 2000).

The Jemez Canyon Dam and Reservoir project has continued to be operated under its existing Congressional authorization solely for flood and sediment control. In the absence of a sediment retention pool the outlet gates remain partially open, facilitating the passage of bedload material through the dam. Sediment transport modeling indicates that the average annual volume of sand-sized and larger material that will pass through the dam is approximately 191 acre-feet, of which approximately 95% originates upstream from the reservoir.

2.5.2 Maintenance Operation

Immediately downstream from the dam's outlet is a 70-foot-long by 80-foot-wide stilling basin that transitions the turbulent discharge to tranquil flow. Periodically, sediment accumulates in the basin and must be flushed to prevent high flows from overtopping the stilling basin walls. To do this, inflow is detained behind the dam for up to 4 or 5 days and then released at a rate of approximately 600 cfs to flush sediment from the stilling basin. The Corps ensures that the detained water is would not interfere with the downstream irrigation demand at the time. Throughout this operation, sufficient water is released from the dam to maintain continuous flow in the Jemez River between the dam and the Rio Grande confluence.

[5] The 24-hour equivalent pool was approximately equal to the volume to the daily inflow when the flow was 40 cfs or greater.

2.6 CORPS RESERVOIR OPERATION IN THE MIDDLE RIO GRANDE VALLEY

This section provides an overview of discretionary and non-discretionary reservoir operations at the four Corps facilities in the Middle Rio Grande. Section 3 of this Biological Assessment describes the Corps' proposed discretionary actions for this consultation.

2.6.1 Flood Regulation

The Corps has limited discretionary authority related to flood-control operations in the middle Rio Grande valley. All Rio Grande basin flood-regulation dams are operated within the explicit criteria contained in the Flood Control Act of 1960 (P.L. 86-645; see Appendix A of this BA). Section 203(a) of the act states: "The outflow from Cochiti Reservoir during each spring flood and thereafter will be at the maximum rate of flow that can be carried at the time in the channel of [the] Rio Grande through the middle valley without causing flooding of areas protected by levees or unreasonable damage to channel protective works." The spoilbank levees constructed by MRGCD in the 1930s along the Rio Grande provide a relatively low level of flood protection. Downstream from Cochiti Dam, these structures are subject to extensive damage or failure if flow exceeds the 10%-chance event (sometimes termed the "10-year flood") of 10,300 cfs at the Albuquerque gage (HEC 2006). Even at lower discharges, adverse seepage problems can develop along spoilbank levees if they are saturated for an extended period.

Flows are typically passed through Corps dams with little, or no, regulation. When flows into a reservoir exceed downstream channel capacity criteria, flood-control regulation is initiated. Flood waters are detained only for the duration needed to evacuate the water as rapidly as downstream conditions permit. Flood storage is normally associated with spring runoff in the period April through June. Summer flood storage is generally the result of short-term, high-intensity thunderstorm events which have a short duration and produce relatively low volumes.

Flood-control criteria have been established by the Corps at each dam based on the maximum channel capacity downstream for safe flood-control releases. These criteria have been determined by hydraulic and geotechnical engineers based on long-term monitoring, including field inspection during flood events. Abiquiu Dam releases are restricted to no more than1,800 cfs directly downstream from the dam, 3,000 cfs at the Chamita gage, and 10,000 cfs at the Otowi gage[6]. Releases from Galisteo Dam are uncontrolled, but are limited to 5,800 cfs by the size of the outlet conduit. Flood-control releases from all four dams are coordinated in order to regulate for the maximum safe flow at Albuquerque (7,000 cfs).

Prior to 1996, the maximum safe channel capacity at Albuquerque was 5,000 cfs. Between 1979 and 1996, the Corps experimentally exceeded this capacity in several years through a series of year-long deviations in flood-control operations. Water control manuals for Rio Grande basin flood-control reservoirs were modified in 1996 to reflect the formal increase in the operational channel capacity to 7,000 cfs at Albuquerque (USACE 1996c)[7]. Presently, the spoilbank levees that protect properties are not suitable to withstand long duration flows of 7,000 cfs. Therefore, the safe operating criteria stipulate short duration peaks of 7,000 cfs, with longer releases of lower discharge (USACE 1996c).

When Elephant Butte Reservoir is at or near its storage capacity, sediment aggradation in the Rio Grande upstream from the reservoir may be sufficient to cause reduced channel capacity at the San Marcial railroad bridge. At such times, discharges of 6,000 to 7,000 cfs at Albuquerque may be sufficient to cause

[6] Multiple criteria were established to account for flows from intervening tributaries and the mainstem of the Rio Grande. See Section 2.3.2.
[7] Section 1.2.2 of this BA summarizes the Section 7 consultation for increasing the channel capacity at Albuquerque.

an operational or structural hazard at the railroad bridge, or induce failure of the upstream spoilbank levee. Consistent with its national flood damage reduction policy, the Corps may discretionarily limit flood releases from upstream reservoirs to minimize damages to this privately owned structure. Conversely, during large magnitude flood events, the Corps may elect to operate in a manner that damages the railroad bridge or other non-protective structures if such operation can reduce the net damages throughout the basin; for instance, to avoid an uncontrolled spill from Cochiti Dam.

2.6.2 Carryover Storage of Flood Waters

P.L. 86-645 provides additional limitations on the detention and release of flood water. Section 203(a) states that

> "... whenever during the months of July, August, September, and October, there is more than two hundred twelve thousand acre-feet of storage available for regulation of summer floods and the inflow to Cochiti Reservoir (exclusive of that portion of the inflow derived from upstream flood-control storage) is less than one thousand five hundred cubic feet per second, no water will be withdrawn from storage in Cochiti Reservoir and the inflow derived from upstream flood-control storage will be retained in Cochiti Reservoir."

The typical situation where this restriction applies is during flood-control regulation for the spring runoff period when flood waters are still being detained at Cochiti Lake or Abiquiu Reservoir into July. If the flow at the Otowi gage—exclusive of flood water being released from Abiquiu Dam—is less than 1,500 cfs, all flood water currently in storage at these reservoirs must be held and not released during the period of July through October. The intent of the law is to prevent the diversion or depletion of water that would otherwise have been delivered downstream but was detained by flood-control operation. Carryover storage may be held at Abiquiu Reservoir or passed to Cochiti Lake; however, such storage cannot encroach on the upper 212,000 ac-ft of the flood-control space at Cochiti Lake, which is the volume of the summer-thunderstorm design flood.

Similar provision is made in the law to maintain adequate space for summer floods at other reservoirs. Section 203(b) of P.L. 86-645 states that releases "during the months of July, August, September, and October, will be limited to the amounts necessary to provide adequate capacity for control of subsequent summer floods; and such releases when made in these months, or thereafter, will be at the maximum rate practicable under the conditions at the time."

Carryover water must be released from Corps reservoirs after October 31, providing that "all reservoirs will be evacuated completely on or before March 31 of each year" pursuant to Section 203(c) of P.L. 86-645. The Corps does have discretion in the manner in which carryover water may be released, except in specific circumstances provided for in Section 203(c) of P.L. 86-645:

> "... That when estimates of anticipated streamflow made by appropriate agencies of the Federal Government indicate that the operation of reservoirs constructed as a part of the Middle Rio Grande project may affect the benefits accruing to New Mexico or Colorado, under the provisions of the eighth unnumbered paragraph of article VI of the Rio Grande compact, releases from such reservoirs shall be regulated to produce a flow of ten thousand cubic feet per second at Albuquerque, or such greater or lesser rate as may be determined by the Chief of Engineers at the time to be the maximum safe flow, whenever such operation shall be requested by the Rio Grande compact commissioner for New Mexico or the commissioner for Colorado, or both, in writing prior to commencement of such operation."

In essence, this mandate requires the Corps to release carryover water at the maximum safe flow rate when a pertinent request is made by the Rio Grande Compact Commissioner for New Mexico or the Commissioner for Colorado, or both.

Carryover storage has occurred at Abiquiu Dam during 15 (30.6%) of its 49 years of operation, and at Cochiti Dam during 3 (8.1%) of its 37 years of operation (Table 2.2).

Table 2.2. Annual volume of carryover storage.

Year	Abiquiu Reservoir	Cochiti Lake	Year	Abiquiu Reservoir	Cochiti Lake
1963	0	--	1988	0	0
1964	0	--	1989	0	0
1965	98,759	--	1990	0	0
1966	22,989	--	1991	36,162	0
1967	1,386	--	1992	0	0
1968	13,704	--	1993	47,121	0
1969	0	--	1994	3,455	0
1970	0	--	1995	102,418	0
1971	0	--	1996	0	0
1972	0	--	1997	0	0
1973	83,130	--	1998	0	0
1974	0	--	1999	0	0
1975	0	0	2000	0	0
1976	0	0	2001	0	0
1977	0	0	2002	0	0
1978	0	0	2003	0	0
1979	118,000	0	2004	0	0
1980	132,160	0	2005	0	0
1981	0	0	2006	0	0
1982	0	0	2007	0	0
1983	16,300	0	2008	0	0
1984	1,700	0	2009	0	0
1985	120,835	130,930	2010	0	0
1986	0	129,100	2011	0	0
1987	0[a]	221,510	2012	0	0

[a] In 1987, Abiquiu Reservoir also had carryover storage of 215,000 ac-ft, but it was released to Cochiti Lake in July-October 1987.

2.6.3 Water Supply Storage at Abiquiu Reservoir

As stated previously, the Corps operates Abiquiu Reservoir pursuant to P.L. 97-140 to store San Juan-Chama Project water for project contractors. Releases of SJ-C water from Abiquiu Reservoir represent individual decisions made by contractors to call for their water, with no discretionary action by the Corps. San Juan-Chama Project water is also used by the Corps to replenish annual evaporation from the permanent pool at Cochiti Lake. The Corps does not regulate the passage of San Juan-Chama Project water that has been released for any other purpose by other entities, except to ensure that such flows are passed in a manner that does not compromise the safety or structural integrity of flood-control facilities.

P.L. 100-522 (see Appendix A of this BA) authorized the Corps to store Rio Grande basin water at Abiquiu Reservoir only "in lieu of the water storage authorized by Section 5 of Public Law 97-140, to the extent that contracting entities under Section 5 of Public Law 97-140 no longer require such storage." Presently, all water supply storage at Abiquiu Reservoir consists of SJ-C Project water; there are no agreements for storage of Rio Grande system water.

2.6.4 Other Operational Considerations

The Corps does ensure that all releases are passed in a manner that does not threaten the safety or structural integrity of flood-control facilities. For example, release discharges will not exceed channel capacity nor will release of this water be at a rate that will cause the flow in the river to spike up for a very short period of time. The change in release rate varies with the magnitude of flow. The frequency of changes to the outflow rate will be limited to one change per hour. Generally, the increase and decrease in stage at the downstream gage should be held to a range of 0.25 to 0.50 feet per change. The limitation on the increase is based on public safety concerns, and limited decrease in stage is based on preventing downstream bank sloughing. To minimize bank instability within the reservoir and ensure structural integrity, the drawdown rate when evacuating storage should not exceed 3 to 5 feet per day. On occasion, conditions may dictate that these general criteria be exceeded. The Corps reserves the right to take such measures as may be deemed necessary in the operation of the projects to preserve life, and to inspect, maintain, or repair the project. For example, concerns regarding structural integrity or functionality may cause the Corps to evacuate water stored for any purpose in order to perform repairs.

Section 203(d) of P.L. 86-645 provides that "whenever the Corps of Engineers determines that an emergency exists affecting the safety of major structures or endangering life and shall so advise the Rio Grande Compact Commission in writing these rules of operation may be suspended during the period of and to the extent required by such emergency." In this context, an emergency is a situation affecting the safety of major structures or endangering life. If the structural integrity of a dam or its controlling facilities is threatened, the Corps is mandated to take the necessary actions to ensure the safety of the structures. Emergency operations include intervention to save the life of a person who is in imminent danger of drowning immediately below a dam, recovery of victims of drowning and other accidents downstream from a dam, and flushing of pollution (USACE 1996a).

Any departure from the normal operation schedule, not deemed an emergency, requires the concurrence by each of the Rio Grande Compact commissioners as set forth in Section 203(d) of P.L. 86-645: "All reservoirs of the Middle Rio Grande project will be operated at all times … in conformity with the Rio Grande compact, and no departure from the foregoing operation schedule will be made except with the advice and consent of the Rio Grande Compact Commission."

Finally, Section 203(e) of P.L. 86-645 states: "The foregoing regulations shall not apply to storage capacity which may be allocated to permanent pools for recreation and fish and wildlife propagation: Provided, That the water required to fill and maintain such pools is obtained from sources entirely outside the drainage basin of the Rio Grande;" namely, the permanent pool at Cochiti Lake.

Except for flood-control purposes, the Corps has no authority to regulate either Rio Grande system water or any water released from upstream reservoirs. Thus, releases from El Vado Dam and from Colorado reservoirs are normally passed through Corps facilities unhindered. Specifically, such water is released at a rate equivalent to its inflow rate. The Corps does ensure that such flows are passed in a manner that does not compromise the safety or structural integrity of flood-control facilities.

2.6.5 Coordination Among Water-resource Entities

The Middle Rio Grande is a highly regulated river system with complex legal, regulatory and physical components. Coordination among all water resource management entities is required to ensure the safe and efficient fulfillment of myriad responsibilities, authorities, and legal obligations.

Coordination among the Corps, Reclamation, and water resource management entities is conducted as necessary on a daily basis throughout the year, through the electronic dissemination of daily reports, or through telephone or electronic mail contact.

Each year, the Corps and Reclamation prepare and distribute to interested parties an Annual Operating Plan (AOP) to forecast reservoir operations in the Rio Grande basin. This document contains streamflow forecasts, including snowmelt runoff forecasts, anticipated operations outlooks for the various Reclamation and Corps-operated facilities along the river, and hydrographs reflecting reservoir operations, including actual (to the date of the plan's publication) and anticipated inflow, outflow, and storage. Much of the planning information in the report is developed through the coordination, cooperation, and agreement of various resource management parties. The Federal agencies provide monthly updates, informing interested parties of operations throughout the course of the water year.

The AOP process typically begins in March and contains the following steps:

1. The March runoff forecast, developed by the National Weather Service (NWS) and the National Resource Conservation Service (NRCS), is used to develop hydrographs of natural Rio Grande system flows, in addition to the trans-mountain diversions by Reclamation.

2. Irrigation and municipal demands for the upcoming season are solicited from water users in the basin. Reclamation and the Corps also meet with the Bureau of Land Management for input on the Wild and Scenic portion of the Rio Chama.

3. Based on the above information, Reclamation tentatively schedules the remainder of deliveries of San Juan-Chama water from Heron Reservoir for that year; that is, the remainder of spring and the next winter.

4. Reclamation and the Corps discuss the draft AOP with Engineer Advisors for Colorado, New Mexico and Texas, and/or with the Rio Grande Compact Commission at their annual meeting in March.

5. The Upper Rio Grande Water Operations Model is used to distill all pertinent information into forecasted hydrographs for the Rio Chama and the mainstem of the Rio Grande. Reclamation determines the need for Supplemental Water during this analysis.

6. After the April snowpack and streamflow forecasts have been released by NWS and NRCS, and steps 1-4 are repeated as necessary. The AOP is then released to interested parties in mid-April.

7. Forecasted hydrographs are updated after the May streamflow forecast has been released. Spring runoff is generally underway by the middle of May, and the AOP is updated, usually on a biweekly basis, to replace forecasted with actual values.

Whenever warranted throughout the year, specific telephone conferences are conducted with water resource management entities. In addition to scheduling releases for specific purposes, these conferences provide current information on river flows that allow entities to react quickly to rapidly changing conditions on the river, facilitate coordination among the agencies to prevent unexpected drying, and prepare for silvery minnow salvage activities. The frequency of such operational conference calls range from 1 to 5 per week as needed. Participants in daily conference calls typically include Reclamation, the Corps, the Service, the Bureau of Indian Affairs, the U.S. Geological Survey, NMISC, MRGCD, ABCWUA, the City of Santa Fe, Bosque del Apache National Wildlife Refuge, and contractors providing information on current river conditions.

3. DESCRIPTION OF PROPOSED ACTIONS

3.1 ACTION AREA

The action area of the Corps proposed actions entails the Rio Chama, including, and downstream from, Abiquiu Reservoir, and the Rio Grande from the confluence with the Rio Chama downstream to the headwaters of Elephant Butte Reservoir (Figure 2.1).

For discussion purposes, the Rio Grande below Cochiti Dam is designated by four reaches defined by the locations of mainstem irrigation diversion structures. 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. The Isleta Reach is bounded upstream by Isleta Diversion Dam and downstream by San Acacia Diversion Dam. Finally, the reach below San Acacia Diversion Dam to the headwaters of Elephant Butte Reservoir is referred to as the San Acacia Reach.

The term “Middle Rio Grande” as used in this BA refers to a more general and slightly larger geographic area than the proposed action area; namely, the entire Rio Chama basin and the Rio Grande basin from Velarde to the headwaters of Elephant Butte Reservoir.

3.2 PROPOSED ACTIONS

3.2.1 Discretionary Flood-control Operation

This section describes all discretionary reservoir operation activities that are authorized, funded, or carried out, in whole or in part, by the U.S. Army Corps of Engineers in the Middle Rio Grande. All of the Corps’ currently proposed actions were included in Section 7 consultations in 2001 and 2003.

As described in the previous section, the Corps has a limited amount of discretionary authority related to flood-control operations. P.L. 86-645 explicitly states that "The outflow from Cochiti Reservoir during each spring flood and thereafter will be at the maximum rate of flow that can be carried at the time in the channel of [the] Rio Grande through the middle valley without causing flooding of areas protected by levees or unreasonable damage to channel protective works." Limiting peak flows to prevent unreasonable damage to spoilbank levees and other protective works is non-discretionary, and, therefore, does not require consultation under Section 7 of the ESA.

Pursuant to P.L. 86-645, flood-control release criteria have been established at each reservoir project by the maximum downstream channel capacity. However, if the Corps determines that the current channel conditions cannot safely convey the entire maximum flow rate, then releases may be less than the defined channel capacity. The existing, primary channel capacity at Albuquerque of 7,000 cfs is part of the environmental baseline, not a newly proposed action, and was the subject of a previous consultation in 1996 (see Section 1.2.2).

Spring Runoff

Flood-control regulation during spring runoff will be initiated at Corps dams when inflows into any reservoir and/or intervening flows downstream of the reservoirs are expected to exceed the downstream channel capacity. If snowmelt runoff increases abruptly, releases will be staged up at increments of approximately 500-cfs while downstream channel conditions are monitored. These staged increases normally are not necessary below a total combined release from Corps reservoirs of 4,500 cfs.

When Elephant Butte Lake is at or near its storage capacity, sediment aggradation in the Rio Grande upstream from the reservoir may be sufficient to cause reduced channel capacity in the downstream portion of the San Acacia Reach. Two known areas of concern are the San Pascual archaeological site on the Bosque del Apache National Wildlife Refuge, and the San Marcial railroad bridge, a privately owned structure. Both of these locations are closely monitored during high-flow periods. The San Pascual archeological site has been an area of concern in previous years. During high-flow runoff years, the Corps routinely coordinated with Bosque del Apache personnel to verify the status of the site. To date, the Corps has not altered flood regulation due to potential damage to this site, even during the relatively large and long runoff season of 2005. However, when considering long-term operations and the possibility of a sediment plugs forming, this is an area that will be closely monitored. Pursuant to the National Historic Preservation Act, Federal agencies have an obligation to preserve sites on the National Register of Historic Properties. The Corps does have limited discretion to regulate flood releases to minimize damages to this structure. Consistent with its flood risk reduction policy, the Corps may limit flood releases from upstream reservoirs to minimize damages to these structures. However, the Corps may elect to operate in a manner that damages the railroad bridge or other non-protective structures if such operation can reduce the net damages throughout the basin; for instance, to avoid an uncontrolled spill from Cochiti Dam.

Summer Thunderstorms

The most likely summer thunderstorm events are low volume and short duration (less than 24 hours of increased discharge) that are passed through the reservoir with essentially no regulation. Less common are large thunderstorms that produce longer duration flows and larger runoff volumes requiring more regulation. In order to conform to P.L. 86-645, the Corps manages flood inflows to the projects so as to release the inflow up to the maximum rate practicable under the conditions at the time. This results in only short-term storage of inflow from summer rains and replacement of high spike inflows with longer duration lower flows downstream. Through this management, the Corps prevents unexpected high flows from damaging downstream properties or resulting in loss of life. Under P.L. 86-645, the Corps cannot store this flood water beyond the extent of time needed to safely evacuate the inflow. In addition, this legislation requires that any deviation from the operational schedule set forth in the law requires approval by the Rio Grande Compact Commission. How the Corps proposes to utilize its discretion in regulating flood inflows is the Federal action described for purposes of this BA.

The specific conditions that the Corps considers in determining the pattern of release of summer floods include: 1) the existing downstream discharge (both actual and forecasted); 2) a safe rate of increase; 3) evacuation within a short time period (usually about 24 to 48 hours) of the event; and 4) weather forecasts.

1. If the existing downstream discharge is already at flood stage due to thunderstorms downstream of the dams, or weather forecasts indicate thunderstorms might produce significant flooding, flood inflows may be released over a longer time to facilitate flood protection.

2. Increased downstream discharge releases from the dams are limited to flow changes that are not likely to result in property damage or loss of life downstream. For example, the rate of increase at Cochiti Dam is limited to one-half foot increase per hour in river stage at the gage below the dam. Usually the increases are limited to about 500 cfs change per hour. The maximum rate of the release is determined primarily by the total volume needed to be evacuated and should not exceed 7,000 cfs at the Albuquerque gage.

3. The release rate is adjusted to evacuate the flood storage within a short time period, usually within about a 24- to 48-hour period after the peak inflow for the most common thunderstorm events. These measures are taken in conformity with project purposes to protect downstream structures from flood damage and to maintain interstate compact deliveries.

4. The Corps constantly monitors precipitation data and qualitative forecasts provided by the National Weather Service. Factors considered during summer flood-control operation include storm type (*e.g.*, frontal, convective, orographic, hurricane), geographic location, duration, and intensity.

Figure 3.1 displays two actual events when the Corps regulated summer flooding at Cochiti Dam. Figure 3.1a displays an example of a short-duration, low-volume runoff pattern from thunderstorm activity in July 1994. The inflow to Cochiti Lake increased by about 150 to 200 cfs for about 24 hours. Cochiti Dam passed this inflow at a similar rate with about a 24-hour response time, with a minor decrease in the flow rate. Because there were no risks of flooding due to the low intensity of the event, little regulation occurred. Figure 3.1b displays an example of a rare, higher discharge rainstorm event that occurred in July-August 1982. This event had a short duration peak of 5,460 cfs, with a mean daily flow of over 2,500 cfs, on July 31. The duration of the inflow was about five days. The outflow from Cochiti Dam matched the inflow volume over the same five days, but did not include the short duration peak of 5,460 cfs. Instead this water was evacuated by holding outflow to over 1,700 cfs for 3 days (100 cfs over inflow on August 1 up to about 500 cfs over inflow on August 3). This flood-control operation was to prevent unexpected high flows of over 5,000 cfs downstream that could result in damage to property or loss of life. In this example, the Corps determined a downstream safe flow of less than 2,000 cfs was adequate to properly evacuate the flood inflow with minimal regulation.

(a) Low discharge

(b) High discharge (The instantaneous peak of 5,460 cfs is not depicted by this mean daily discharge data.)

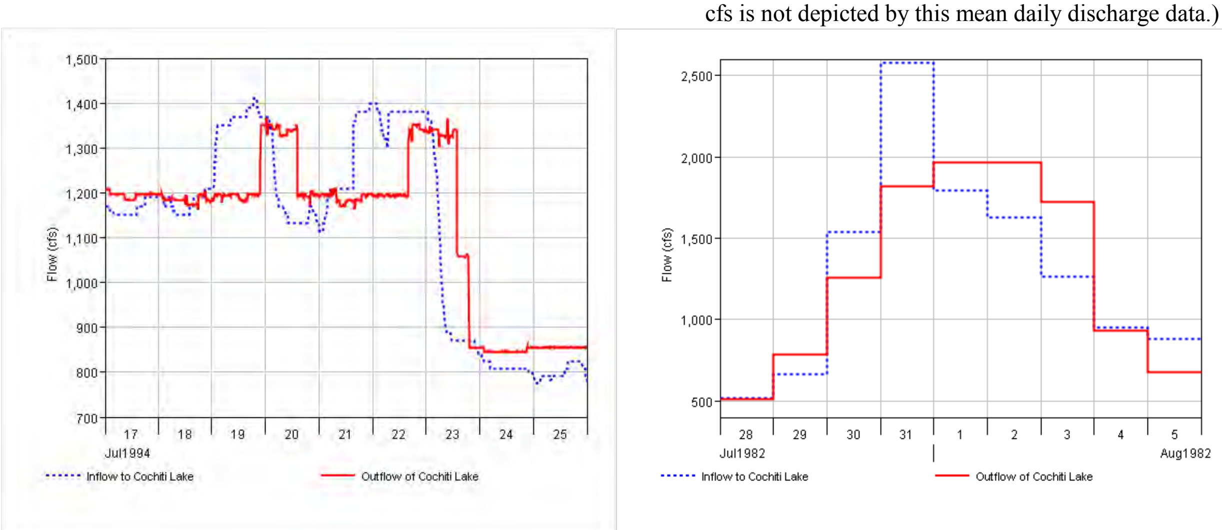

Figure 3.1. Hydrographs of historic operations of Cochiti Lake showing two examples of past summer thunderstorm regulation events.

3.2.2 Delivery of "Carryover" Flood Water

The Corps is directed by P.L. 86-645 to hold carryover flood water in Abiquiu Reservoir or Cochiti Lake after July 1 when the river flow at Otowi gage—exclusive of flood waters released from Abiquiu Dam—

decreases to less than 1,500 cfs. Although this water must be released during the subsequent period from November 1 to March 31, the Corps has some discretion as to how this water is evacuated. Normal procedures include coordination with the New Mexico Interstate Stream Commission so that these operations minimize the effects of New Mexico meeting its Rio Grande compact obligation to Texas. Alternatives for delivering this water range from a constant low-flow release over the entire five-month period to a maximum release equal to the stated channel capacity.

As described in Section 1.21 of this BA, the Corps conducted informal ESA consultation with the Service during the fall of 1995 regarding the release of about 98,000 ac-ft of carryover water (Consultation #2-22-96-I-011). The primary species of concern was the Rio Grande silvery minnow. Alternatives were evaluated based on the potential impact of increased winter discharges on physical habitat conditions (depth and velocity distributions) available in the reach of the river where minnow are most abundant. The Corps considered several release alternatives to meet the water delivery requirements and examined possible impacts to the aforementioned Federally listed species for each alternative. The final determination was that a constant flow of 325 cfs over normal flows during a five-month period maintains the natural hydrograph shape with a minimum change in magnitude and was not likely to adversely affect the minnow or adversely modify its proposed critical habitat.

Based on this previous consultation and subsequent input from the Service, the Corps proposes to deliver future carryover water from Abiquiu Dam and/or Cochiti Dam to Elephant Butte Reservoir at a constant rate above the base flow of Rio Grande basin discharge during the period from November 1 through March 31 (152-153 days). The rate and duration of carryover releases will depend on the actual volume to be evacuated. Based on historical records, in most years Corps reservoirs would be able to safely pass spring runoff inflow without the need for carryover storage (see Table 2.2). In other years, carryover storage may range from as little as 1,700 ac-ft (as in 1984) to as much as 215,000 ac-ft (as in 1987). Therefore, the future rate of release of carryover storage could be as low as 50 cfs for 34 days (or less), or as high as 725 cfs (or more) for 150 days, depending on the detained volume.

3.2.3 San Juan-Chama Water Storage at Abiquiu Reservoir

In 1981, P.L. 97-140 (see Appendix A of this BA) authorized the Secretary of the Army to enter into agreements with entities that have contracted with the Secretary of the Interior for water from the SJ-C Project (USACE 1995). The authorization allows for up to 200,000 ac-ft of this water to be stored in Abiquiu Reservoir within the flood-control space and unused portion of the sediment reserve space. The Corps has entered into an agreement with the Albuquerque-Bernalillo County Water Utility Authority (ABCWUA) and Memorandums of Understanding with other entities for water storage (see Table 1.1). Up to 180,713 ac-ft (elevation 6,220 ft.) can be currently stored pursuant to storage easements held by the ABCWUA (USACE 1995). The legislation stipulates that this water shall not interfere with the authorized purposes of Abiquiu Reservoir (*i.e.*, flood and sediment control). Releases of SJ-C water from Abiquiu Reservoir represent individual decisions made by contractors to call for their water. The sole discretion exercised by the Corps is to ensure that such flows are passed in a manner that does not threaten the safety or structural integrity of flood-control facilities.

3.2.4 Delivery of Cochiti Lake Permanent Pool Replacement Water

Public Law 88-293 (see Appendix A in this BA) provided for the initial filling of a 1,200-acre permanent pool at Cochiti Lake with water from the San Juan-Chama Project, as well as "sufficient water annually to offset the evaporation from such area." The Corps uses discretion regarding timing for delivery of San Juan-Chama Project water to replace this net depletion. The Corps requests the Bureau of Reclamation to release San Juan-Chama Project water from Heron Lake several times during the year. The proposed method of delivery to Cochiti Lake is to deliver about a third of this water during the first part of July to enhance fish and wildlife habitat at the upper end of the lake in what is known as the Cochiti Lake delta. The remaining water would be delivered from November to February at a rate targeted to achieve a total release (including native inflow) from Abiquiu Dam of about 70 cfs in order to protect the downstream fishery. Because the native inflow varies from day to day, the amount of replacement water released varies from 0 to about 50 cfs on any given day during this period. Table 3.1 provides further detail regarding annual net depletion due to evaporative loss since 1982. The future water requirements are dependent on the weather and concomitant evaporation conditions in a given year, which cannot be influenced by the Corps.

Table 3.1. Net depletion (ac-ft) from permanent pool at Cochiti Lake, 1982-2012.

Calendar year	Depletion (ac-ft)	Calendar year	Depletion (ac-ft)
1982	3,473	2000	4,048
1983	3,535	2001	4,343
1984	3,650	2002	5,165
1985	2,255	2003	4,858
1986	2,177	2004	3,848
1987	2,922	2005	3,901
1988	3,162	2006	3,901
1989	4,476	2007	4,265
1990	3,604	2008	4,462
1991	3,166	2009	4,288
1992	3,678	2010	4,803
1993	4,309	2011	4,329
1994	3,994	2012	4,381
1995	5,025		
1996	5,263	Average	3,991
1997	3,698	Median	3,994
1998	5,155	Minimum	2,177
1999	3,583	Maximum	5,263

3.2.5 Maintenance Actions

Cochiti Dam Fish Screen Placement

Under normal conditions, the native flow entering Cochiti Lake is discharged through the outlet works, in compliance with the Rio Grande Compact. During dam construction, the head works for the Sile and Cochiti Eastside Main Canals were incorporated in the upper stilling basin of the Cochiti Dam outlet works. The initial operation of the irrigation headworks in 1975 revealed a design problem that entrained fish from the stilling basin through the head works into the irrigation canals. A significant die-off of fish stranded in the canals occurred when the canals dried, creating a major maintenance problem as well as a waste of resources. The solution was the installation of approximately one-inch mesh, grated metal fish screens on the stilling well side of each head works opening, thus preventing fish from entering the canals.

To exclude fish from passing from the Cochiti Dam stilling basin into adjacent irrigation canals, fish screens will be installed (and solid bulkheads removed) in February of each year, prior to the start of the irrigation season. In November of each year, the fish screens will be replaced by solid bulkhead gates to minimize leakage into the irrigation outlets during the winter. These operations routinely require reduction in flows downstream of Cochiti Dam to approximately 100 cfs for three to four hours to permit access by maintenance workers to the screen guides and bulkhead fasteners. Unusually high amounts of debris or sediment may require temporary removal of the fish screens for cleaning at any time during February through October, using the same protocol.

Abiquiu Dam Tunnel Inspection

To maintain the structural integrity and safety of Abiquiu Dam, the Corps must conduct periodic inspections of the outlet tunnel. These inspections require suspending releases from Abiquiu Dam for approximately one hour while personnel are physically present within the outlet. These inspections will normally be performed during periods of low flow in the winter, but may be performed at any time of the year if there is a structural or safety concern. The proposed operation is to conduct these shutdowns in the morning hours.

Flushing Jemez Canyon Dam Stilling Basin

Immediately downstream from the outlet of Jemez Canyon Dam is a 70-foot-long by 80-foot-wide stilling basin that transitions the turbulent discharge to tranquil flow. Periodically, sediment accumulates in the basin and must be flushed to prevent high flows from overtopping the stilling basin walls. To do this, inflow will be detained behind the dam for up to 4 or 5 days and then released at approximately 600 cfs to flush sediment from the stilling basin. During the entire period when water will be detained behind the dam, sufficient water will be passed to maintain continuous flow within the channel of the lower Jemez River from the dam to the Rio Grande (typically, 5 to 10 cfs).

The flushing operation will be performed when required. Historically, this operation has been required once or twice per year. Detention and flushing would occur only when there is sufficient inflow in excess of downstream demand at the time. The sediment volume flushed from the stilling basin is included in the 191 acre-feet currently transported annually through Jemez Canyon Dam (Appendix E). Based on the size of the outlet channel and stilling basin (with 3 to 5 feet of sediment), approximately 0.8 to 1.3 ac-ft of sediment may be flushed during this maintenance action. Typically, this operation is performed at the beginning or end of the spring runoff peak on the Jemez River, or immediately following sufficiently large summer thunderstorm events.

3.2.6 Coordination Among Management Entities

The Corps will continue to coordinate (as described in Section 2.6.5 of this BA) with Federal and non-Federal water resource management entities on the daily, seasonal, and annual operation of Corps dams.

3.2.7 Conservation Measures

Contingent on continuing authority and the availability of funds, the Corps will endeavor to fulfill the following conservation measures.

- The Corps will continue to coordinate with water- and resource-management entities on daily, seasonal, and annual operation of Middle Rio Grande dams and reservoirs.

- The Corps will continue to work in coordination with Reclamation and water management entities to produce an Annual Operating Plan for Middle Rio Grande dams and reservoirs by mid-April of each year.

- The Corps will work with Reclamation and non-federal entities with water management responsibilities to incorporate the Annual Operating Plan into a more broadly based plan. The goal of such a plan would be to integrate pertinent water-related activities and ecological investigations necessary to adaptively manage Middle Rio Grande resources.

- The Corps will continue to document and investigate geomorphic conditions and trends in the interest of improving sediment transport in the Middle Rio Grande and its tributaries.

- The Corps will continue to coordinate with the Pueblos of Santa Ana, Santo Domingo, and Cochiti regarding sediment management at Corps reservoirs.

- The Corps will continue to operate reservoirs to allow seasonal overbank flooding to the extent feasible within the limits of the stated safe channel capacities.

- The Corps will compile a summary of the findings of the Cochiti Lake Baseline Study in coordination with the Pueblo of Cochiti, and, investigate the potential for facilitating spawning and recruitment flows for the silvery minnow in the future with pertinent resource management entities.

- The Corps will continue to implement ecosystem restoration projects in the Rio Grande basin through existing authorities and with the support of local, cost-sharing sponsors. Planning objectives would include improvements for listed species and their critical habitats. The principles of adaptive resource management would be incorporated into habitat restoration projects.

- The Corps will continue to utilize its authorities to actively participate in the Middle Rio Grande Collaborative Program (Collaborative Program) and support its objectives to alleviate jeopardy in a manner consistent with existing and future water uses, and Federal and State laws. Since 2005, the authority and appropriations to support the Corps' participation in the Collaborative Program were provided through acts of Congress (see Appendix A of this BA). These authorities and funding allow the Corps to carry out and fund planning studies, watershed surveys and assessments, or technical studies to accomplish the purposes of the 2003 Biological Opinion or any related subsequent biological opinion, and the Collaborative Program Long-Term Plan. The Corps' involvement also will include:

    - continued participation with the Collaborative Program in implementing Adaptive Management for the silvery minnow and Willow Flycatcher.

    - participation with the Collaborative Program to identify habitat improvements for silvery minnow, willow flycatcher, and other species of interest. The principles of adaptive resource management would be incorporated into the restoration projects.

3.3 TIMEFRAME OF ANALYSIS

The effect of longest duration evaluated in Chapter 6 of this BA is the maximum degradation (worst-case condition) of the downstream channel that would result from sediment retention at Corps dams and other locations, and which may entail 30 or more years to be realized.

The operation of Corps dams and reservoirs for flood control is largely determined by the point at which damages result from downstream discharges, rather than being limited by the frequency or magnitude of inflow. As such, the present operating rules will continue until a change in downstream conditions warrants revision of the safe channel capacity. Corps flood-control operation is not limited by the availability of water. Given this, there is no reason to limit the timeframe of this consultation due to unpredictability of future flow conditions. The standard conditions contained in 50 CFR §402.16[8] are sufficient to address all contingencies for future reinitiation.

3.4 CONSIDERATION OF RELATED ACTIONS

In addition to activities authorized, funded, or carried out by Federal agencies, Section 7 consultation regulations also require agencies to consult on the effects of interrelated and interdependent actions. Interdependent actions are those having no independent utility apart from the proposed action (defined in 50 CFR §402.02). Interrelated actions are those actions that are part of a larger action and depend on the larger [proposed] action for their justification (defined in 50 CFR §402.02).

3.4.1 Bureau of Reclamation Actions

Both Reclamation and the Corps received the primary Congressional authorization for their actions in the Middle Rio Grande from the Flood Control Acts of 1948 (P.L. 80-858) and 1950 (P.L. 81-516). The responsibilities of each agency were defined in these acts and in a Joint Agreement[9] signed by the Corps, Reclamation, and the Department of Interior in 1947. The Corps is responsible for the construction, operation, and maintenance of:

- Chamita Reservoir [later relocated and re-named Abiquiu Dam and Reservoir]
- Chiflo Dam [later relocated and re-named Cochiti Dam]
- James Reservoir [a typographical inaccuracy referring to Jemez Canyon Reservoir]
- Levees for local flood protection

Reclamation is responsible for:

- El Vado Reservoir
- Channel rectification
- Irrigation and project rehabilitation
- Drainage rehabilitation and extension

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[8] 50 CFR §402.16, Reinitiation of formal consultation: "Reinitiation of formal consultation is required and shall be requested by the Federal agency or by the Service, where discretionary Federal agency involvement or control over the action has been retained or is authorized by law and: (a) If the amount or extent of taking specified in the incidental take statement is exceeded; (b) If new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered; (c) If the identified action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in the biological opinion; or (d) If a new species is listed or critical habitat designated that may be affected by the identified action."

[9] Joint Agreement Between the Secretary of the Interior and the Secretary of the Army on a Unified Plan for the Control of Floods, Irrigation, and use of Water in the Middle Rio Grande Basin in New Mexico, July 25, 1947.

The Corps has determined that these Reclamation activities are neither interrelated nor interdependent with the Corps' flood-control operation. El Vado Reservoir, irrigation, channel rectification, and drainage actions each have an independent utility separate from flood-control actions; and they do not singly or collectively depend on flood-control operation for their justification, functionality, or implementation.

Because these Reclamation actions also are Federal actions subject to contemporaneous consultation, the Corps also evaluated interrelatedness and interdependency in the reverse case: Corps flood-control operation has an independent utility separate from the aforementioned Reclamation actions, and flood-control operation does not depend on any of those Reclamation actions for its justification or implementation.

Reclamation, in its submission of its own amended and complete BA (Reclamation 2013), concurs with the Corps' assessment of interrelatedness and interdependency, and has stated that assessment of the effects of Corps and Reclamation actions does not require one single analysis. Reclamation, citing 50 CFR §402.02:

> "…determined and included in its [Reclamation's] BA analysis of certain water management actions taken by the Corps that are I&I to Reclamation's actions associated with the San Juan-Chama (SJ-C) Project. However, Reclamation did not include other actions taken by the Corps that were not part of, nor dependent upon, Reclamation's larger action for justification, as they have independent utility, i.e. flood control. The Corps' BA provides an I&I analysis complementary to Reclamation's analysis. This approach is consistent with the Service's initiation of formal consultation and issuance of specific BiOps for two SJ-C Project contractors, the City of Albuquerque and the Buckman Direct Diversion Project, without the requirement of a 'single analysis.'" [Reclamation memo requesting reinitiation of formal consultation, dated January 15, 2013.]

The determination that Federal water projects are not all part of a single system is supported by analogous case law. In American Rivers v. NOAA Fisheries and U.S. Bureau of Reclamation[10], the Court found that the upper Snake River water projects and down-river dams were not part of the same agency action and were not interrelated or interdependent. The Court denied the request for reconsideration saying that "simply because one Federal action causes a discrete component of another to occur differently" does not make them interrelated. Further, "if that were the case, it would be difficult to imagine any Federal action in the Columbia Basin that is not interrelated with the downstream dams." In the middle Rio Grande basin, the Corps has no discretion to manipulate flows passed through the reservoir system for any purposes other than flood and sediment control (at all four dams) or San Juan Chama water supply storage at Abiquiu Reservoir.

Section 3.2 of this chapter describes the Corps' discretionary storage of San Juan-Chama Project water at Abiquiu Reservoir for non-Federal contractors. The subsequent release of that water, at the discretion of the non-Federal contractors, is evaluated as an interrelated and interdependent effect in Chapter 6 of this BA.

3.4.2 Middle Rio Grande Conservancy District Actions

The Middle Rio Grande Conservancy District (MRGCD) diverts streamflow at four locations in the Middle Rio Grande basin: Cochiti, Angostura, Isleta, and San Acacia. The physical capacities of these

[10] 2006 U.S. Dist. LEXIS 32391, 63 Env't Rep. Cas. 1009 (D. Or. May 23, 2006), reconsideration denied 2206 U.S. Dist. LEXIS 48195 (D. Or. July 14, 2006)

diversion dams, and all other irrigation headings along the Middle Rio Grande, are limited to a maximum of a few hundred cfs, or less. Typically, diversions are highest during June, and operate at a combined rate of 900 to 1,000 cfs (Figure 3.12). The Corps does not begin flood regulation on the mainstem of the Rio Grande until the discharge at Albuquerque reaches approximately 5,500 cfs, which is more than 5 times the typical capacity of the diversion structures. The operation of Corps dams does not limit, or otherwise affect, the diversion of water by other entities at any permitted diversion structure in the action area.

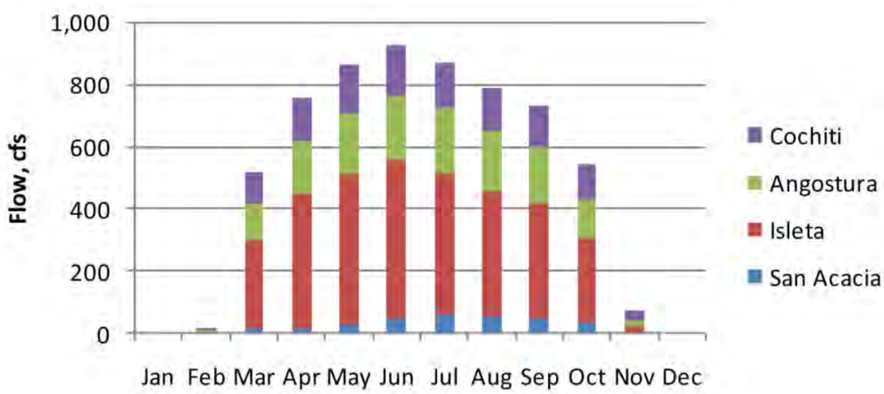


Figure 3.12. Average monthly diversion at four diversion structures, 2001-2010, expressed as flow (cfs). (Chart courtesy of Reclamation [2011b].)

At all four Corps dams in the Middle Rio Grande, the Corps must pass all inflow until it threatens to exceed the safe channel capacity downstream. Corps dams must pass native Rio Grande flow unimpeded below that threshold. There are, and will continue to be, times when the operation of diversion structures by other entities is "affected" by the low discharge of Rio Grande system water, regardless if that water flows through any Corps facility.

MRGCD performs maintenance of spoilbank levees they have constructed and on engineered levees built by the Corps and transferred to MRGCD. Neither the existence of these protective works nor their maintenance is dependent on the operation of dams for their utility or justification. Spoilbank levees in the action area were constructed in the early 1930s, well before the construction of flood-control dams in 1950 through 1975. The engineered levees in the action area (at Albuquerque and Corrales) were designed to reduce the risk of flood damage from precipitation events occurring downstream from Corps dams. The presence and operation of flood regulation dams does not preclude the need for, or function of, downstream levees, nor the need for their ongoing maintenance.

3.4.3 Other Water Management Entities

The principal non-Federal water-management actions in the Middle Rio Grande are summarized in Section 4.2 of this BA. Additionally, several non-Federal signatories in the Collaborative Program have compiled summaries of their water management and depletion-related activities. The Corps has evaluated these activities and determined that they each have an independent utility separate from the Corps' proposed reservoir operation actions; and they do not singly or collectively depend on Corps actions for their justification or implementation.

4. HISTORIC TRENDS AND EXISTING CONDITIONS

Under Section 7(a)(2) of the ESA, when considering the effects of the action on Federally listed species, agencies are required to take into consideration the environmental baseline. Regulations implementing the ESA (50 CFR §402) 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; 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.

This chapter outlines pertinent information regarding the environmental baseline for this Section 7 consultation to facilitate the Service's effects analysis. 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 construction and operation of the dams, as well as ongoing, Federal actions, non-Federal activities and existing physical features such as dams, diversion structures, and protective works for flood control are part of the environmental baseline. The information provided is not intended to be all-inclusive, but rather is provided to assist the Service in their responsibility to determine the baseline and ongoing effects.

4.1 RECENT AND CONTEMPORARY FEDERAL ACTIONS

The 2003 BO (USFWS 2003b) contained a succinct summary of the environmental baseline up to its date of issue. A summary of pertinent Section 7 consultations since that date has been provided in Appendix B of this BA to facilitate the Service's determination of the effects of ongoing operation of Corps reservoirs in the Middle Rio Grande.

4.2 RECENT AND CONTEMPORARY NON-FEDERAL ACTIONS

The past and present impacts of non-Federal actions which are contemporaneous with the consultation in process are included in the environmental baseline. Future impacts of these same non-Federal actions will be considered as cumulative effects in the analysis of effects discussion in Chapter 6 of this BA. The following is considered a non-exhaustive list of non-Federal actions.

4.2.1 Rio Grande Compact

Water uses on the Middle Rio Grande must be conducted in conformance with the Compact administered by the Rio Grande Compact Commission. The four-member Commission is composed of Commissioners from Colorado, New Mexico, and Texas, as well as a Federal representative who chairs Commission meetings. Colorado is prohibited from accruing a debit, or under-delivery to the downstream States, of more than 100,000 ac-ft, while New Mexico’s accrued debit to Texas is limited to 200,000 ac-ft. These limits may be exceeded if caused by holdover storage in certain reservoirs, but water must be retained in the reservoirs to the extent of the accrued debit. Any deviation from the terms of the Compact requires unanimous approval from the three state Commissioners.

In order to meet delivery obligations under the Compact, depletions within New Mexico are carefully controlled. Allowable depletions above Otowi gage (located outside of Santa Fe, near the Pueblo of San Ildefonso) are confined to levels defined in the Compact. Allowable depletions below Otowi gage and above the headwaters of Elephant Butte Reservoir are calculated based on the flows passing through Otowi gage. The maximum allowable depletions below Otowi gage are limited to 405,000 ac-ft in addition to tributary inflows. In an average year, when 1,100,000 ac-ft of water passes the gage, approximately 393,000 ac-ft of water is allowed to be depleted below Otowi gage, in addition to tributary inflows. Depletion volumes are lower in dry years. For instance, in 1977, allowable depletions were 264,600 ac-ft in addition to tributary inflows. No Indian water rights may be impaired by the State's Compact management activities.

4.2.2 State of New Mexico

The State of New Mexico has a wide range of agencies that actively represent different aspects of the State's interest in water management:

- The New Mexico State Engineer has general supervision of the waters of the State and of the measurement, appropriation, and distribution thereof (N.M. Stat. Ann. 72-2-1 Repl. Pamp. 1994). The Office of the State Engineer (OSE) grants state water rights permits, ensures that applicants meet state permit requirements, and enforces the water laws of the State. The OSE is responsible for administering water rights, including changing points of diversion and places or purposes of use. The OSE uses the "Middle Rio Grande Administrative Area Guidelines for Review of Water Right Applications" to assess the validity and transfer of pre-1907 water rights.

- The New Mexico Interstate Stream Commission is authorized to develop, conserve, protect and to do any and all things necessary to protect, conserve, and develop the waters and stream systems of the State. It is responsible for representing New Mexico's interests in making interstate stream deliveries, as well as for investigating, planning, and developing the State's water supplies. The State cooperates with Reclamation to perform annual construction and maintenance work under the State of New Mexico Cooperative Program. In the past, this work has included some river maintenance on the Rio Chama, maintenance of Drain Unit 7, drain and canal maintenance within the Bosque del Apache National Wildlife Refuge, similar work at the state refuges, and temporary pilot channels into Elephant Butte Reservoir.

- The New Mexico Department of Game and Fish (NMDGF) administers programs concerned with conservation of endangered species, and game and fish resources. It also manages the La Joya Wildlife Management Area and Bernardo Wildlife Area.

- The New Mexico Environment Department (NMED) administers the State's water quality program including compliance with various sections of the Clean Water Act. Section 303 of the Clean Water Act allows NMED to establish water quality standards for water bodies and total maximum daily loads for each pollutant. Section 402 of the Clean Water Act includes the NPDES Storm Water Permit Program.

4.2.3 Counties

All counties that border the Rio Grande, the Rio Chama, and their respective tributaries perform actions or can perform actions that may at least indirectly affect these rivers. The primary area in which county actions may influence water management is providing for general development and infrastructure of these counties, and activities may include pumping of wells or land-use regulations within the immediate Middle Rio Grande watershed.

4.2.4 Villages, Towns, and Cities

Citizens in a multitude of villages, towns, and cities are served with municipal and industrial water systems. While most use groundwater exclusively, Santa Fe also uses surface water supplies, and both the cities of Albuquerque and Santa Fe use San Juan-Chama surface water in addition to groundwater. To the extent that future groundwater pumping or use of surface water depletes the river, the New Mexico State Engineer requires that these depletions be offset, either by acquiring other water rights or with San Juan-Chama Project water. Many of these contractors have voluntarily entered into annual lease programs with Reclamation to enhance middle Rio Grande valley water management. Municipalities also manage wastewater treatment systems that are point source discharges into the Rio Grande. Municipalities also release storm water discharge into the Rio Grande.

4.2.5 Irrigation Interests

Irrigation interests include a variety of the acequias, pueblos, individual irrigators, and ditch associations, as well as the Middle Rio Grande Conservancy District (MRGCD), which have water rights to divert the natural flow of the Rio Grande for beneficial use and then return unused water to the Rio Grande. Many of these irrigation interests have existed for hundreds of years. The MRGCD was established under state law in 1928, to address issues such as valley drainage and flooding, and currently operates the diversion dams of the Middle Rio Grande Project to deliver irrigation water to lands in the middle valley, including areas on six pueblos.

4.3 GEOMORPHOLOGY

This section summarizes current and ongoing geomorphologic conditions, especially as they relate to the operation of Corps dams along the Rio Grande and lower Rio Chama. In this section, discussion of sediment supply is almost exclusively referring to bed material, that is, sand and larger particles; suspended sediment has little effect on geomorphology.

4.3.1 Rio Grande

Current geomorphic processes in the Middle Rio Grande are described in Appendix E of this BA: *2007 Rio Grande Geomorphic Summary* (Massong *et al*. 2008). All of the information in that document is incorporated by reference into this BA. In addition, Makar and AuBuchon (2012) provide an overview of geomorphic trends combined with local trends by subreach.

Numerous studies of the geomorphology of the Rio Grande and its tributaries have been completed through the years. As part of a study prepared for the New Mexico Interstate Stream Commission, Mussetter Engineering, Inc. (MEI 2002) in June of 2002 performed a review of literature "… pertaining to geology, geomorphology, sediment transport, engineering practices, and riparian vegetation of the Middle Rio Grande" which "resulted in the identification of seven general conclusions reached by numerous investigations." These conclusions were:

"1. The channel of the Middle Rio Grande has narrowed. The narrowing began prior to the closure of Cochiti Dam, and it may be the result of reduced sediment delivery from tributaries as well as water diversions and engineering structures.

2. The channel of the Middle Rio Grande has deepened. Degradation is probably the result of reduced sediment loads and channel narrowing.

3. The channel of the Rio Grande downstream of Cochiti Dam has armored as a result of reduced sediment loads.

4. The Middle Rio Grande has changed from a braided channel to a single channel as a result of reduced bed load.

5. Riparian vegetation along the Middle Rio Grande has changed, and it reflects former channel locations.

6. Sediment characteristics vary from reach to reach of the Middle Rio Grande as a result of tributary influences.

7. The Middle Rio Grande is significantly affected by geologic controls. Between Belen and Socorro, active uplift has caused changes in gradient. Earthquakes are concentrated in this reach and at Albuquerque."

Controls on the geomorphology of the Middle Rio Grande were also described by Mussetter Engineering, Inc. (MEI 2002):

> "The variability of the Middle Rio Grande channel among and within reaches indicates that there are several significant controls on river morphology and behavior. Although the Rio Grande is for the most part an alluvial river with its channel composed of sediments currently transported by the river, geology plays an important role in river character and response. Hydrologic changes in the basin have been substantial and have affected river character and response. Sediment supply, transport, and deposition have been modified through time and have affected the form and characteristics of the river as well as the gradation of the bed material. Finally, much of the variability is associated with man-made interventions for irrigation and drainage, flood control, and water conveyance."

Hydrologic change has come from irrigation and flood-control efforts since the 1800s (Scurlock 1998), as well as climatic changes affecting the frequency and intensity of precipitation patterns in the Southwest (Molnar and Ramirez 2001; Schmidt *et al.* 2003).

Sediment supply to the Middle Rio Grande has been reduced in large part because of a general reduction in sediment supplied by tributary arroyos and watersheds such as the Rio Puerco in the latter part of the 20^{th} century (Gellis 1992). This coincided with the human effort to reduce sediment and flooding on the Rio Grande through engineered structures (Scurlock 1998).

As stated previously, the Rio Grande historically was an aggrading channel throughout the middle reach. Many water development projects constructed during the 1900s have reduced the sediment contribution from tributaries either as a primary project objective, or as a secondary effect. Flood-control facilities maintained by local entities—such as the Albuquerque Metropolitan Flood Control Authority, the Southern Sandoval County Arroyo Flood Control Authority, and the City of Socorro—intercept large arroyos and retain sediment in basins that are periodically excavated. In areas without arroyo-control systems, irrigation canals and drains may intercept flow and require recurring dredging to remove accumulated sediment. Main stem diversion dams and their inlet channels accumulate sediment which is routinely removed and deposited in upland locations. Water supply and flood-control dams that maintain pools function as highly effective sediment traps.

Sediment control is a primary purpose at all four Corps dams in the Middle Rio Grande; however, the Cochiti Dam and Lake Project has most pointedly affected the geomorphology of the main stem. Since its closure in 1973, sediment retention behind Cochiti Dam has caused significant incision immediately downstream. The incision migrated downstream at a rate of 3.1 mi/yr (5 km/yr) from 1973 to 1980 (Lagasse 1980), and, later, at a rate of 0.4 mi/yr (0.7 km/yr) from 1980 to 2003 (Ortiz 2004).

The amount of incision varied greatly both spatially and temporally due to local influences. Spatial variability was due to the erodibility of local material, tributary sediment supply, and historic deposition zones. Temporal variability was due to episodic tributary sediment supply, discharge patterns from upstream portions of the Rio Grande basin, and secondary influences such as vegetation encroachment on the channel. However, the amount of incision generally decreases in the downstream direction. According to Ortiz (2004), by 2004 the downstream extent of this incision appeared to be near the confluences of Baranca and Montoyas arroyos in Corrales. This is supported by analysis of relative bank heights using cross-section data from Reclamation's 2002 aggradation/degradation survey (Figure 4.1).

Evidence of incision associated with the closure of Cochiti Dam has not been documented downstream of the Baranca and Montoyas arroyos. However, a coarsening of the bed material of the Rio Grande has been associated with this incision and has appears to be progressing downstream in tandem with it (Makar 2010). The coarsening can be seen within a transition zone of the river bed and may indicate the location where incision is occurring. The transition zone appeared to be located near the town of Bernalillo in the early 1990s (Ortiz 2004), and near Corrales in the early 2000s (Massong *et al*. 2008). Currently the transition zone is spatially less apparent and appears to be located within the city limits of Albuquerque. Downstream of this, and upstream of Isleta Diversion Dam, the Rio Grande continues to be a sand bed river.

Bank height analysis suggests that incision is approximately 3 feet greater upstream from Angostura than it is immediately downstream from Baranca Arroyo (Figure 4.1). In addition, you can reasonably fit a linear relationship in the incision transition zone between these locations (approximately 11 miles).

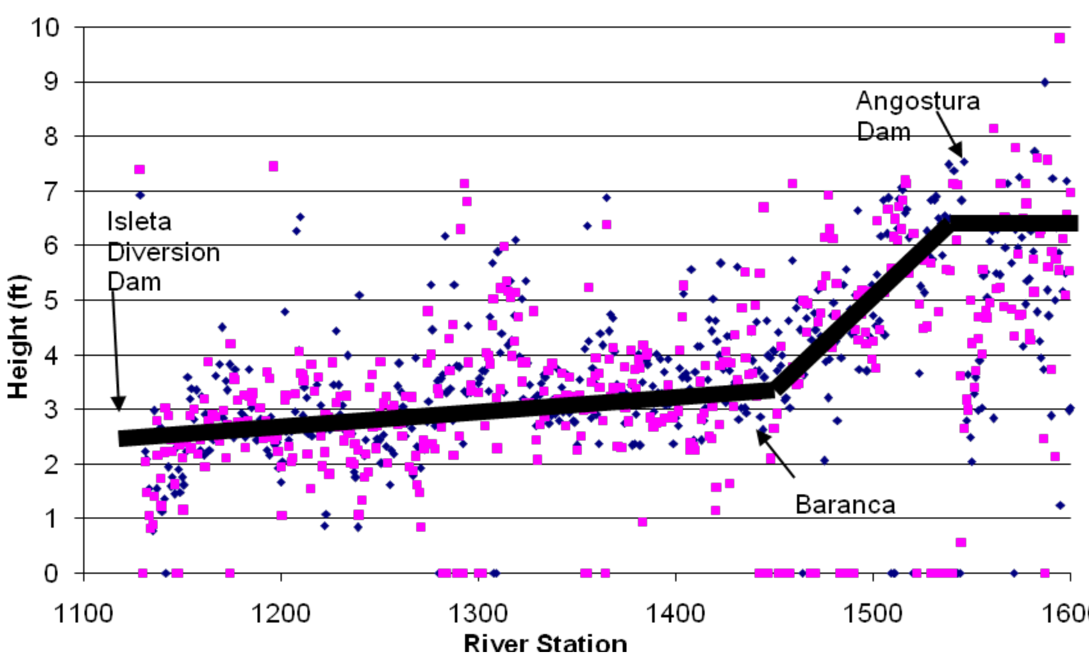


Figure 4.1. Bank heights above the 4,000-cfs water surface from Isleta Diversion Dam to upstream of Angostura Diversion Dam.

The channel upstream from Angostura Diversion Dam appears to have stabilized vertically (Lagasse 1980, Ortiz 2004) and exhibits little lateral migration. The incision has, in effect, cut off the historical floodplain from inundation by flows less than 12,000 cfs. The channel cross-sections in the upper reaches have, to some extent, kept their historical form in that the bars and islands have dropped in elevation along with the channel thalweg. However, recent evidence points to a different method of channel degradation where islands and bars become vegetated (especially during drought), armoring them and essentially stabilizing their elevation. The non-vegetated low-flow channel becomes the only areas available to degrade. This then has the effect of decreasing the inundation frequency of the islands and bars, reducing the amount of available aquatic habitat.

The ultimate downstream extent of incision is not known, but is not likely to progress further than the area immediately upstream from the Isleta Diversion Dam (Lagasse 1980, 1994; USGS 1984). It is possible that the Rio Grande has reached an equilibrium where incision will not progress downstream of Montoyas Arroyo (Ortiz 2004) due to sediment supplied by tributaries, including additional supply from the Jemez River since 2001. In a study done for the Corps' Middle Rio Grande Bosque Restoration project, MEI (2008) predicted no more than 0.1 feet of degradation in the Albuquerque area over the next 50 years. It is more likely that incision will continue downstream but at a slower rate, and to a lesser degree, than has been observed in other river systems in response to dams construction (Williams and Wolman 1984). In addition to the channel adjusting itself to a new sediment supply regime, the sediment deficit becomes less in the downstream direction due to supply from tributaries (Table 4.1).

Vegetation responses to climatic and hydrologic variability, as well as the introduction of exotic species to the valley, play a role in the geomorphology of the Middle Rio Grande. As vegetation takes hold in the islands, bars, and channel margins during periods of lower flows, these margins can become "locked in", resulting in a narrowing and deepening of the channel (Scurlock 1998, Makar *et al*. 2006). This process is currently seen throughout the Middle Rio Grande, most notably within the Isleta reach (Massong *et al*. 2008) and is similar to the channel's response to closure of Cochiti Dam. Due to this, direct cause and effect relationships become more difficult with increasing distance downstream of Cochiti Dam.

4.3.2 Lower Reach of the Rio Chama

The Rio Chama continues to be an active gravel bed river even after construction of Abiquiu Dam (USACE 1996b). Gravel bed load continues to be the most significant factor in channel morphology. Middle bars continue to develop, meandering and lateral migration are still active processes, and gravel deltas form in the river when large quantities of sediment are washed out of tributary watersheds. The reduced magnitude of peak flows, caused by flood regulation, has decreased the supply of gravel from upstream but has also decreased the river's ability to move accumulated gravel deposits. The rate of channel change can best be determined by establishing and monitoring monumented cross-sections and by comparing historical aerial photos. An examination of historical channel surveys indicated a general degradation trend in the first three miles downstream from Abiquiu Dam between 1963 and 1983, although the rate of degradation has decreased over time. The overall trend for the next 12 miles was aggradation, although some shorter sections had degraded.

An active maintenance program conducted by the New Mexico Interstate Stream Commission has been successful in reducing bank erosion and in maintaining hydraulic conveyance at many local gravel accumulation sites. This has been accomplished by channel reshaping projects where gravel deposits are pushed up onto eroding banks.

Table 4.1. Average annual bed material contribution from Middle Rio Grande tributaries (MEI 2004).

Tributary Name	Drainage Area (mi^2)	Average Annual Sediment Volume (ac-ft)	Unit Volume (ac-ft/mi^2)	Source
Galisteo Creek*	43.0	4.6	0.11	RTI Main Report (1994)
Borrego Arroyo	75.0	1.7	0.02	Unit Yield Analysis
Tonque Arroyo	163.0	3.6	0.02	Unit Yield Analysis
Las Huertas Arroyo	29.2	0.6	0.02	Unit Yield Analysis
Jemez River	1034.0	0.0	0.00	Assume all bed matl load trapped under historic Jemez operations
Agua Sarca Arroyo	5.7	0.0	0.00	Intercepted by Albuquerque Main Canal u/s of Bernalillo
Arroyo de la Baranca	9.6	0.2	0.02	Unit Yield Analysis
Calabacillas Arroyo	100.8	10.1	0.10	Assume 0.10 ac-ft/mi2
Montoyas Arroyo	61.0	0.0	0.00	Intercepted by Detention Basin
N Diversion Chnl	102.0	8.3	0.08	Copeland, et.al. (1995)
S. Diversion Chnl	133.0	13.3	0.10	Assume 0.10 ac-ft/mi2
Pajarito Arroyo	0.9	0.4	0.47	Unit Yield Analysis
Comanche Arroyo	15.0	0.3	0.02	Unit Yield Analysis
Abo Arroyo	290.0	29.0	0.10	Unit Yield Analysis
Rio Puerco	7188.8	25.0	0.00	Back-computed for equilibrium in SR6a
Palo Duro Canyon	63.5	1.4	0.02	Unit Yield Analysis
Los Alamos Arroyo	58.8	1.3	0.02	Unit Yield Analysis
Bernardo Arroyo	1.8	0.4	0.19	Unit Yield Analysis
Canada Ancha	4.5	0.2	0.03	Unit Yield Analysis
Canoncito Colorado	1.8	0.4	0.20	Unit Yield Analysis
Rio Salado	1419.3	48.6	0.03	Based on USBR measured bed elevation change in SR6b
Arroyo Rosa de Castillo	5.5	0.1	0.03	Unit Yield Analysis
San Lorenzo Arroyo	30.5	0.0	0.00	Intercepted by San Lorenzo Settling Basin
Arroyo Sevilleta	2.6	0.3	0.13	MEI Tributary Study, MEI (2003)
Arroyo de Alamillo	3.2	0.2	0.06	MEI Tributary Study, MEI (2003)
Arroyo del Veranito	5.8	0.1	0.03	Unit Yield Analysis
Arroyo del la Parida	42.1	0.6	0.01	MEI Tributary Study, MEI (2003)
Coyote Arroyo	3.2	0.0	0.00	Intercepted by Eastside Drain
Arroyo de los Pinos	12.1	0.2	0.02	MEI Tributary Study, MEI (2003)
Arroyo de Tio Bartolo	2.6	0.2	0.09	MEI Tributary Study, MEI (2003)
Arroyo de la Presilla	15.5	0.3	0.02	MEI Tributary Study, MEI (2003)
Arroyo del Tajo	9.0	0.2	0.02	MEI Tributary Study, MEI (2003)
Arroyo de las Canas	26.3	0.4	0.01	MEI Tributary Study, MEI (2003)
San Pedro Arroyo	47.3	0.6	0.01	MEI Tributary Study, MEI (2003)

* Below dam

Diversion dams located along the Rio Chama affect the gravel transport through the reach. Sediment transport analyses generally indicate an aggradational trend upstream of diversion dams and degradational trend downstream of these dams, as would be expected. On a reach-wide basis, these diversion dams may help to stabilize the overall degradational or aggradational trends (USACE 1996b).

The sediment budget analysis conducted at three cross-sections for the 1996 study (USACE 1996b) indicated that the sediment transport capacity of the Rio Chama has been decreased by the dam. The transport capacity of gravels and cobbles has been reduced by a greater percentage than the transport of sands due to the reduced magnitude in peak flow below the dam.

Analysis of the suspended sediment data at the Chamita gage indicated that sand yield on the Rio Chama has been significantly reduced by construction and operation of Abiquiu Dam. The reduction in capacity of sand transport is overshadowed by the reduction in supply of sand, so that general aggradation trends due to sand deposition are not expected.

4.4 HYDROLOGY

Located in a rift valley at the western edge of the Great Plains, the Rio Grande is one of the longest rivers in the United States. It runs 1,960 miles from its headwaters in the San Juan Mountains of southern Colorado to its terminus in the Gulf of Mexico. Human activities affecting flows in the Rio Grande system have been documented back to the arrival of Spanish settlers in the late 16th Century (Wozniak 1997). However, major changes in river hydrology followed statehood in 1912. A timeline of human activities since 1870 that have affected the Rio Grande is shown in Figure 4.2.

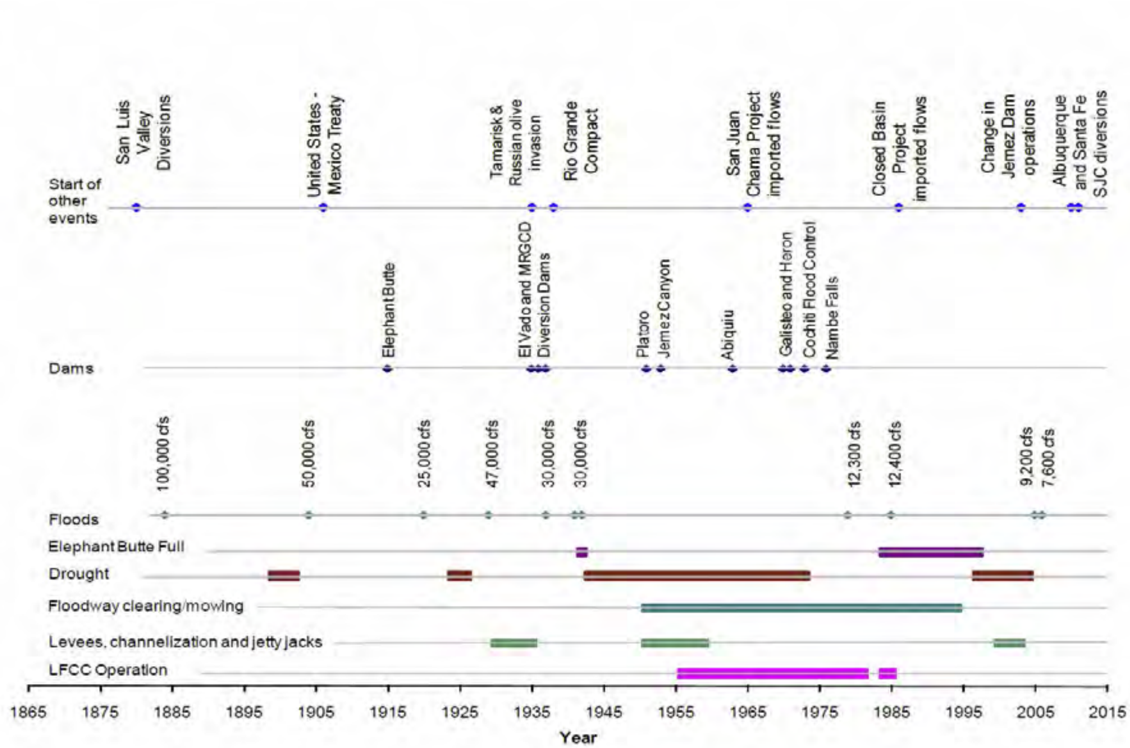


Figure 4.2. Timeline of human activities since 1870 that have affected the Rio Grande.

Natural flows in the Rio Grande system are derived from three primary sources: 1) snowmelt originating predominantly from upstream, higher elevations of the watershed; 2) summer thunderstorms that tend to be localized and concentrated at lower elevations; and 3) groundwater inflow. During the last century, about 60% of the natural runoff volume in the Rio Grande at Otowi Bridge, as indicated by the Otowi Index Supply, occurs during April, May, and June snowmelt. Along the Rio Chama, about 80% of the natural annual flow occurs during April, May, and June. While the peak runoff period typically occurs from April through June, the highest evapotranspiration and irrigation demands along the Rio Grande occur from June through mid-September. In contrast, along the Rio Puerco, near Bernardo, nearly 80% of the recorded annual flow occurs between July 1 and October 31, with nearly 40% occurring during August alone (USACE 2007).

Under natural, unconstrained river conditions, the annual flow volume varies significantly from year to year in response to climatic conditions, ranging across an order of magnitude from 250,000 to 2.25 million ac-ft. Annual variations in timing and volume of streamflow are strongly influenced by the El

Niño-southern oscillation (ENSO) through its modulation of seasonal cycles of temperature and precipitation and their effects on snow accumulation and melting (Lee *et al*. 2004). ENSO cycles can be several years to decades long and can result in extended drought or wet periods. An extended period of below-average precipitation occurred from the 1940s through the mid 1970s, with above-average precipitation from 1981 through the mid 1990s (National Oceanic and Atmospheric Administration [NOAA] 2002). Drought [11]returned in the late 1990s through the current period (USACE 2007).

4.4.1 Rio Grande Basin Water Operations

River flow and water movement throughout the Rio Chama and Middle Rio Grande are constrained by management of water in existing facilities under existing authorities and physical channel capacities. Changes in operations typically have the greatest impacts to the river sections immediately in or downstream of the proposed change. The Middle Rio Grande is affected by Colorado state-line Rio Grande Compact (Compact) deliveries; Rio Chama and other tributary contributions; imported San Juan-Chama (SJ-C) Project waters; Corps flood-control reservoirs along the Rio Chama and Rio Grande; and Reclamation's Middle Rio Grande Project, all of which contribute to or regulate flows along the Middle Rio Grande, ultimately providing New Mexico Compact deliveries at Elephant Butte Reservoir (Rio Grande Project facility). Major Federal reservoir facilities within the action area include:

Rio Chama:	Heron Dam Reservoir (Reclamation, SJ-C Project) El Vado Dam Reservoir (Reclamation, Middle Rio Grande Project) Abiquiu Dam and Reservoir (Corps)
Rio Grande:	Cochiti Dam and Lake (Corps)
Off-Channel:	Jemez Canyon Reservoir (Corps) Galisteo Dam (Corps)

Water operations along the Rio Grande have four general purposes: flood and sediment control, irrigation supply, municipal and industrial supply, and environmental operations. Water operations also include downstream monitoring to ensure that desired flows are achieved. Little native Rio Grande flow is actually captured and stored in the major reservoirs in this system. On average, only 100,000 ac-ft of native Rio Grande water (less than 10% of annual average flow at Otowi gage), is historically stored in El Vado Reservoir. Except for temporarily detained flows due to flood regulation, all of the water stored in Heron, Abiquiu, and Cochiti reservoirs is imported SJ-C Project water. When P.L. 86-645 is triggered, Abiquiu Reservoir or Cochiti Reservoir are required to retain carryover flood storage because no Rio Grande water may be withdrawn from storage after July 1 (exclusive of water from upstream storage) or when the natural flow at the Otowi gage is less than 1,500 cfs. Rio Grande water that is locked into storage is not permanent: it must be released at the end of the irrigation season (November1) and must be fully evacuated by March 31 of the following year.

Flood-control operations adjust the rate of releases at the Corps' reservoirs (Abiquiu, Cochiti, Galisteo, and Jemez Canyon reservoirs) along the Rio Grande main stem and its tributaries. Flood-control operations are typically in effect during snowmelt runoff, when mountain snowpack is heavier than

[11] As used here, drought is defined as: "A period of below average water content in streams, reservoirs, groundwater aquifers, lakes and soils." (Yevjevich et al. 1977). Average annual runoff volume for the period from 1919 to 2010 is approximately 1,000,000 acre-ft. During periods of drought, the average annual runoff volume is below this. While there may be isolated years within the drought period when the runoff volume exceeds this average, when combined with the previous year's volumes, the short period average volume remains below the 1,000,000 acre-ft entire period average volume.

normal, and during unusually heavy summer monsoon seasons. Releases from these reservoirs are adjusted to take into account uncontrolled flow through Galisteo Dam. These four reservoirs are operated as a system to ensure that flows at critical downstream points are not exceeded. (Chapter 2 of this BA contains a detailed description of flood-control operations.)

Cochiti Lake is the only flood-control reservoir on the Rio Grande main stem and is typically operated to pass inflow (Public Law (P.L.) 86-645) and maintain a 1,200 acre (surface acres) permanent pool of San Juan-Chama water for conservation and development of fish and wildlife resources (P.L. 88-293).

P. L. 86-645 provides the Rio Grande Compact Commission (RGCC) with the authority to approve Corps-requested departures from the reservoir operations schedule. The Corps must also obtain approval from the Corps' South Pacific Division in order to deviate from its approved reservoir operation schedule. Since the 1980s, the RGCC has approved deviations to conserve the maximum amount of total water as far upstream as possible in the Rio Grande system; to avoid losing the recreation pool at Elephant Butte resulting from spills (1985-1986) via a paper transfer to Abiquiu Reservoir; and to facilitate water quality testing, downstream diversion structure repairs, bridge foundation work, and aerial surveys (USACE 1993). Most recently, deviations were approved for 2007 and 2009-2013 to facilitate a minnow spawning and recruitment flow of approximately 3,000 cfs for at least a period of 7 to 10 days as measured at the Central Avenue (Albuquerque) gage, contingent on annual assessment and approval by the RGCC.

Along the Rio Chama, Heron Reservoir manages imported SJ-C Project waters, passing all native Rio Grande flows. El Vado Reservoir reregulates native Rio Grande waters for 'Prior and Paramount' water needs and stores native Rio Grande water when allowed by the Rio Grande Compact for use by the MRGCD. When space is available, El Vado can also store SJ-C Project waters. Abiquiu Reservoir is Congressionally authorized for flood control, sediment control, and storage of both SJ-C Project and native Rio Grande waters. However, native Rio Grande water has been stored only once. Since 2008, Abiquiu Reservoir has remained near its water supply storage capacity.

The eight major dams listed on Figure 4.2 affect flows in the river by storing and releasing water in a manner that generally decreases flood peaks and alters the timing of the annual hydrograph. However, these facilities do not cause significant changes in the annual flow volume (USACE 2007). The San Juan-Chama (SJ-C) Project was authorized in the 1960s and began releasing water into the Rio Grande system in the early 1970s, concurrent with the construction of Cochiti Dam. This project has increased the flow volume above historical conditions in the Rio Grande system. The SJ-C Project, which imports flows into the basin, began operating in late 1971, thereby increasing flow in the system downstream from Heron Reservoir (Figure 4.3).

The annual average for the ten-year period shown in Figure 4.3 is approximately 61,500 acre-feet of San Juan-Chama water past the Otowi gage in response to downstream demands by contractors and Reclamation Supplemental Water Program releases. The remainder of SJ-C Project water is stored in El Vado and Abiquiu Reservoirs. Since 2000 the range in flow of SJ-C Project water at the Otowi gage has ranged from a low of 2% in 2005 to a high of 60 % in 2002. In 2002 the annual flow at the Otowi gage was 337,069 acre-feet of which 202,800 acre-feet was San Juan-Chama water.

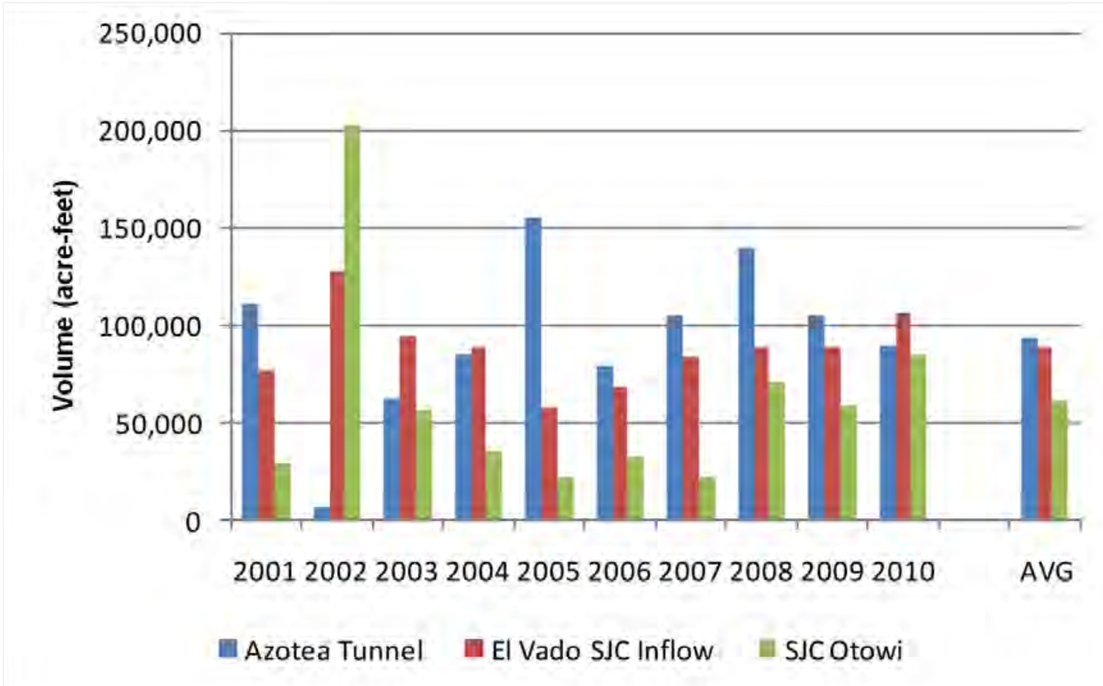


Figure 4.3. Summary of annual San Juan-Chama Diversions at Azotea Tunnel, releases from Heron Dam to El Vado Reservoir, and annual amounts of San Juan-Chama water crossing the Otowi gage for consumption within the Rio Grande or delivered to Elephant Butte Reservoir. (Graphic courtesy of Bureau of Reclamation [2011b].)

4.4.2 Middle Rio Grande Discharge Characteristics

While the Middle Rio Grande has become a regulated river system, the general character and shape of the annual hydrographs above and below Cochiti Dam have remained similar from 1975-2010, as shown in the graph below. Figure 4.4 displays the maximum, median, and minimum monthly discharge (cfs) of the Rio Grande at three locations on the mainstem based on U.S. Geological Survey data from 1975 to 2010. Figure 4.4 shows that the Rio Grande hydrographs have a relatively low baseline flow from about August through February, followed by an increase in discharge associated with spring runoff from mid-March through mid-July. The difference between the Cochiti Dam release and the flow of the Rio Grande at Albuquerque gage is a result of diversions and channel losses. On a mean-cfs-per-month basis, the hydrograph shows a difference of approximately 300 cfs during the month of May.

In response to the combined effects of both natural and human factors, the Rio Chama below Abiquiu Dam and the Rio Grande downstream of Cochiti Dam are less dynamic rivers than they had been historically. Changes in hydrology and channel morphology have reduced the frequency of overbank flows in most of the reaches, except where aggradation is occurring downstream of the Bosque del Apache National Wildlife Refuge (USACE 2007).

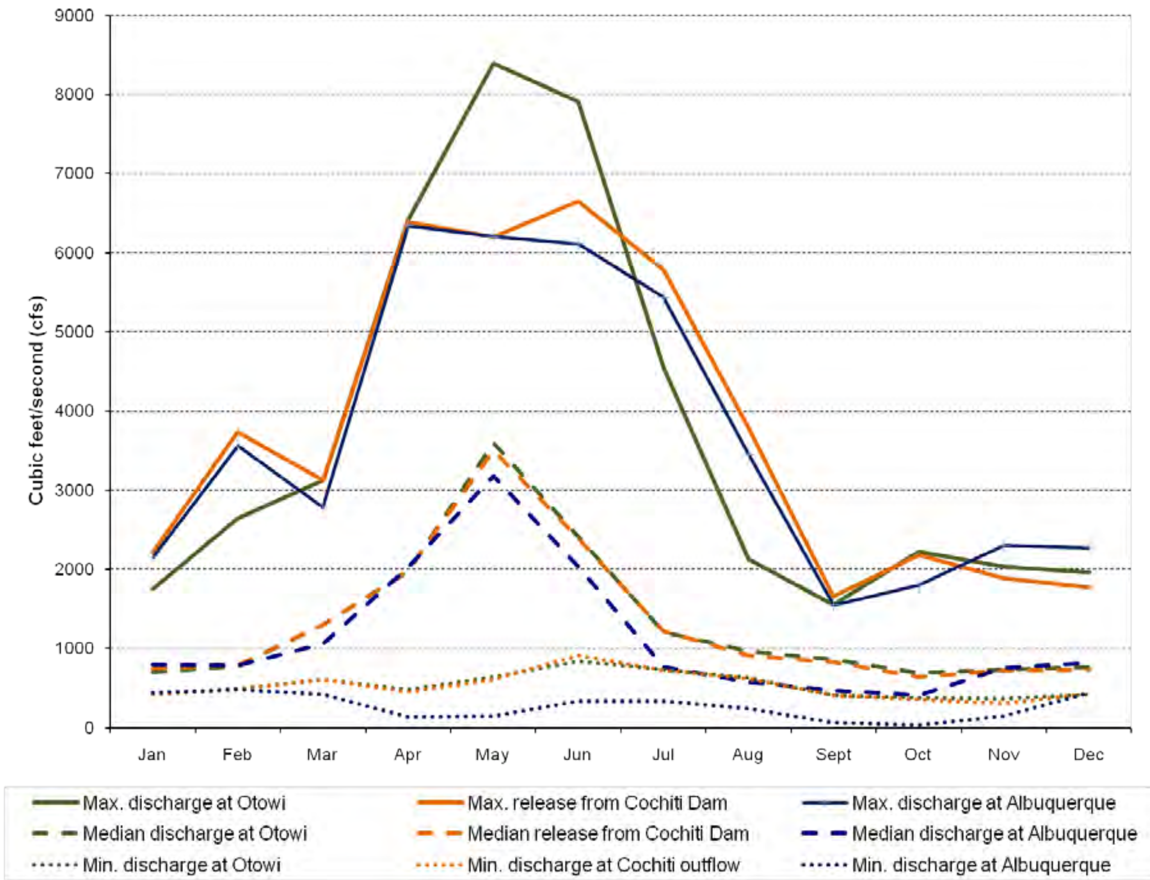


Figure 4.4. Monthly discharge (cfs) of the Rio Grande at Otowi gage, Cochiti Dam outlet, and Albuquerque gage, 1975-2010.

A more recent representation of median flows at the Rio Grande gage at Otowi Bridge from 1975 through 2010 is shown on Figure 4.5. This more recent period reflects main stem flows since the start of the San Juan-Chama Project and the construction and operation of Cochiti Dam. This period also includes the recent wet period in the early- to mid-1980s. Flows in the Rio Grande basin are skewed and mean monthly discharges, especially during spring runoff, are significantly higher than median flows. Median flows are the 50th percentile flows – wherein half the discharges are higher and half are lower. Median spring peak flows are less than 3,500 cfs and occur in late May. These hydrographs reflect more contemporary hydrologic and water management conditions. Increasing urban populations are increasing the amount of return flows provided from wastewater treatment plants and stormwater management facilities. Population increases in the basin that may affect flows along the Rio Grande main stem include growing numbers of domestic wells in the middle valley, water rights transfers within and outside the middle valley, and decreases in irrigated lands resulting from housing development in the valley floor.

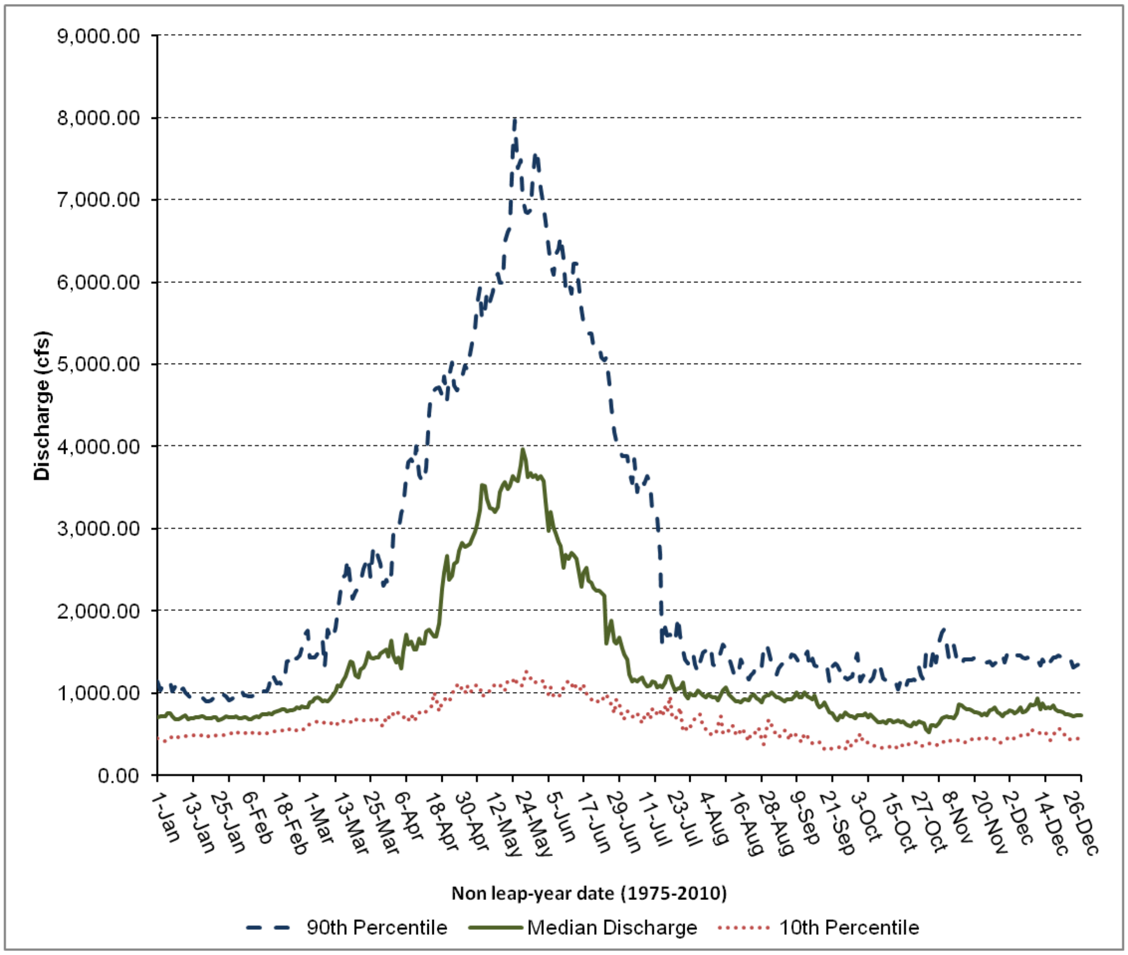


Figure 4.5. Rio Grande flows at the USGS Rio Grande Otowi gage site (1975-2010).

Flows at Otowi consist of unregulated, main stem Rio Grande flows crossing the border from Colorado and discharges from reservoirs along the Rio Chama, including both imported SJ-C Project waters (about 54,000 ac-ft per year) and native Rio Grande watershed inputs. Native Rio Grande spring runoff from April through June is typically allowed to pass unregulated, with the exception of peak flows that exceed safe channel capacity. Cochiti Dam and Lake is the sole main stem reservoir capable of regulating these native Rio Grande flood flows. Abiquiu Reservoir is the primary flood-control reservoir along the Rio Chama, and Jemez Canyon Dam regulates flood flows on the Jemez River. Releases from the other water supply reservoirs along the Rio Chama typically occur later in the year, from May through October, depending on irrigation demand and biologic flow requirements.

4.4.3 Changes to Magnitude and Duration of Peak Flows

While the general shape of the annual hydrograph is similar to pre-1900 conditions, continuing irrigation withdrawals and more recent flood-control regulation has reduced the magnitude of peak flows that historically inundated the middle Rio Grande floodplain.

Water is diverted for irrigation at 470 acequias in the Rio Grande basin within New Mexico and upstream from San Acacia (USACE 1987). In the early 1930s, the MRGCD constructed four diversion dams—at Cochiti, Angostura, Isleta, and San Acacia—to consolidate water delivery to communities on the Rio Grande main stem between Cochiti Pueblo and San Marcial. At these acequias and main stem diversion dams, flow is diverted from March through October or November of each year when physically and legally available. A portion of the diverted flow is returned to the main stem at system outfalls.

Natural Rio Grande basin flow is stored at El Vado Reservoir during spring snowmelt runoff and after summer storms in the upper Rio Chama watershed. The reservoir releases this stored water for withdrawal at the four Middle Rio Grande Project diversion dams during the June through October period.

Operation of the Corps' flood-control dams also has modified the natural flow of the river. As described in Chapter 2 of this BA, the Corps regulates the highest discharges during spring snowmelt runoff and summer storms that would normally cause flooding damage. Flood water detained in these reservoirs normally is released at the maximum non-damaging rate, as stipulated in P.L. 86-645. The general effect is that the peak discharge for the season, or for a shorter event, is decreased and prolonged relative to the inflow hydrograph.

The magnitude and date of spring (March-July) instantaneous peak flows from 1975 to 2011 are presented in Table 4.2. For the majority of the time, the Cochiti Dam maximum release occurs within two weeks of the peak inflow at the Otowi gage. An exception to this occurred in 1985, 1986, and 1987, because the downstream reservoirs on the Rio Grande—Elephant Butte and Caballo—were full and Corps projects were being used to provide flood protection downstream of Caballo Reservoir.

At the tail end of the spring snowmelt runoff, P.L. 86-645 may affect the Corps flood water evacuation at Abiquiu and Cochiti dams. The Corps is directed by P.L. 86-645 to hold (carryover) flood water in Abiquiu Reservoir or Cochiti Lake after July 1 when the natural flow at Otowi gage falls below 1,500 cfs. This water must subsequently be released between the following November 1 and March 31. While carryover storage is not a common occurrence, the Corps does have discretion as to how this water is evacuated. These releases are made during the winter months, when low flows would normally occur. From 1963 through 2012, carryover storage has occurred at Abiquiu Reservoir 15 times and 3 times at Cochiti Lake (Table 2.2). The last year that carryover storage occurred was in 1995 at Abiquiu Reservoir. Channel conditions and release rates from downstream reservoirs can influence carryover storage.

4.4.4 Low Flow Conditions (1956-2000)

A database was assembled for the 2003 Programmatic Biological Assessment (Reclamation and USACE 2003) that contains historic daily river flows measured at the Albuquerque (Central Avenue), San Acacia, and San Marcial gages over the 45-year period from 1956 through 2000. The database was used to calculate the percentage of days with zero flow at the noted gage locations. These percentages represent actual historic zero flow occurrences under river management practices that existed at the time that the measurements were made. River management practices that were employed at various times from 1956 through 2000 included active and complete diversion of the Rio Grande into the LFCC at San Acacia; diversion into Middle Rio Grande Project facilities and irrigation of Indian and non-Indian land by MRGCD; active operation of all existing reservoirs for storage and release; SJ-C Project water releases; and actions specifically targeted to benefit endangered species.

Based on the total annual flow recorded at Embudo and La Puente, the driest year within this record occurred in 1977, with a total annual combined flow at Embudo and La Puente of 256,256 ac-ft. The wettest year within this record occurred in 1985, when the combined Embudo and La Puente flow was 1,872,072 ac-ft. The average of the flows recorded at Embudo and La Puente over the entire 45-year period is 853,141 ac-ft.

Table 4.2. Spring runoff (March-July) instantaneous peak flows (cfs). Data were obtained from USGS and the Corps of Engineers database.

	Otowi Gage		Cochiti Lake outflow		Albuquerque Gage	
Year	**Date**	**Discharge**	**Date**	**Discharge**	**Date**	**Discharge**
1975	May 19	5,070	June 19	5,331	May 24	6,160
1976	July 31	4,480	May 20	3,343	May 21	3,340
1977	June 13	1,540 [a]	June 4	1,522 [a]	July 28	980 [a]
1978	May 21	4,020	May 21	3,881	May 24	4,580
1979	June 9	12,300	May 31	7,140	June 1	8,650
1980	May 25	8,270	May 28	7,072	May 28	7,130
1981	May 4	1,950 [a]	May 4	1,640 [a]	May 5	2,170 [a]
1982	July 31	5,460	June 1	5,421	June 2	5,460
1983	June 3	8,760	June 15	6,946	June 10	7,700
1984	May 17	9,790	May 31	10,406	May 28	9,500
1985	May 10	12,400	May 7	8,649	April 24	9,370
1986	June 12	7,980	July 31	4,400 [a]	July 31	4,413 [a]
1987	May 20	9,860	July 21	6,185	July 24	7,840
1988	April 17	2,570 [a]	March 30	3,912 [a]	July 9	4,820 [a]
1989	April 12	4,210	April 25	4,049 [a]	April 25	3,730
1990	July 11	4,260	May 13	2,814 [a]	May 12	2,528
1991	May 22	8,560	June 18	5,335 [a]	June 20	4,290 [a]
1992	April 14	6,690	May 11	5,781 [a]	April 29	6,250
1993	May 30	8,200	June 4	7,427 [a]	June 7	7,210
1994	May 19	10,200	May 24	6,429 [a]	May 11	7,050
1995	July 6	8,800	May 25	6,858	May 25	6,570
1996	July 9	3,790	May 20	1,410 [a]	June 27	2,690
1997	June 8	6,940 [a]	June 10	6,830 [a]	June 8	6,270
1998	May 25	4,310	May 9	4,296 [a]	May 9	4,060
1999	May 25	5,410	May 27	5,131 [a]	May 28	4,920
2000	July 30	3,760	June 4	1,762 [a]	June 3	1,500 [a]
2001	May 17	3,700 [a]	May 22	4,311 [a]	May 22	4,970
2002	May 13	1,710 [a]	May 14	1,842 [a]	May 15	1,240 [a]
2003	May 15	1,820 [a]	May 23	1,958	March 21	1,880
2004	May 10	3,600	May 12	3,562	April 3	3,590
2005	May 27	9,190	June 1	6,948	June 3	6,510 [a]
2006	July 6	4,460			July 9	4,030
2007	May 18	3,840	May 19	3,860	May 21	3,810
2008	May 24	6,130	May 24	6,591 [a]	May 25	5,400
2009	May 11	6,150	May 12	5,590	April 14	4,940
2010	May 22	2,010	May 21	6,250	May 22	5,140

[a] Mean daily flow in cfs.

For this analysis, the 45-year record was subdivided into three categories representative of "Dry Years," "Average Years," and "Wet Years" (as defined in the 2003 BO). These divisions were simply made by sorting the years using the annual summed flows recorded for Embudo and La Puente and then categorizing the years into 15-year slots. Defining a measured daily average flow less than 1 cfs as equivalent to zero flow (dry river) at a gage, the number of zero-flow days was summed by month for the Albuquerque, San Acacia, and San Marcial gages. This analysis is summarized in Table 4.3 for Dry Years and Average Years in terms of percentage of days with zero flow for the months of May through October. Low daily average flows (<10cfs) in the Angostura Reach, while rare, have occurred as shown in Table 4.3.

Table 4.3. Historic percentage of days with zero flow (1956-2000).

Historic Percentage of Days with Zero Flow – Dry Years						
Location	**May**	**June**	**July**	**August**	**Sept.**	**Oct.**
Albuquerque	3	12	17	9	6	20
San Acacia	0	13	31	11	24	13
San Marcial	65	73	62	44	45	54

Historic Percentage of Days with Zero Flow – Average Years						
Location	**May**	**June**	**July**	**August**	**Sept.**	**Oct.**
Albuquerque	0	0	0	0	5	9
San Acacia	0	3	3	8	8	3
San Marcial	11	30	54	38	45	54

4.4.5 Recent History of River Drying (1996-2010)

The previous section used river gage data to determine the number of days of river drying. In this section, the number of miles and days of river drying are based on recorded observations. From 1996 to 2010, the Service provided observations of river drying and intermittency incidental to Rio Grande silvery minnow monitoring, rescue, and salvage operations. In 1998, there was a gap in minnow population monitoring, and no observations were identified other than anecdotal reports concerning river drying appearing in the Albuquerque Journal. Various minnow monitoring efforts resumed in 1999, and records of drying were again noted in the literature. The RiverEyes program was initiated in 2002 to monitor river drying and the need for silvery minnow rescue. As the RiverEyes program has matured, there are various levels of detail available in recorded observations. From 2004 through 2010, RiverEyes data have been compiled into a searchable geodatabase (ArcGIS 9, ArcMap V 9.2). RiverEyes observations provide fairly detailed summaries of drying in the Isleta and San Acacia reaches.

During the spring and summer of 1996, river drying included a 5-mile reach near Tome, a 5-mile reach near the US highway 60 Bridge, and an extended 36-mile reach from near Brown Arroyo to Elephant Butte Reservoir (Table 4.4). In 1997, at least 16 river miles were dry for approximately five to seven days. Approximately 16 river-miles were dry for 28 days in 1998 (Smith 1999). The river was dry in 1999 for four to five days for at least 28 river miles (Platania and Dudley 1999). At least seven miles of the river became intermittent in 2000 for about three days in late July between the southern boundary of Bosque del Apache Refuge and Ft. Craig. In 2001, limited river drying occurred, approximately 8 to 10 miles of river with the period of intermittency usually lasting less than two days (USFWS 2002b). From 2000 to 2008, Low Flow Conveyance Channel (LFCC) pumping was 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 does not preclude river drying when allowed by conditions specified in the 2003 BO.

During the period from 1996 through 2010, the Angostura Reach did not go dry. Various degrees of drying are noted for the Isleta and San Acacia reaches. The information for the Isleta Reach from 1996 through 2001 is not considered definitive. There was little to no actual field monitoring occurring in the Isleta Reach. Early monitoring efforts focused on the San Acacia Reach because at the time it had the largest percentage of the silvery minnow population, based on catch-per-unit-effort data.

Table 4.4. River drying by reach and by percent of RGSM critical habitat, 2001-2010. (Data compilation courtesy of Reclamation [2011b].)

Year	Information source	Percent of total critical habitat dry	Percent of reach that dried		Maximum drying distance (mi.)		
			Isleta[b]	San Acacia	Isleta[b] (53 miles)	San Acacia (58.5 miles)	Combined (111.5 miles)
1996	USFWS	14	0	40	0	23.5	23.5
1997	USFWS	6	0	15	0	9	9
1998	ABQJ	8	0	22	0	13	13
1999	ASWIRF	13	0	35	0	20.5	20.5
2000	Anec	0	0	0	0	0	*300 cfs SA*
2001	USFWS	6	0	17	0	10	10
2002	USFWS	31	18.2	43	18.2	25	43.2
2003	Sum	57	72	95	38	55.5	93.5
2004	GIS	30	36	50	19	29.5	48.5
2005[a]	GIS	26	11	63	6	37	43
2006	GIS	15	11	31	6	18	24
2007	ExpAct	21	18	42	9.5	24.5	34
2008[a]	RE	0	0	0	0	0	0
2009	RE	9	0	26	0	15	15
2010	RE	18	17	36	9	21	30

[a] Reporting criteria differed 2005 vs. 2008. [b] Zero values assumed at Isleta, 1996-2001.

Abbreviations:

ABQJ = Albuquerque Journal citations
Anec = Anecdotal Information
ASWIRF = American Southwestern Icthyological Research Foundation
ExpAct = 2007 experimental activities
GIS = Geographic Information System data
RE = RiverEyes
SA = San Acacia
Sum = Summary
USFWS = U.S. Fish & Wildlife Service

Trends in drying related to nearest river gages are still being analyzed. A preliminary observation suggests that whenever gaged flows drop below 150 cfs at both the Bosque Farms and San Acacia gages, downstream drying begins in three to four days. The timing of drying is highly variable, presumably affected by local weather, the degree and nature of the wetted sands, local return flows, the timing and nature of tributary inflows from the Rio Puerco and Rio Salado, and the degree of surface water inundation. As can be seen on Table 4.4, 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 in 2008.

The extreme river drying in 2003 occurred in response to low snowmelt runoff and a poor monsoon that year, in combination with extremely dry antecedent conditions that had already reduced reservoir levels. The Middle Rio Grande Conservancy District storage in El Vado was depleted, and therefore non-Indian irrigators were in run of the river operations from late August through the end of the irrigation season. Consequently, irrigation water released from storage for delivery to downstream irrigation structures was not available to supplement river flow. Due to the extreme hydrologic drought in 2003, over 72% of the Isleta reach and 95% of the San Acacia reach experienced river drying. 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 snowpack was at 20 percent 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 reach. This was the lowest amount since 2001, when flows were maintained at unusually high levels through the release of supplemental water. A succession of higher runoff years followed.

Figure 4.6 summarizes the extent of river drying over the past decade, in terms of the total number of days of drying per year in the Isleta and San Acacia reaches. Drying did not occur in the Cochiti 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.

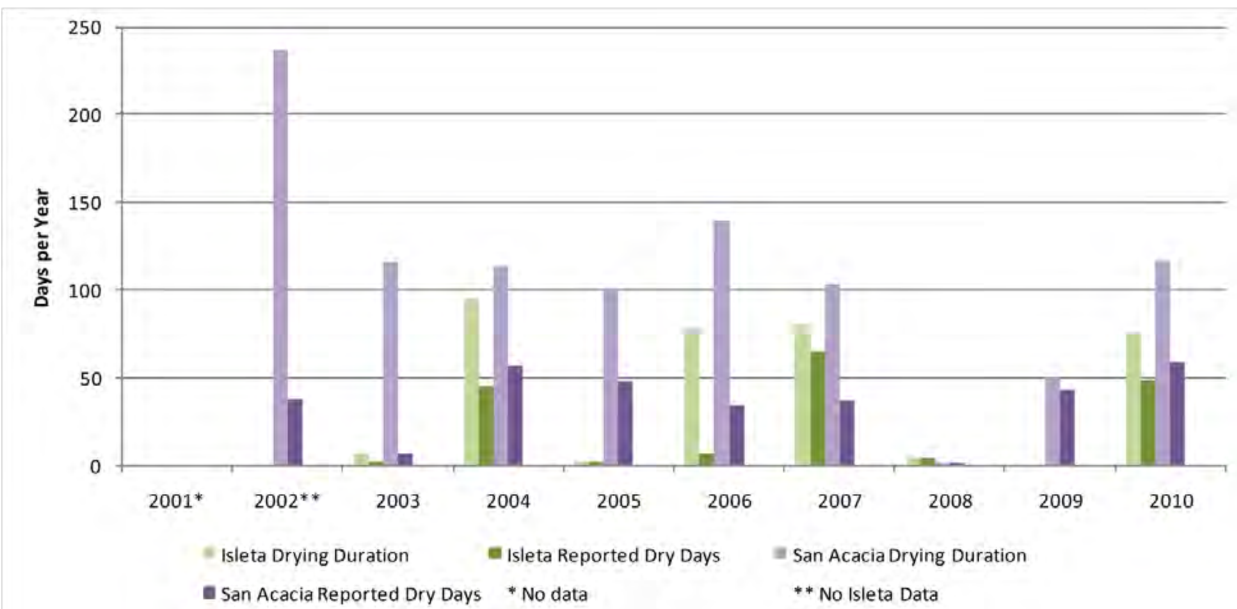


Figure 4.6. Number of days per year of river drying, and maximum number of continuous days of drying, in the Isleta and San Acacia reaches, 2001 to 2010.

Recent Hydrologic Conditions and Water Operations (2001-2010)

Since 2002, tight daily coordination among water managers, biologists, irrigators, and a multi-agency commitment to expedite river maintenance actions that improve water deliveries to Elephant Butte Reservoir helped reduce time spent under Article VII storage restrictions. These collaborative efforts resulted in increased opportunities for storage in El Vado Reservoir as compared to previous drought periods in the 1950s and 1970s. With regard to more recent water operations under the 2003 BO, Dry Year operations were in effect from 2003 through 2007, and in 2010-2012, due to the combination of relatively dry hydrologic conditions and Article VII compact restrictions. In 2008 Wet Year operations were conducted for 2003 BO compliance based on the combination of a hydrologically Wet Year designation and Article VII restrictions lifted as a result of New Mexico credit relinquishments allowing more than 400,000 ac-ft of Rio Grande Project usable storage at Elephant Butte Reservoir. Water management operations since implementation of the Reasonable and Prudent Alternative (RPA) described in the 2003 BO for the years 2003–2011 are described below.

4.4.6 Hydrologic Conditions Since the 2003 BO

The 2003 BO started during an austere hydrologic period that challenged water management. The gaged annual flow record for the Rio Grande at Otowi, New Mexico for 1919 through 2010 is shown in Figure 4.7. In this record, 1934 is the year with the lowest flow, 2002-2003 had the lowest two-year mean flow total, and 2002-2004 had the lowest three-year mean flow total when the San Juan-Chama water is subtracted from the flow at the gage.

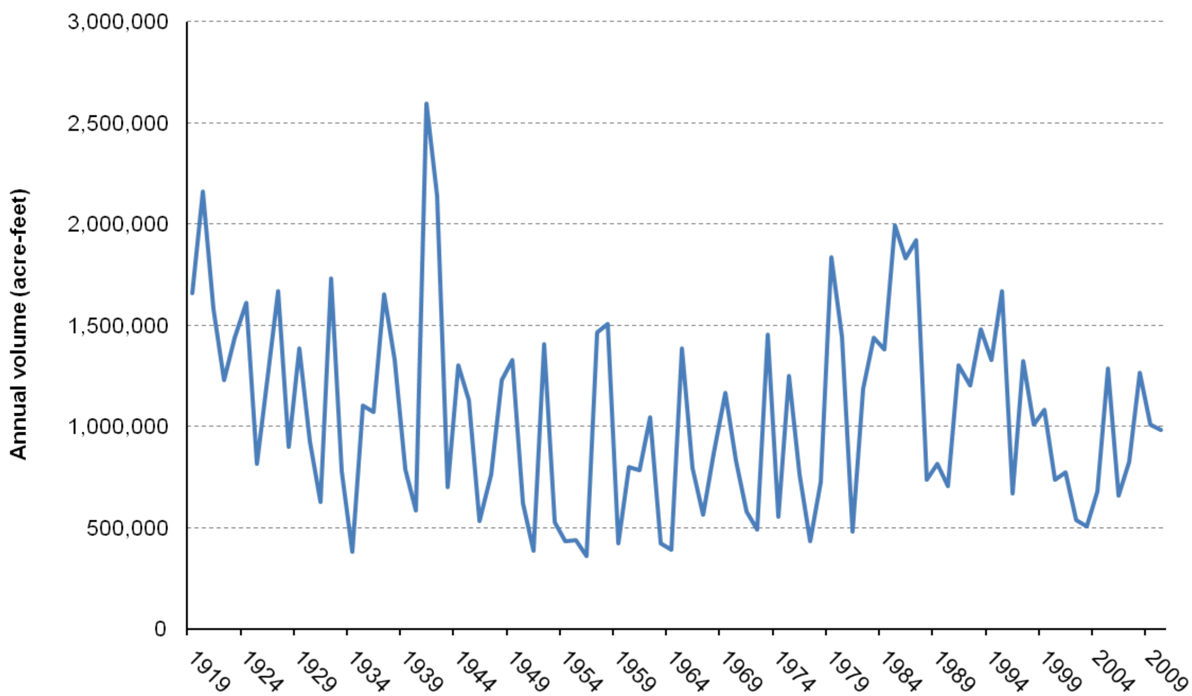


Figure 4.7. Annual flow (acre-feet) of the Rio Grande at Otowi Bridge.

The average flow for this period at the Otowi gage is 1,058,330 ac-ft. The above annual volumes include SJ-C water at the gage (1971-2010). The lowest volumes occurred during drought periods from 1948-1978 and 1996-2004. During these periods, there are a number of years when the annual flow at the gage is less than 500,000 ac-ft, which represents an approximately 50% reduction in the annual flow. This variability is related to irregular episodic dry and wet periods that continue to this day (Waltermeyer 1987; Scurlock 1998; Lewis and Hathaway 2002; USACE *et al.* 2007).

Due to the combination of relatively dry hydrologic conditions and Rio Grande Compact restrictions (Article VIII), the BO-designated Dry Year flow targets were in effect from 2003 through 2007. The highest flow volume of the decade passed the Otowi gage in 2005, but since 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. During both 2011 and 2012, a Dry Year was designated based on both Article VII Compact restrictions, and an extremely low snowmelt-runoff forecast. Spring flow volumes for 2003 were the driest on record, followed closely by the spring conditions recorded in 2006.

4.4.7 Water Operations Since the 2003 BO

Middle Rio Grande Project operations related to 2003 BO compliance involved, in part, the implementation of Emergency Drought Water Agreements (EDWAs) with the State of New Mexico. When New Mexico has a Compact credit surplus, it can request credit relinquishments of accrued credit waters to Texas. A bilateral agreement is needed for relinquishments to be in effect; that is, Texas must accept the water as theirs. In 2003, New Mexico offered to relinquish up to 217,500 ac-ft of accrued credit waters in Elephant Butte Reservoir. In April 2003, New Mexico relinquished 122,500 ac-ft 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 ac-ft, if available. In 2004, Texas accepted an additional 53,000 ac-ft. These agreements allowed Reclamation to store in El Vado Reservoir a maximum of 169,448 of the 175,500 ac-ft 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 ac-ft over the six-year period from 2003-2008. Credit relinquishments for 125,000 ac-ft in 2008 enabled Article VII restrictions to be lifted. Approximately 82,000 ac-ft of water was allocated to Reclamation under the EDWA in 2003; and in 2001, 58,000 ac-ft were allocated under the Conservation Water Agreement for species needs in later years. In 2010 New Mexico again relinquished credit water in the amount of 80,000 ac-ft.

Reclamation also sought to maximize storage for Supplemental Water, whether resulting from EDWA or SJ-C Project water leases. Storage agreements for conservation water storage at Abiquiu Reservoir were secured, should space be available that is not required for SJ-C Project storage by the Albuquerque-Bernalillo County Water Utility Authority (ABCWUA). In 2005 and 2006, 20,000 ac-ft of storage at Abiquiu Reservoir was designated for conservation storage through 2012. A new agreement signed in 2011 identified 10,000 ac-ft of conservation storage space. It is anticipated that as the ABCWUA brings its SJ-C Drinking Water Project online, the amount of potentially available conservation storage space available at Abiquiu Reservoir will increase to about 30,000 ac-ft.

The SJ-C Project operations augment the Rio Grande water supplies through trans-basin diversion of Colorado River water and must be consumptively used in New Mexico. The ten-year average (2001-2010) SJ-C Project diversion of 93,829 ac-ft, which is slightly below the 96,200 ac-ft estimated firm yield for the project. SJ-C Project contractors received full allocations in all six years of 2003 BO compliance operations. Some of these SJ-C Project allocations were leased to Reclamation under the Supplemental Water Program for use in 2003 BO compliance activities. During the ten-year period (2001-2010), an annual average of about 61,500 ac-ft of SJ-C Project water passed the Otowi gage in response to downstream demand by SJ-C Project contractor requests and Reclamation Supplemental Water Program releases. The remainder of SJ-C Project water remains stored in El Vado and Abiquiu reservoirs.

As the ABCWUA, Santa Fe, and other municipalities with planned diversion projects begin using more of their annual SJ-C Project allocations, there will be less water available to Reclamation for lease on behalf of ESA compliance needs. Reclamation's Supplemental Water Program SJ-C Project leases over the ten-year period (2001-2010) averaged approximately 25,000 ac-ft per year.

Drought, as an overriding condition of the last decade in the Southwest, is an important factor in the environmental baseline. However, stream conditions in 2004 and 2005 improved over the previous four years. The United States Geological Survey (USGS) in Albuquerque, New Mexico, reported that stream flow conditions in 2005 were well above average to significantly above average statewide leading to a peak of over 6,000 cfs at Albuquerque and sustained high flows (> 3,000 cfs) for more than two months. These flows improved conditions for both spawning and recruitment. Despite above-average runoff, reservoir levels continue to be below average across the state through the end of 2010.

The 2006 spring runoff was well below average because of lower than normal snowpack. In May 2006, year-to-date precipitation was well below average with the snow pack at 20% of average in the Rio Grande basin. Fortunately, a strong monsoon season led to the wettest period of record in July and August. Consequently, only 26.5 miles of river dried in the summer of 2006 in the Isleta and San Acacia reaches, the lowest amount since 2001.

In spring 2007, the Rio Grande basin snowmelt runoff was expected to be below average. Therefore, the Engineer Advisors to the Rio Grande Compact Commission requested that the Corps deviate from the normal schedule of releases from the Corps reservoirs to facilitate spawning and recruitment flows for the silvery minnow in the Middle Rio Grande during the spring runoff of 2007 (Figure 4.8). The deviation allowed storage of native flows in Cochiti Lake to supplement flows in the main stem of the Rio Grande below Cochiti and Jemez Canyon Dams for the benefit of silvery minnow. As part of the deviation, the Corps could temporarily store up to 10,000 acre-feet of native water in Cochiti Lake. The water was stored when native flows exceeded downstream demands. Storage occurred during the ascending limb of the runoff hydrograph and was released at the peak and descending limb of the hydrograph. The deviation operations produced an extended peak runoff flow with 26 days above 2,500 cfs and 10 days above 3,000 cfs at Albuquerque to cue spawning and inundate nursery habitats, resulting in good silvery minnow recruitment in all reaches. The observed inflow and outflow hydrograph for this time period is shown in Figure 4.8.

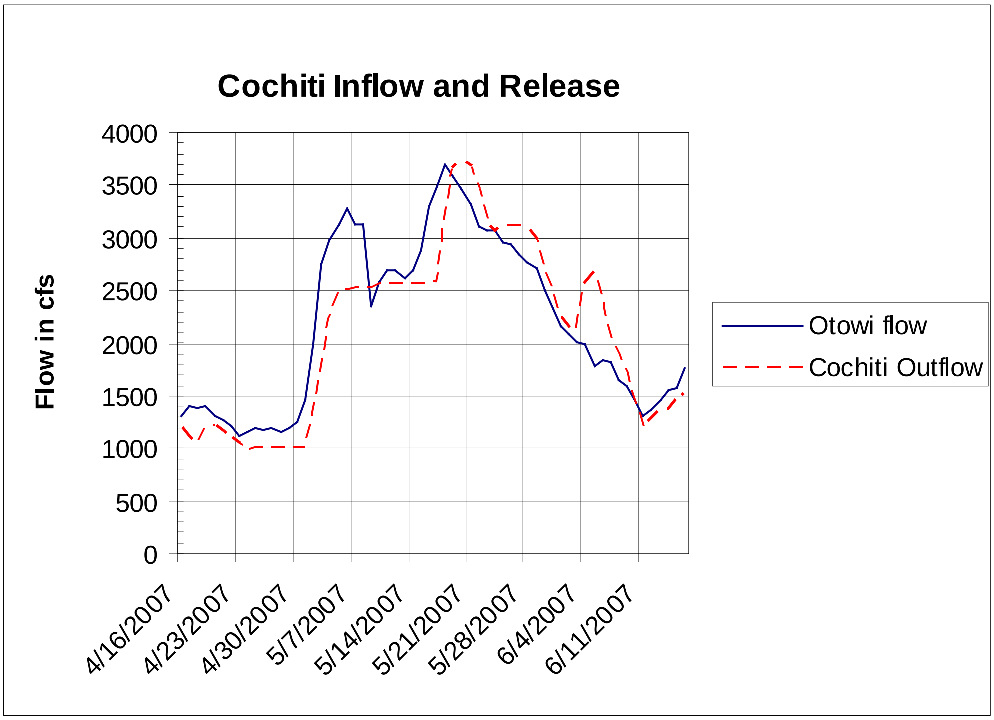


Figure 4.8. Otowi flow (blue) and Cochiti outflow (red) resulting from approved 2007 deviation.

In 2008, with the significantly above average spring runoff in most areas of the Rio Grande, the Corps engaged in external coordination activities with stakeholders up and down the Rio Grande from Alamosa to San Marcial. Excessively high peaks were avoided due to a fairly orderly and normal warming progression in the spring and river stage reductions assisted by careful floodwater storage and release. In passing flood waters, the Abiquiu Reservoir release on May 26 reached 1,800 cfs (channel capacity below the dam). The release rate remained this high from May 26 until mid June. The peak release from Cochiti Lake of 6,200 cfs on June 8 was approximately 200 cfs above the peak inflow measured at the Otowi Bridge gage. The hydrograph provided a spawning/recruitment flow, and some overbanking occurred downstream of Isleta Diversion Dam. The water year was classified as "wet" under the 2003 BO, requiring Reclamation to maintain continuous flow from Cochiti to Elephant Butte. The continuous flow minimized the level of silvery minnow rescue conducted by the Service.

Based on the success of the 2007 deviation, the Corps developed a longer water operations plan in 2009. A five-year, temporary deviation from the normal release schedules for Cochiti Lake and the Jemez Canyon Reservoir was approved, which would facilitate spawning and recruitment flows for the silvery minnow and also to provide overbanking opportunities to benefit habitat for the Southwestern Willow Flycatcher. The decision as to which action (spawning/recruitment or overbanking) to take during the spring runoff in any given year was determined in the spring of that year (primarily based on the March forecast) in coordination with Reclamation and the Service. The action required the concurrence of the Engineer Advisors, the Pueblo de Cochiti, the Pueblo of Santa Ana, and the Rio Grande Compact Commission.

In 2009 the snowpack was average in the upper Rio Grande Basin, the Rio Chama Basin, and the Sangre de Cristo Mountains. In passing floodwaters, the Abiquiu Reservoir release on May 5th reached 1,800 cubic feet per second (cfs), which is the Rio Chama channel capacity downstream of the dam. The release rate remained above 1,800 cfs from May 5 until May 29. The peak release from Cochiti Lake measured 5,649 cfs on May 13, less than the 7,800 cfs maximum release that would result in channel capacity flows of 7,000 cfs at Albuquerque.

In 2010, the Corps initiated action to provide for overbanking flows since the last widespread overbanking event was in 2005. The goal of the overbanking action was to provide a 5,800 cfs flow in the Rio Grande at the Albuquerque gage for five days. However, in the 2010 action, the Corps was only able to achieve 2.5 days at 5,300 cfs at Albuquerque. Although this flow was less than the target flow, large areas were inundated in the Isleta, Los Lunas and San Marcial reaches.

For the 2010 deviation, storage at Cochiti Lake began on April 19, 2010, and reached a maximum storage of approximately 29,000 acre-feet on May 13. Releases began on May 17, reaching a maximum of 6,045 cfs on May 21, 2010. The maximum change in elevation was approximately 17 ft. The 29,000 acre-feet of stored water was evacuated by May 26, 2010. The annual hydrograph of Cochiti Lake inflow and outflow is shown Figure 4.9 below.

A deviation was not executed in 2011 or 2012 due to insufficient runoff volume.

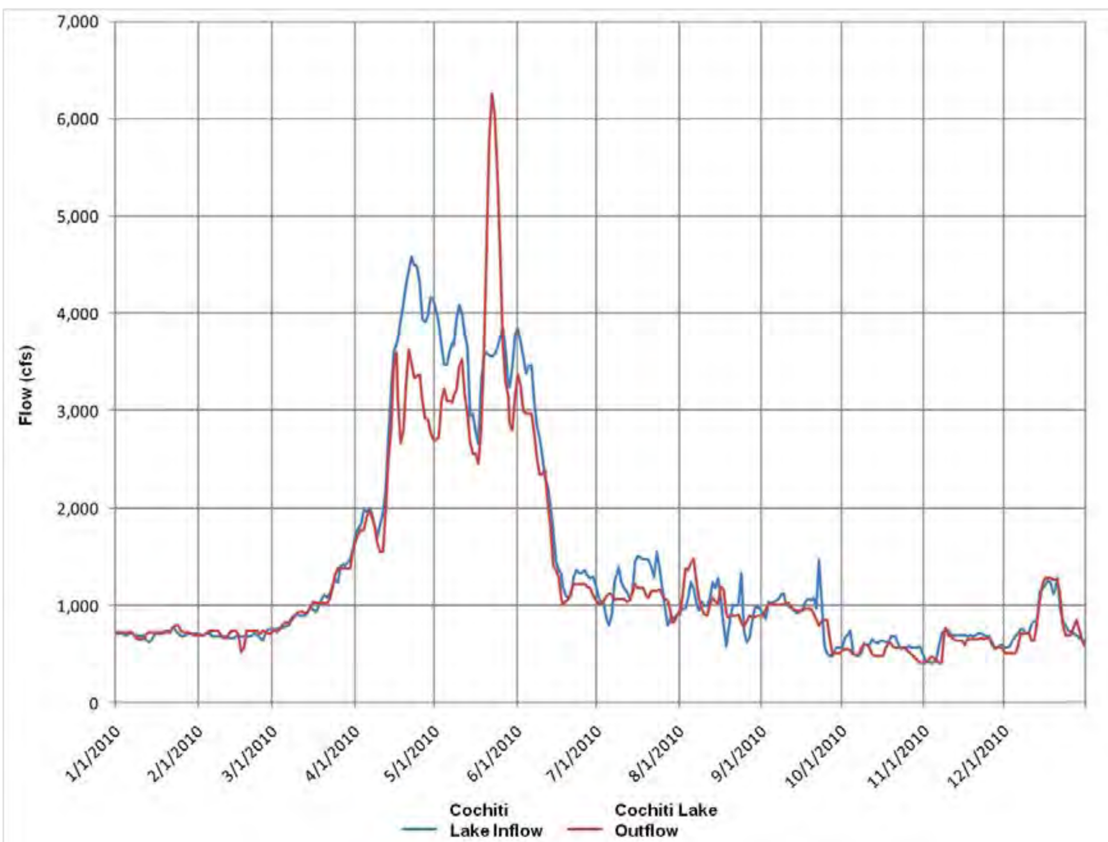


Figure 4.9. Cochiti Lake inflow and outflow resulting from the approved 2010 deviation

5. SPECIES STATUS AND LIFE HISTORY

5.1 RIO GRANDE SILVERY MINNOW

5.1.1 Status and Distribution

Until the late 1950s, the silvery minnow was distributed throughout many of the larger order streams of the Rio Grande basin upstream of Brownsville, Texas to points north in New Mexico (about 2000 miles) primarily below 5,500 ft elevation (1,676 m). This elevation coincides with the approximate vicinities of Abiquiu on the Chama River, Velarde on the Rio Grande, and Santa Rosa on the Pecos River. Today the silvery minnow is restricted to a variably perennial reach of the Rio Grande in New Mexico, from the vicinity of Bernalillo downstream to the head of Elephant Butte Reservoir, a distance that fluctuates as the size of the pool of water in storage in Elephant Butte Reservoir changes, but that approximates 150 river miles (241 km).

Historically, the silvery minnow was distributed throughout the Rio Grande basin over a broad range of environmental parameters (including chemical, physical, hydrological, climatic, and biological attributes) that are typical of the arid southwest. Sublette *et al*. (1990) describe the taxonomic characteristics of the silvery minnow and provides an overview account of the life history and species distribution. Bestgen and Propst (1996) provide a detailed morphomeristic study of the silvery minnow and document the distinctiveness of the species. 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*; NMDGF 1988). On July 20, 1994, the Service published a final rule to list the silvery minnow as an endangered species with proposed critical habitat (USFWS 1994). The Service issued the final rule for silvery minnow Critical Habitat on February 19, 2003 (USFWS 2003a).

The primary constituent elements (PCEs) for silvery minnow critical habitat include: (i) a hydrologic regime capable of forming and maintaining a diversity of aquatic habitats, including backwaters, shallow side channels, pools, eddies, and runs to support all silvery minnow life-history stages; (ii) the presence of eddies created by debris piles, pools, backwaters, or other refuge habitat within reaches of sufficient length to provide a variety of habitats with a wide range of depth and velocities; (iii) substrates of predominantly sand or silt; (iv) water temperatures that vary on a daily, seasonal and annual basis, and that annually range no lower than 1°C and no greater than 30°C; and (v) water with reduced degraded conditions, such as decreased dissolved oxygen and increased pH.

Designated critical habitat for the middle Rio Grande extends through Sandoval, Bernalillo, Valencia, and Socorro Counties, New Mexico from Cochiti Lake downstream to the utility line crossing the Rio Grande at the upstream end of the Elephant Butte Reservoir. The designation excludes the lands of Santo Domingo, Santa Ana, Sandia, and Isleta Pueblos. The Service considered the Lower Rio Grande around Big Bend National Park, and the Pecos River between Ft. Sumner Dam and Brantley Reservoir for critical habitat but elected not to so designate these areas even though they are essential to silvery minnow conservation (*e.g.*, possible re-introduction). For all of these reaches, the lateral extent of critical habitat includes those areas bounded by existing levees, or spoil banks. In areas without levees or spoil banks, the lateral extent of critical habitat is defined as 300 feet (91.4 m) of riparian zone adjacent to each side of the river.

Population monitoring for silvery minnows has been conducted at twenty sites between Angostura Diversion Dam and the Elephant Butte Reservoir pool since 1993 (Dudley and Platania 2008). Population monitoring provides information for the October population index (Figure 5.1), and yields trends in recruitment and population centers. The October population index has rebounded starting in 2004 with spring runoff flows greater than 2000 cfs (Dudley and Platania 2007a), indicating the importance of overbanking floods in creating suitable habitat for population recruitment.

5.1.2 Life History and Ecology

Rio Grande Silvery Minnow Habitat

Floodplain habitat appears important for supporting silvery minnow recruitment (Porter and Massong 2004a, b; Fluder *et al* 2007; SWCA 2008; Hatch and Gonzales 2008a, b), and habitat fragmentation is likely a major mechanism for extirpation of the silvery minnow from most of its range (Dudley and Platania 2007b). Silvery minnow habitat is typically described as shallow (0.7- 2.6 ft) water bodies with fine grained substrate (silt, sand) and slow water velocities (<1 ft/sec) (USFWS 2010). Silvery minnows are most commonly collected in shallow water (<1.3 ft) with low water velocities (<0.32 ft/sec), primarily over silt and sand substrate (Dudley and Platania 1997). Silvery minnows are capable of moving through narrower incised channels with faster water velocities by remaining in the boundary layer adjacent to the bank to avoid the main current (Porter and Massong 2004c). Surveys in 1977-1978 collected large numbers of silvery minnows in adjacent aquatic habitats connected to the Rio Grande main channel (Painter unpublished data), such as the Albuquerque Oxbow, Elephant Butte Marsh (headwaters), the (Low Flow) Conveyance Channel, and various irrigation drains and canals.

The Rio Grande and Pecos River have been fragmented by dams and reservoirs, resulting in a total of 82 disconnected sub-reaches (Dudley and Platania 2007c). Barriers restricting upstream fish movement between sub-reaches reduce the ability of fish species to re-colonize upstream sub-reaches following downstream movement. While large dams and reservoirs prevent dispersal of fish upstream and downstream, smaller diversion dams may allow limited movement of some fish. The diversion dams on the Middle Rio Grande were designed to pass sediment, allowing passage of fish in both directions during the winter when no irrigation was occurring. Silvery minnow populations (Figure 5.1) also persist in shorter reaches that are unsuitable for other pelagic spawning fishes with semi-buoyant eggs (Dudley and Platania 2007b; Hoagstrom *et al*. 2008). The role of silvery minnow dispersal and habitat connectivity within reaches may benefit from additional research (Rodriguez 2010). Less than 2% of tagged silvery minnows released downstream of the Albuquerque–Bernalillo County Water Utility Authority (ABCWUA) drinking water diversion dam were detected moving upstream through the fish passage channel (Archdeacon and Remshardt 2012).

In addition to forming barriers to silvery minnow movement, large reservoirs trap sediment, resulting in channel incision extending downstream from the dam. The extent of downstream incision is a function of scouring flows, time and sediment contribution from downstream tributaries (Massong *et al*. 2006; Schmidt *et al*. 2003). Channel incision increases the depth of turbid water, reducing primary productivity within the river (Joel Lusk, USFWS, *pers. comm.*). Channel incision also reduces annual connectivity to floodplain and riparian areas for many fish species (Coutant 2004). The loss of inundated riparian habitat for nursery areas limits recruitment by fish species with life histories that are dependent on this habitat. The correlation of October catch rates with spring flow above 2,000 cfs ($r^2 = 0.83\text{-}0.91$) supports recruitment as a function of inundated habitat for the silvery minnow (Dudley and Platania 2007a). Loss of riparian connectivity within the Rio Grande flood plain has decreased the amount of critical habitat for the silvery minnow.

The USGS modeled silvery minnow habitat availability as a function of instream flow in the lower Isleta Reach between the Rio Puerco confluence and San Acacia Diversion Dam (Bovee *et al*. 2008). The study focused on hydraulic and structural habitat for juveniles (young-of-the-year, YOY) and adults at the lower range of flows typical of dry and normal summers in this reach of the river. The maximum area of suitable hydraulic habitat for adults was at flow between 40 to 80 cfs. The area of suitable adult habitat declined rapidly as flow increased above 150 cfs, shifting the preferred shallow, low velocity habitat to the margins of the river.

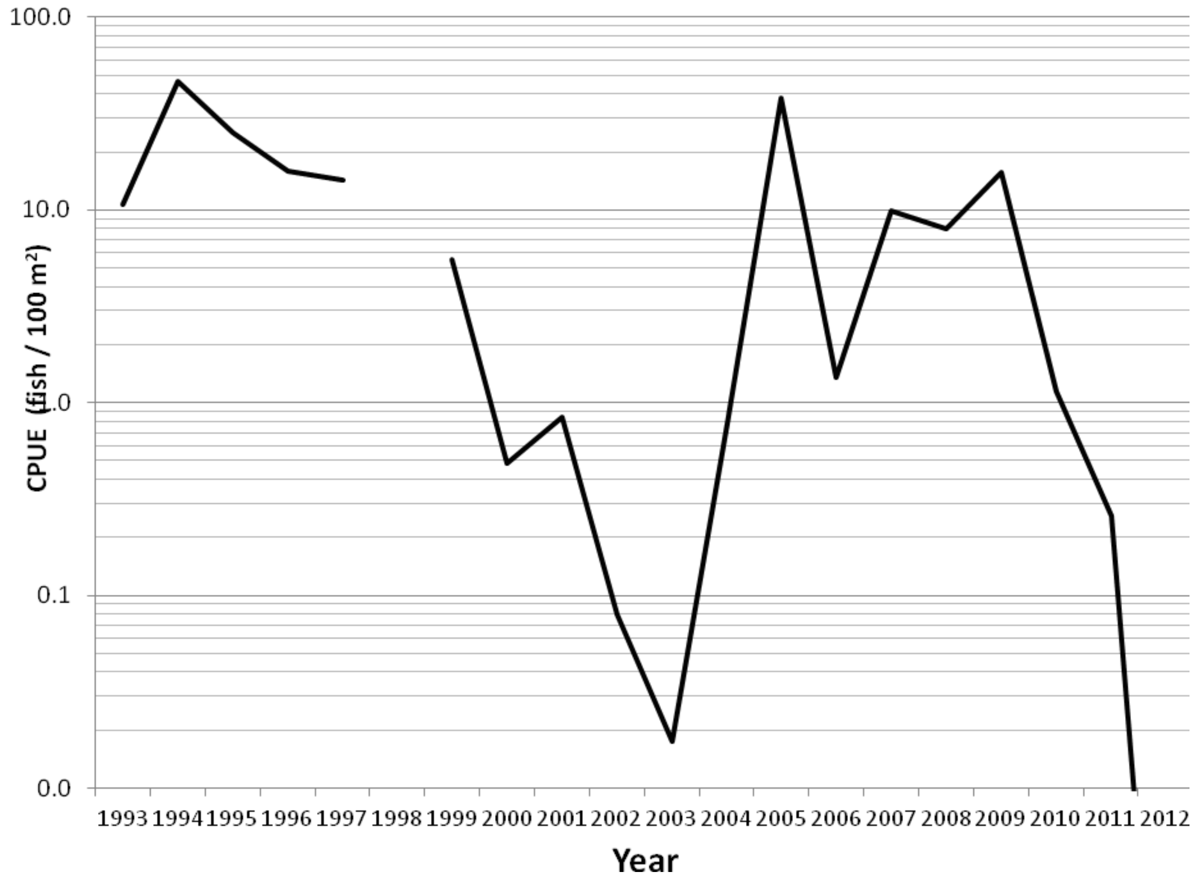


Figure 5.1. Average estimated October density (catch per unit effort [CPUE]) of Rio Grande silvery minnow for the period 1993-2012.

The MRGCD irrigation system may provide habitat for silvery minnows, particularly as refugia during river drying, with fish returning to the river as flow increases (Cowley *et al*. 2007). Because of this, declines in the occurrence of silvery minnows in the irrigation system since the 1970s (Painter unpublished data; Lang and Altenbach 1994) indicate the need for more information about how irrigation practices affect minnow survivorship in the ditches. Cowley *et al*. (2007) suggests several concepts for managing the irrigation system to enhance habitat values for native fish species.

Evolutionarily, the silvery minnow appears to be a physiological generalist with specific habitat requirements for completion of its life cycle to support recruitment, persistence and abundance of the species. Silvery minnow primarily consume diatoms, cyanobacteria, and green algae associated with sand or silt substrates in shallow areas of the river channel (Shirey *et al.* 2008; Propst 1995; USFWS 1999). Dudley and Platania (1997) studied habitat preferences of the silvery minnow in the Middle Rio Grande at Rio Rancho and Socorro. They characterize habitat preference and habitat availability in terms of water depth, water velocity and stream substrate. Both juvenile and adult silvery minnows primarily use mesohabitats with moderate depths 0.5-1.3 ft (15-40 cm), low water velocities 0.13-0.30 ft/sec (4-9 cm/sec), and silt/sand substrates. Avoidance of swift water velocities by the silvery minnow is one means of conserving energy, a general life strategy shared by many lotic fish species (Facey and Grossman 1992). Young-of-year (YOY) silvery minnows are generally captured in shallower and lower velocity habitats than adult individuals. Silvery minnows used low velocity habitat with instream debris (cover) more frequently during winter months (Dudley and Platania 1996). At near-freezing water temperatures, silvery minnow become less active and seek habitats with cover such as debris piles and low water velocities.

Rio Grande Silvery Minnow Spawning and Recruitment

Age and body length analyses by Cowley *et al*. (2006) indicate silvery minnows had a maximum longevity of 4-6 years in the late 1800s. Data from minnow rescue in 2006 (USFWS 2007) indicates five possible classes (Age 0-4) based on standard length size distribution. More recent age-at-length studies using silvery minnow scales and otoliths show four age classes (Age 0-3) (S. Horwitz *et al*. 2011). The majority of spawning individuals are Age 1 fish (1-year old) with older, larger fish (Age 2+) constituting less than 10% of the spawning population (Platania and Altenbach 1996). Reproductively mature females are typically larger than males. Each female may produce 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). Few adult silvery minnows are captured by late summer, suggesting that spawning adults may either experience high post-spawning mortality or reduced catchability.

Silvery minnows spawn from late April through June over a relatively narrow range of water temperatures between 68-77ºF (20-25ºC; Platania and Dudley 1999, 2001). Peak egg production occurs in mid- to late May and generally coincides with high spring discharge produced by snowmelt. Silvery minnows produce numerous semi-buoyant, non-adhesive eggs typical of the genus *Hybognathus* (Platania and Altenbach 1998). The specific gravity of silvery minnow eggs ranges from 1.012-1.00281 as a function of time post-fertilization (Cowley *et al* 2005b). Eggs produced by related species, such as *H. regius* (Raney 1939) and *H. hankinsoni* (Copes 1975), are non-adhesive and considered demersal. More data on the specific gravity of related species of *Hybognathus* may provide useful insights for understanding spawning behavior and site selection among silvery minnow species. Egg hatching time is temperature-dependent, occurring in 24-48 hours at water temperatures of 68-86ºF (20-30ºC; Platania 2000). Recently hatched silvery minnow larvae are about 3.7 mm in length. Environmental variables, such as photoperiod, degree days (average water temperature *x* number of days), and water turbidity, influence silvery minnow spawning. Additional research should improve our understanding of environmental factors on the timing and duration of silvery minnow spawning.

The summer catch rates (July catch per unit effort [CPUE]) are correlated with spring flow (mean cfs from April 15 to June 15, adjusted $r^2 = 0.7588\text{-}0.7763$) and overbank area (inundated acres adjusted $r^2 = 0.7594\text{-}0.835$), supporting recruitment as a function of spring flow (Figure 5.2) and inundated habitat (Figure 5.3) (Dan Goodman, *pers. comm.*; Dudley and Platania 2007a). Nursery habitat consists of shallow inundated surfaces with low water velocities where eggs hatch without downstream displacement, and larval fish can readily find food (Pease *et al*. 2006; Porter and Dean 2007). Shallow water areas provide the productive habitats required by larval fishes to successfully complete their early life history (Dudley and Platania 2007a; Turner *et al*. 2010). Creating additional shallow water habitats in the Middle Rio Grande is an objective of temporary deviations of flow from Cochiti and Jemez Canyon Dams (USACE 2009; Grand *et al*. 2006).

Platania and Altenbach (1998) discussed the difficulty for explaining the persistence of the silvery minnow in the Rio Grande while other minnow species with semi-buoyant eggs were extirpated from the system. Dudley and Platania (2007b) observed that many silvery minnow eggs incubate as they drift downstream through channelized reaches and they suggest that adult silvery minnows migrate upstream to complete their life cycle.

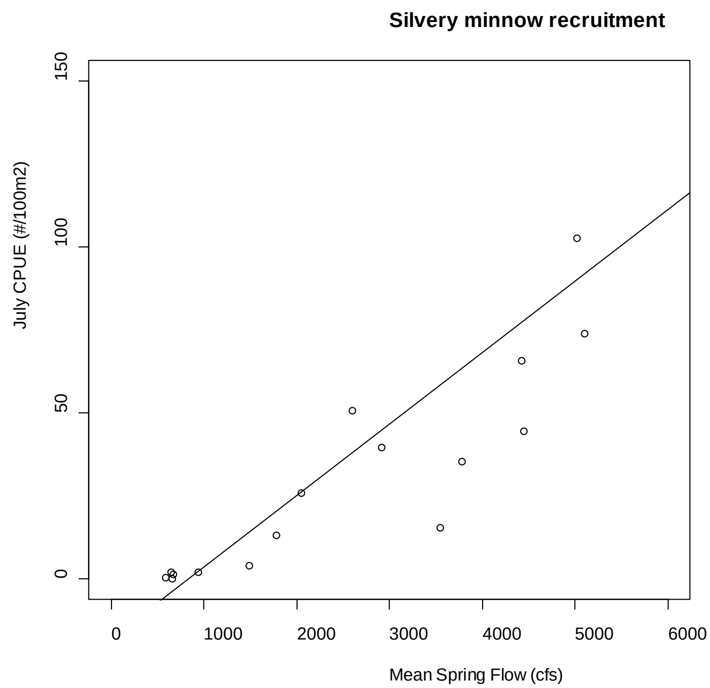


Figure 5.2. Relationship of Rio Grande silvery minnow July catch per unit effort (CPUE) as a function of spring runoff between 1993-2010 (r^2 = 0.7588-0.7763 based on different linear models).

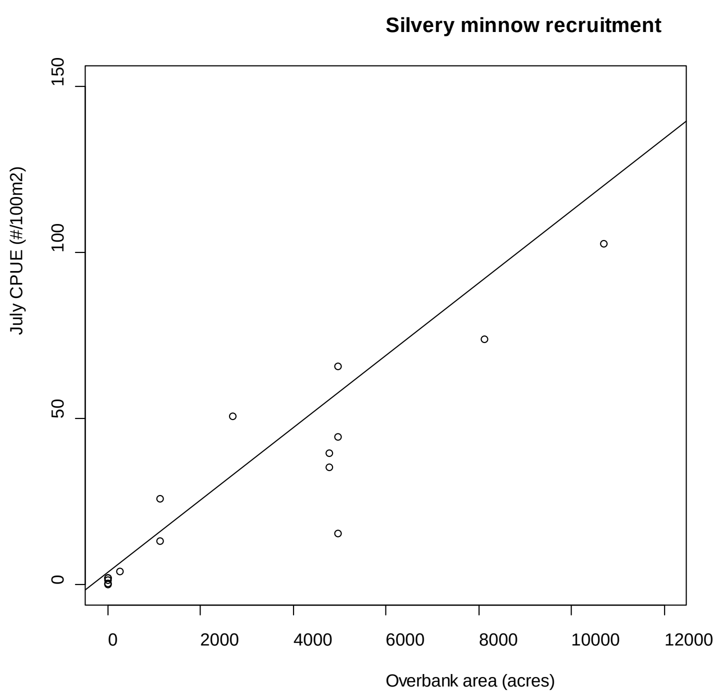


Figure 5.3. Relationship of Rio Grande silvery minnow July catch per unit effort (CPUE) as a function of inundated area during spring runoff between 1993-2010 (r^2 = 0.7594-0.835 based on different linear models).

Egg retention from the current into inundated riparian zones favorable for larval fishes provides a mechanism for silvery minnow recruitment in the Middle Rio Grande (Widmer *et al* 2007, 2010). Egg retention is consistent with the interactions of channel incision and hydrology leading to egg drift, declining recruitment and populations (Dudley and Platania 2007a, 2007b; Porter and Massong 2004b, 2005; Widmer *et al* 2007, 2010). Larval silvery minnows have been associated with low water velocity habitat including inlets, shelves, and side channels (Pease *et al*. 2006; Turner *et al*. 2010). Higher silvery minnow densities, measured as catch per unit effort (CPUE), appear to be spatially associated with reaches with higher egg retention (Widmer *et al*. 2007).

Rio Grande silvery minnow spawning is closely tied to the annual spring flood. During the ascending limb of the hydrograph, silvery minnows appear to move into flooded riparian areas and backwaters to spawn. Habitat monitoring has documented silvery minnow adults (Hatch and Gonzales 2008a, b; SWCA 2008), and eggs (SWCA 2008) on constructed nursery habitat sites. Similar habitat use by silvery minnows, razorback suckers (*Xyrauchen texanus;* Valdez and Wick 1983; Tyus 1987; Tyus and Karp 1990; Modde and Wick 1997; Modde and Irving 1998), and Colorado pikeminnow (*Ptychcocheilus lucius*, Grand *et al*. 2006) suggests that nursery habitat is important for population management (USFWS 2007b).

There has been annual monitoring of silvery minnow egg drift (Table 5.1) since 2002 (Platania and Dudley 2002, 2003, 2004, 2005, 2008, 2009, 2010, 2011) to evaluate recovery goals. These samples provide information on the magnitude of reproduction carried downstream of nursery habitat in the channelized San Marcial reach (at River-mile [RM] 58.8). The duration of high flows during the April-June spawning season were positively correlated with silvery minnow mean October densities, while extended low-flow periods were negatively correlated with silvery minnow mean October densities (Dudley and Platania 2008). Elevated flows in 7 of the past 10 years (2001-2010) have contributed to silvery minnow recruitment compared with the 2002-2003, 2006 year-classes (Dudley *et al*. 2008; Dudley and Platania 2010).

Table 5.1. Results of monitoring for silvery minnow eggs at irrigation diversion structures. (Total egg numbers are presented; see the referenced reports for sampling protocols and effort.)

Date	Albuquerque Main	Peralta Main	Belen Highline	Socorro Main	Totals	San Marcial[d]
2002 [b]	0	729	826	28	1,583	92,000
2003 [a,b]	3	26	48	-	77	13,292
2004 [a,b]	0	3	3	-	6	5
2005 [a,b]	1	1	3	-	4	-
2006 [a,b]	0	1	8	8	17	7,900
2007 [a,b]	0	49	43	2	94	10,995
2008 [a,c]	0	1	0	9	10	155
2009 [a,c]	0	12	3	29	44	645
2010 [a,c]	-	11	1	0	12	364
2011 [a,c]	-	8	4	13	25	96,266
2012 [a,c]	-	3	82	0	85	12,398

[a] Diversions managed to minimize entrainment of silvery minnow eggs.

[b] Porter and Dean 2007.

[c] Data provided to Reclamation by the Service. Monitoring for the Albuquerque Main was discontinued after 2009.

[d] Estimated egg numbers collected, from Platania and Dudley (2002 through 2012).

Minimal egg drift during a typical spring runoff is illustrated by egg drift studies and reduced entrainment at diversion facilities (Reclamation 2003). Reclamation has contracted egg entrainment monitoring from 2002 through 2011 (Table 5.1) as part of RPA elements in the BO (USFWS 2001, 2003b). After 2002, MRGCD has managed diversions to minimize entrainment during peak egg drift. Higher spring flows since 2003 have inundated riparian areas, providing nursery habitat for spawning and rearing. The availability of nursery habitat probably reduces entrainment of silvery minnow eggs into the current, reducing the number of eggs drifting downstream.

Rio Grande Silvery Minnow Population Trends 1994-2010

Long-term monitoring of fish populations is fundamental for evaluating how management affects riverine fish communities and silvery minnow populations. Fish community surveys have been conducted since 1993 (with the exception of 1998) in the Rio Grande of New Mexico between Angostura Diversion Dam (RM 209.7) and Elephant Butte Reservoir (RM 58.8). Survey methodology consists of single-pass seine samples (Dudley *et al*. 2008) with results reported as count data, such as catch per unit effort (CPUE) or catch per area sampled. Although the statistical properties of these indices (*e.g.*, measures of bias, capture or detection probabilities, and variance) are unknown, these surveys document silvery minnow density (fish per 100 m^2) variability over time and space.

The 2001 and 2003 Biological Opinions (USFWS 2001, 2003b) included several Reasonable and Prudent Alternative elements for maintaining minimal wetted silvery minnow habitat in the Angostura, Isleta, and San Acacia reaches. It also provided for a one-time increase in flows (spawning spike) between April 15 and June 15 of each year to cue spawning if needed (USFWS 2001, 2003b). This action has been transformed into recruitment flows based on the predictions of nursery habitat and silvery minnow population trends following riparian habitat inundation from 2004-2008 (USACE 2007, 2008a). Though recruitment was highly variable both annually and longitudinally, the 2007 fish community monitoring results show June-July YOY recruitment throughout all three reaches.

Over the period 1993-2010, October counts were conducted in the Angostura, Isleta, and San Acacia reaches. The data show that the density of silvery minnows was generally lower (CPUE $< 35 / 100\ m^2$) for the October surveys (1993-2010) in the Angostura Reach (Figure 5.1). The density of silvery minnows (CPUE $< 0.1 – 118 / 100\ m^2$) during October has a broader range in the Isleta Reach (Figure 5.1). Silvery minnow fall abundance (CPUE $< 0.1 – 207 / 100\ m^2$) has fluctuated the greatest in the San Acacia Reach (Figure 5.1).

5.1.3 Reasons for Rio Grande Silvery Minnow Decline

Understanding the effects of habitat degradation, connectivity and fragmentation on different fish species' life history patterns provides clues for analyzing future actions (Koster 1955). The range of the Rio Grande silvery minnow has contracted significantly since the 1950s. The Service's proposal (USFWS 1993) to list the silvery minnow as an endangered species discusses many factors that have led to the decline of the species. The silvery minnow has several common factors for extinction-prone species including specialized habitat requirements, restricted geographic distribution with limited opportunities for dispersal, and small but demographically-variable populations (Brown and Lomolino 1998).

Habitat Modification

Factors currently affecting silvery minnow habitat include loss of habitat due to: water impoundment; channel drying; channel straightening and other geomorphic channel alterations; and water pollution (USFWS 1994; Schmidt *et al* 2003; USFWS 2007b). Impoundment of water in the Rio Grande by main

stem dams has affected the flow regime of the river, fragmented habitat, and resulted in geomorphological changes to the channel (USFWS 1994; USFWS 2007b). Habitat fragmentation and degradation (resulting from dams) may be a factor in the decline of the silvery minnow, including the sequential decline and loss of fish from upstream to downstream (Platania and Altenbach 1998; Porter and Massong 2004).
The conversion of riverine habitat into reservoirs creates barriers to silvery minnow movement. Silvery minnows are generally obligate riverine species that have not been documented using limnetic habitat. The unsuitability of reservoir habitat creates barriers to silvery minnow dispersal and does not provide refugial habitat for maintaining populations.

Flows in the Middle Rio Grande are extreme and highly erratic, including episodic flooding and, at times, intermittence (USACE 2007, 2009). Reservoir operations may reduce the size of the flood peaks, extend or decrease the duration of the snowmelt runoff (depending on the size of the runoff), and increase the volume of water entering the middle Rio Grande valley during normal low flow periods (USFWS 1994; USFWS 2007b). Managed flow regimes can alter silvery minnow habitat by reducing the frequency and magnitude of overbank flooding, trapping nutrients, altering sediment transport regimes, prolonging summer base flows, and creating reservoirs that favor non-native fish species. The changes in hydrology may reduce silvery minnow food supplies, alter its habitat, prevent dispersal, and provide non-native fish with a competitive advantage.

River engineering projects have variable effects on silvery minnow habitat quality and area depending on how they are implemented. Traditional river engineering activities have confined the Rio Grande to a narrower channel and reduced the connectivity with adjacent riparian habitat. Channels have been straightened and deepened, and aquatic plants and snags have been removed to lessen hydraulic resistance. Sediment retention by upstream reservoirs results in channel incision, reducing surface water inundation. Conventional river engineering projects typically increase water velocity by reducing surface area and the physical complexity of aquatic habitat.

Channelization of the middle Rio Grande has resulted from the placement of Kellner jetty jacks along the river to protect levees by retarding flood flows, trapping sediment, and promoting vegetation (USFWS 1994, 2007b). Meanders, oxbows, and other components of silvery minnow habitat have been eliminated in order to pass water as efficiently as possible for agricultural irrigation and downstream deliveries. The loss of low-velocity nursery habitat (inundated riparian vegetation, backwaters, etc) has likely reduced silvery minnow larval and juvenile recruitment.

River Diversions and Dewatering

Dewatering (channel drying) is caused primarily by agricultural water diversion and by climatic drought. These actions result in a fragmented range with reduced habitat area and connectivity (USFWS 1994, 2007b). The impacts of water diversion may not be severe in years when an average or above average amount of water is available (USFWS 1994, 2007b). In years of below-average water availability river channel drying may be extensive from Isleta Diversion Dam downstream to Elephant Butte Reservoir (111 mi). Approximately 90 miles of the Rio Grande have a net loss of water as it flows downstream.

Dewatering is implicated in many studies of silvery minnow range contraction from its historic extent. For example, Trevino-Robinson (1959) documented the early 1950s "cosmopolitan" occurrence of silvery minnows in the Rio Grande downstream of its confluence with the Pecos River where, for "the first time in recorded history," a portion of this reach of river went dry in 1953. Although Trevino-Robinson (1959) could not document any "apparent undesirable or severe after effects" from the drought, silvery minnows have not been documented from this lower portion of the Rio Grande since the mid-1950s (in part, USFWS 1999). Edwards and Contreras-Balderas (1991) confirm the absence of the silvery minnow from the Rio Grande below Falcon Dam, which is downstream of the Pecos confluence at Amistad Lake.

Drought leading to channel drying has also been implicated in the extirpation of the silvery minnow from upstream reaches of the Rio Grande. Hubbs *et al*. (1977) documented the "inexplicable" absence of silvery minnow from the Rio Grande in Texas between El Paso and its confluence with the Pecos River where Hubbs (1958) had earlier documented the species to occur. However, Chernoff *et al*. (1982) noted that much of this stretch, particularly the Rio Grande between El Paso and the mouth of the Rio Conchos, is at times dry. Sublette *et al*. (1990) documented the former occurrence of the silvery minnow in the Rio Grande from Caballo Reservoir, NM downstream to El Paso, TX, another stretch that is now often dry and from which the silvery minnow has been extirpated. Thus, between 1950 and 1991, the Rio Grande silvery minnow was extirpated from that portion of its historic range lying downstream of Caballo Reservoir to the Gulf of Mexico.

Observations suggest that during periods of such extreme water scarcity, the silvery minnow seeks out cooler pool habitats associated with overhead cover, irrigation return flow, and shallow groundwater (USFWS 1994, 2007b). During periods of no flow, the silvery minnow is thought to have survived in the irrigation ditches and drains, the reaches above the diversions, and in channels maintained by irrigation return flows or leakage from the diversion dams. River drying increases silvery minnow mortality rates due both to decreasing water quality in temporary pools and the eventual disappearance of such pools as water seeps into the substrate.

It has been proposed that the entrainment of silvery minnows (primarily eggs and larvae) in the infrastructure of irrigation systems that derive water directly from the Rio Grande could be a factor contributing to the decline of the species (*e.g.*, USFWS 1999). Egg entrainment in irrigation canals has been monitored since 2001 (*e.g.*, Reclamation 2003). These studies show that recent management actions have minimized egg entrapment in irrigation infrastructure.

Water Quality for Rio Grande Silvery Minnow Habitat

Water quality in the Middle Rio Grande varies spatially and temporally throughout its course primarily due to inflows of groundwater, as well as surface water discharges and tributary delivery to the river. Factors that are known to cause poor fish habitat include temperature changes, sedimentation, runoff, erosion, organic loading, reduced oxygen content, pesticides, and an array of other toxic and hazardous substances. Both point source pollution (*e.g.*, pollution discharges from a pipe) and non-point source pollution (i.e., diffuse sources) affect Rio Grande water quality.

Changes in water quality from increasing agriculture and urbanization along the Rio Grande during the last century have been suggested as a factor in declining silvery minnow populations (USFWS 1999). A screening level risk assessment based on two Middle Rio Grande datasets suggests that while there may be locally poor water quality, the analysis does not indicate that human activities have adversely impacted silvery minnow populations (Marcus *et al*. 2010). Though there are many natural and anthropogenic factors that affect water quality in the Middle Rio Grande, a 2006-2008 water quality study (NMED 2009) concluded, "while water chemistry may be a contributing factor, it is not likely to be the most critical issue affecting the RGSM especially compared to a lack/timing of adequate flows to maintain the needed habitat." Further downstream the International Boundary and Water Commission (IBWC 2003) and the Texas Natural Resources Conservation Commission (TNRCC 1994) have documented water quality impairment from toxic chemicals at sites along the international border.

The expansion of cities and agriculture along the Middle Rio Grande may have adverse effects on river water quality (USFWS 1994, 2007b). During low flow periods, the increased proportion of municipal and agricultural discharge to native flow may allow pollutants to significantly degrade water quality. Agricultural water use appears to reduce nutrient availability in return flows to the river (Van Horn and

Dahm 2008). Recent water-quality data have not identified limiting factors for silvery minnows or habitat (NMED 2001, 2009; USFWS 2004b; Marcus *et al*. 2005).

Major point sources include wastewater treatment plants and dairy cattle feedlots. USEPA conducted endocrine disruption testing of wastewater treatment plant effluents from Rio Rancho, Bernalillo, Albuquerque, Bosque Farms, Los Lunas, Belen, and Socorro in 2007 (NMED 2009). Effluent from Los Lunas and Socorro during the summer (low flow volumes) could make endocrine disruption a seasonal water quality concern for silvery minnow in the Isleta and San Acacia reaches respectively. In 1999, water quality in the Angostura reach (RM 203.3 - 178) was found to not be adversely affecting aquatic life (NMED 2001, 2009). Nitrogen and phosphorous concentrations were less than 2 mg/L, with increasing specific conductance (calcium bicarbonate) in the downstream direction (Langman and Nolan 2005). Diatom species from the late 1800s are indicators of high nutrient loads in the Rio Grande (Shirey *et al*. 2008). Though wastewater treatment plants are a major nutrient source (Van Horn and Dahm 2008), it appears that there is significant removal of nutrients (nitrate and phosphate) from water diverted for irrigation (Peterson *et al*. 2001). These observations are consistent with the low overall gross primary productivity in the Rio Grande (USFWS 2004b). There have been no longitudinal studies bracketing wastewater treatment plants to examine the aquatic primary productivity and fish community response to the effluent (*e.g.* Lewis *et al*. 1981).

Potential major non-point sources include agricultural activities (*e.g.*, fertilizer and pesticide application, livestock grazing), urban stormwater run-off, and mining activities (Ellis *et al*. 1993). Large precipitation events wash sediment and pollutants into the river from surrounding lands through storm drains and intermittent tributaries. Contaminants of concern to the silvery minnow that are frequently found in stormwater include the metals aluminum, cadmium, lead, mercury, and zinc; organics such as petroleum products; the industrial solvents trichloroethene and tetracholoroethene (TCE); and the gasoline additive methyl tert-butyl ether (USGS 2001). However, chronic aluminum and *E. coli* are the only water quality impairments in the Middle Rio Grande identified by recent studies (NMED 2009).

Pesticide contamination may originate from agricultural, residential and commercial landscaping activities. Nine pesticides were identified as constituents of concern (Tier II risk) in the Middle Rio Grande (Marcus *et al*. 2010). The presence of pesticides in surface water depends on the amount applied, timing, location, and method of application. Water quality standards have not been set for many pesticides, and existing standards do not consider cumulative effects of several pesticides in the water at the same time. Pesticide degradation products have been detected in whole body fish collected throughout the Rio Grande (Roy *et al*. 1992).

Semi-volatile organic compounds including polycyclic aromatic hydrocarbons, phenols, and phthalate esters, were analyzed in sediment collected by the USGS (Levings *et al*. 1998). The analysis of the polycyclic aromatic hydrocarbon data by Levings *et al*. (1998) shows that one or more polycyclic aromatic hydrocarbon compounds were detected at 14 sites along the Rio Grande, with the highest concentrations found below Albuquerque and Santa Fe. More recent studies reported the absence of detectable organic chemicals (despite urbanization) in the Middle Rio Grande (NMED 2009). These compounds likely result from past water-quality or stormwater-runoff events, and may pose a greater risk to aquatic life when attached to the sediment than as waterborne compounds (Marcus *et al*. 2010).

Sediment-borne contaminants may be ingested by the silvery minnow as they graze on benthic algae in the Middle Rio Grande (Marcus *et al*. 2010). Sediment is the sand, silt, organic matter, and clay portion of the river bed, or the same material suspended in the water column. Ong *et al*. (1991) recorded the concentrations of trace elements and organochlorine pesticides in suspended sediment and bed sediment samples collected from the Middle Rio Grande between 1978 and 1988. Available water quality data do not support a conclusion that sediment toxicity has produced population-level impacts to silvery minnows in the MRG (Marcus *et al*. 2010).

Rio Grande Silvery Minnow Population Genetics

While population size (N) is an important variable for endangered species survivorship, the effective population size (N_e) of an endangered species is also crucial because it describes the genetic diversity of the population (Minckley *et al*. 2003). The effective size is inversely related to genetic drift and inbreeding. Genetic diversity determines the ability of species to cope with environmental variability (Gilpin & Soulé 1986). Small effective numbers can negatively impact long-term survival because reduced genetic variability can translate into a reduced ability to adapt to environmental changes. These values are poorly understood for most species (Minckley *et al* 2003). The silvery minnow effective population size is moderately low based on different estimators (PBS&J 2011).

Due to the increased efforts in captive propagation, recent studies by the Collaborative Program have focused on the genetic composition of the silvery minnow. Several studies since 2003 have demonstrated a decline in overall mitochondrial mtDNA and gene diversity in the silvery minnow (*e.g.*, Osborne *et al*. 2005; Turner *et al*. 2006). The results are consistent with smaller overall population numbers and/or increasing relatedness of the females. Additional studies need to be conducted on the genetic effects of stocking hatchery fish. Currently, these fish are artificially spawned in groups, where fish are assumed to form pairs. However, both competition between males and gametic competition could produce effective numbers far smaller than those that are assumed. The effect of communal spawning on effective number must be assessed so the genetic consequences of stocking hatchery fish can be accurately measured and a true effective population number can be determined.

Finally, the changes in gene frequency caused by fish culture practices must be assessed (Minckley *et al*. 2003). Osborne *et al*. (2006) reported that genetic heterozygosity in captive-reared fish and wild fish were the same, with a loss only in allelic diversity. They also stated that hatchery-reared fish stocked into the wild will cause a lower effective breeding number and could cause a reduction in fitness of the entire population. However, the effects of domestication and inadvertent selection have not been studied in the silvery minnow. Additional problems may occur due to the increased survival of wild genotypes brought into the hatchery that would have died in the wild. These fish survive due to lack of predation and increased care and then are stocked back into the river as brooders and are still considered to be "wild fish." This is critical because captive-reared fish could affect the natural population's level of fitness.

Competition, Predation, Disease

Accidental or intentional releases of fishes outside of their native ranges (including bait and aquarium sources) have established numerous exotic fish species in the Rio Grande basin (Sublette *et al*. 1990), representing potential competitors or predators of the silvery minnow. The silvery minnow evolved sympatrically with about 90 other fish species, including those with similar feeding habitats. Competition among fish species often evokes resource partitioning through selective and interactive segregation.

Predation and competition with other fish species has been cited as a factor possibly contributing to the decline of the species (*e.g.*, USFWS 1999). Predation by piscine and avian predators upon silvery minnows has not been quantified, but probably has a minor role in declining silvery minnow populations (USFWS 1994, 2007b). Swimming performance of silvery minnows may provide a reasonable capability for escaping predators (Bestgen *et al* 2003). Experiments using brassy minnows (*H. hankinsoni*) exhibited a change in habitat use when predators are present (Schlosser 1988). The turbidity of the Rio Grande serves to lessen the impacts of would-be predators on silvery minnows because the effective predatory strike zone is shortened.

Fish confined to pools during periods of low flow may experience outbreaks of *Ichthyophthirius multifilis* or *Lernaea* (USFWS 1994, 2007b). Ongoing studies are examining the impact of disease and parasites on silvery minnows (USFWS unpublished data).

5.1.4 U.S. Fish and Wildlife Service Actions to Avoid Jeopardy

Rio Grande Silvery Minnow Population Augmentation

In 2000, the Service identified captive propagation as an appropriate strategy to assist in the recovery of the silvery minnow. Captive propagation is designed to preserve the genetic and ecological distinctiveness of the silvery minnow and minimize risks to existing wild populations. Augmentation of endangered fish species on the lower Colorado River has documented improved survival and recruitment from rearing wild fish larvae in off-channel habitats (Minckley *et al*. 2003; Mueller and Carpenter 2008).

Since 2000, over a million propagated silvery minnows (Table 5.2) have been released into the Angostura Reach (2002-2007) to ensure downstream repopulation (Remshardt 2008). Augmented fish are marked with a visible fluorescent elastomer tag and released in large numbers at a few locations. Marked fish have been released by the Service since 2002 under a formal augmentation effort funded by the Middle Rio Grande Endangered Species Collaborative Program (Collaborative Program). The percentage of recaptured (marked) silvery minnows (Table 5.2) provides an index of the contribution of augmented fish to the overall population (Annual Recapture) and recruitment (April-May Recapture).

Table 5.2. Summary of augmented (marked), recaptured, and salvaged silvery minnows.

		Annual recapture (USFWS)			April-May recapture (fish community monitoring)			Salvaged silvery minnows	
Year	Stocked	Total captured	Marked	Percent recaptured	Total captured	Marked	Percent recaptured	Total salvaged	Ratio salvaged / stocked
2002	43,582	53	7	13.21%	270	0	0.00%	3,662	0.08%
2003	83,384	141	32	22.70%	48	14	29.17%	713	0.86%
2004	180,651	450	99	22.00%	566	22	3.89%	12,865	7.12%
2005	255,217	31,457	264	0.84%	280	5	1.79%	207,746	81.40%
2006	418,851	8,375	298	3.56%	2,058	9	0.44%	69,889	16.69%
2007	133,154	10,172	53	0.52%	123	35	28.46%	13,953	10.48%
2008	0	9,666	5	0.05%	455	2	0.44%	N/A	
2009	21,218	11,308	0	0.00%		N/A		18,473	87.06%
2010	135,990	7,794	458	5.88%	1,274	0	0.00%	10,273	7.55%
2011	190,838	2,957	873	29.52%	120	10	8.33%	8,244	4.32%
2012	274,577	654	486	74.31%	172	92	53.49%	4,251	1.55%
Total	1,737,462	83,027	2,575	3.10%	5,366	189	3.52%	350,069	20.15%

Ongoing research by the Service is designed to document the movement of silvery minnows. Initial studies had crews sample upstream and downstream from the release site in an attempt to capture the marked fish. Recent studies are using passive injected transponder (PIT) tags implanted in silvery minnows to document individual fish movement (Remshardt 2008; Archdeacon *et al*. 2009; Archdeacon and Remshardt 2012). Less than 2% of tagged silvery minnows released downstream of the Albuquerque–Bernalillo County Water Utility Authority (ABCWUA) drinking water diversion dam were detected moving upstream through the fish passage channel (Archdeacon and Remshardt 2012).

Rio Grande Silvery Minnow Rescue and Salvage

During river drying periods, the Service's silvery minnow salvage crew capture and relocate silvery minnows upstream to the perennial reaches. Since 2002, over 300,000 silvery minnows (Table 5.2) have been salvaged and relocated to wet reaches. The contribution of salvaged fish to the population is about 28% of the total augmented fish. Silvery minnows were repatriated into the Angostura Reach (2002-2007) of the river near Alameda Bridge. Starting in 2007, silvery minnows were released in flowing water within the reach in which they were captured to minimize handling stress (Remshardt 2008).

5.2 SOUTHWESTERN WILLOW FLYCATCHER

5.2.1 Listing and Critical Habitat

A final rule was published in the February 27, 1995, Federal Register to list the southwestern U.S. population of the Willow Flycatcher as an endangered species under the ESA with proposed critical habitat. However, the final rule designating critical habitat for the species range-wide (USFWS 1995) did not include the Rio Grande at that time. A proposal to re-designate critical habitat was published in October 2004, and final designation was published October 19, 2005 (USFWS 2005), which did include portions of the action area in the Middle Rio Grande. On August 15, 2011, the Service again proposed to revise critical habitat for the Southwestern Willow Flycatcher (flycatcher; USFWS 2011a), and final designation was published on January 3, 2013 (USFWS 2013a). Within the action area, critical habitat has been designated along 0.4 mile near the Fairview Bridge in Española, and from the southern boundary of Isleta Pueblo, downstream to the headwaters of Elephant Butte Reservoir (extending south to USBR River-mile 52). The lateral extent of critical habitat varies, but entails nearly all riparian vegetation within the floodway in the action area downstream from Isleta Pueblo, and portions of the 1%-chance floodplain outside of the floodway (USFWS 2013b). Chapter 6 of this BA evaluates potential effects of the proposed actions on designated critical habitat for the flycatcher.

The Primary Constituent Elements (PCEs) of flycatcher critical habitat are:

1. Primary Constituent Element 1— Riparian vegetation. Riparian habitat along 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 Goodding's willow, coyote willow, boxelder, tamarisk, Russian olive, buttonbush, cottonwood, stinging nettle, alder, seep willow, rose, false indigo, and Siberian elm[12]]and some combination of:

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

    b. Areas of dense riparian foliage at least from the ground level up to approximately 4 m (13

[12] Only tree and shrub species likely to occur in the action area for this consultation were included in this list.

ft) above ground or dense foliage only at the shrub or tree level as a low, dense canopy; and/or

c. Sites for nesting that contain a dense (about 50 percent to 100 percent) 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 ac) or as large as 70 ha (175 ac); and

2. Primary Constituent Element 2— Insect prey populations. A variety of insect prey populations found within or adjacent to riparian floodplains 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).

5.2.2 Status and Distribution

The species currently occurs in southern California, Arizona, New Mexico, southern portions of Nevada and Utah, and possibly southwestern Colorado (USFWS 1995). The species is likely extirpated from west Texas (Durst *et al*. 2007). Arizona, New Mexico, and California account for the greatest number of known flycatcher sites (93%) in this region and 88% of the total known territories located in 2001. Within these states, the largest known population of flycatcher territories is found along the Gila River drainage, while the Rio Grande in Colorado and New Mexico contributes the second largest number of territories to the overall population (Durst *et al*. 2007).

In New Mexico, the flycatcher has been observed in the Rio Grande, Rio Chama, Zuni River, San Francisco River, 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 historic numbers to current status is not possible; however, the available native riparian habitat overall along the Rio Grande has declined, and it is assumed populations may have declined from historic numbers as well.

Since the initial surveys of the Rio Grande valley in the 1990s, breeding pairs have been found from Elephant Butte Reservoir upstream to the vicinity of Velarde. 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 increasing numbers 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.

In the Middle Rio Grande, surveys for flycatchers in selected areas have been conducted during environmental compliance activities for various projects. Although a systematic survey effort throughout the entire riparian corridor of the Middle Rio Grande has not occurred, reaches of the river with the most suitable habitat for flycatchers have been surveyed fairly thoroughly. Presence/absence surveys and nest monitoring along selected areas of the Rio Grande have been conducted from 1993 to 2008. With expanded or increased survey efforts during this 12-year 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.

The status of the Southwestern Willow Flycatcher in the Middle Rio Grande from 2000 to 2002 was presented in the *Final Programmatic Biological Assessment of Bureau of Reclamation's Water and River Maintenance Operations, Army Corps of Engineers' Flood Control Operation, and Non-Federal Actions on the Middle Rio Grande, New Mexico,* February 2003. Surveys have continued at selected sites along the Rio Grande from Velarde, New Mexico, to the delta of Elephant Butte Reservoir during the breeding seasons from 2003 to 2009. The summaries of flycatcher surveys and nest monitoring in the Middle Rio Grande from 2003 and 2009, previous consultations, surveys conducted during the 2009 breeding season, and other data obtained subsequent to the 2003 BO, are considered the environmental baseline for the current population of breeding flycatchers in the Middle Rio Grande for this Biological Assessment. These data are further discussed below.

Six general locations of flycatcher populations have been established throughout the Middle Rio Grande (Figure 5.4). These areas have consistently held several territories; however, the number of territories, pairs, nest attempts, and successful nests has varied through the years.

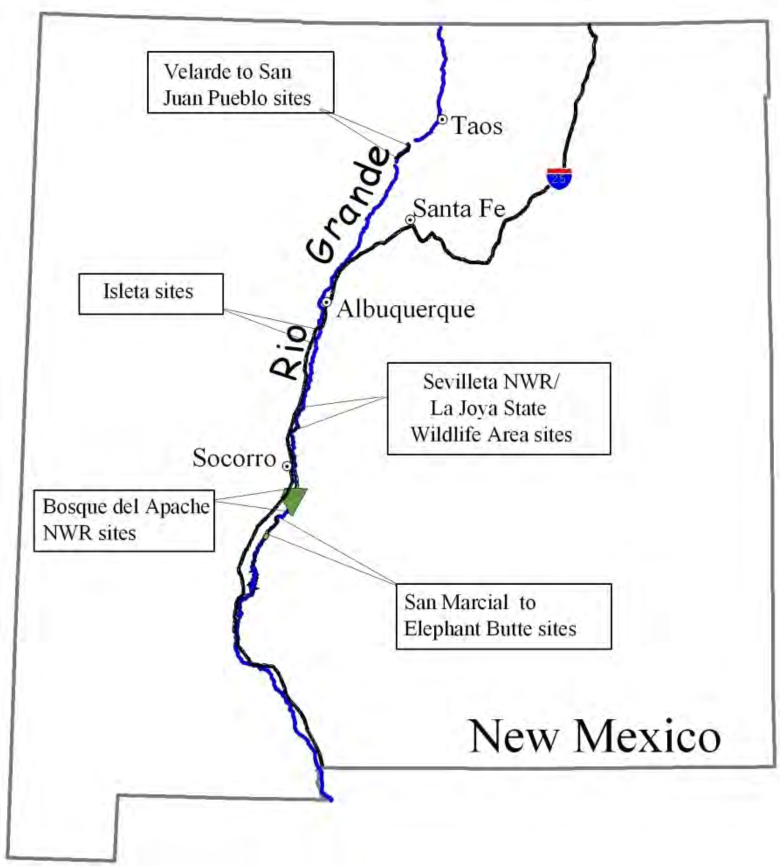


Figure 5.4. Six general locations of flycatcher populations along the Rio Grande of New Mexico.

5.2.3 Reasons for Southwestern Willow Flycatcher Decline

During the last two centuries, human induced hydrological, geomorphological, and ecological changes have heavily influenced the composition and extent of floodplain riparian vegetation along the Middle Rio Grande (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. Fragmentation of forested breeding habitat may also 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; Robbins *et al*. 1989; Rappole and McDonald 1994).

Brood parasitism by Brown-headed Cowbirds (*Molothrus ater*), has been implicated in the decline of songbirds including those found in the western riparian habitats (Gaines 1974, 1977; Goldwasser *et al*. 1980; Laymon 1987). Brown-headed Cowbirds have increased their range with the clearing of forests and the spread of intensive grazing and agriculture. Flycatchers are particularly susceptible to Brown-headed 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. Nest parasitism, combined with declining populations and habitat loss, has placed this species in a precarious situation (Mayfield 1977; Rothstein *et al*. 1980; Brittingham and Temple 1983; Laymon 1987).

5.2.4 Life History and Ecology

Southwestern Willow Flycatcher Breeding Chronology

The flycatcher is a late spring/summer breeder that builds nests and lays eggs in late May and early June, and fledges young in late June or early July (Sogge *et al*. 1993; Tibbitts *et al*. 1994). If re-nesting or second broods occur, they will fledge into mid-August (USFWS 2002a). Based on data from flycatcher survey and nest monitoring along the Middle Rio Grande, particularly in the San Marcial reach, flycatchers have been found in the area as early as May 6; however, actual nest initiation has been documented to occur later in May (Ahlers *et al*. 2001). Flycatchers that re-nest or produce a second brood can remain in the nesting area through the end of August.

Flycatcher breeding chronology in the lower portion of the Middle Rio Grande is presented in Figure 5.5 and falls within the generalized breeding chronology of Southwestern Willow Flycatchers (based on Unitt 1987; Brown 1988; Whitefield 1990; Maynard 1995; Sogge 1995; Skaggs 1996; Sferra *et al*. 1997; Sogge *et al*. 1997). 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 to 15 days. Adults depart from breeding territories as early as mid-August, but may stay until mid-September in later nesting efforts. Fledglings probably leave the breeding areas a week or two after adults.

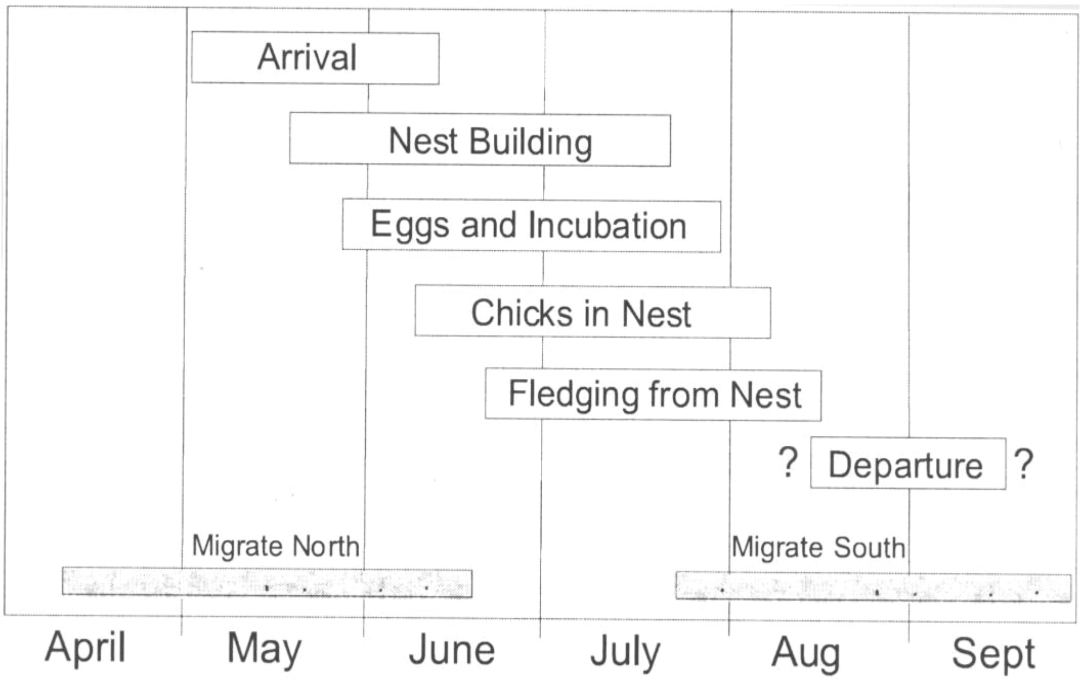


Figure 5.5. Generalized breeding chronology of the Southwestern Willow Flycatcher (from Sogge *et al*. 1997).

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 if the conditions in the selected breeding habitat become adverse.

Southwestern Willow Flycatcher Breeding Habitat

The flycatcher is an obligate riparian species occurring in habitats adjacent to rivers, streams, or other wetlands characterized by dense growths of willows (*Salix* sp.), seepwillow (*Baccharis* sp.), arrowweed (*Pluchea* sp.), saltcedar (*Tamarix* sp.), or other species (USFWS 1995). Flycatchers may utilize areas without surface water, but if suitable habitat goes without water for several years, substrate plants may die and habitat quality may decline. The presence of surface water may also affect nesting success and food availability.

Nesting habitat for the flycatcher varies greatly by site and includes plant species such as willow, saltcedar, box elder (*Acer negundo*), and Russian olive (*Elaeagnus angustifolia*). Species composition, however, appears less important than plant and twig structure (D. Ahlers, Reclamation, *pers. comm.*), as slender stems and twigs are important for nest attachment. Nest placement is highly variable: nests have been observed at heights ranging from 2 to 33 feet and generally occur adjacent to or over water or saturated substrates (Paxton *et al*. 2007). Along the Middle Rio Grande, 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.

A majority of the birds within the Middle Rio Grande have selected 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 younger trees in the understory having more slender vertical stems and twigs are selected for nest placement. Most recently, nests located at the Sevilleta

NWR and La Joya State Wildlife Management Are (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 Middle Rio Grande is dominated by native species and not saltcedar (Moore and Ahlers 2005, 2008).

A critical component for suitable nesting conditions is the presence of water, usually provided by overbank flooding or some other hydrologic source. Along the Rio Grande, nests have been consistently found within 150 feet of surface water, usually a flowing channel (Moore and Ahlers 2005, 2008). Reclamation has found that 95% of all flycatcher nests in the Reclamation-surveyed areas of the Middle Rio Grande occur within 100 m of surface water, and 91% occur within 50 m (Moore and Ahlers 2008). The presence of surface water at the onset of nest site selection and nest initiation is likely critical, though not absolutely necessary. In rare cases in Arizona, birds have nested over 300 feet from water (Sogge *et al*. 2001). Nesting appears to be initiated only after high flows and groundwater levels have created and maintained at least moist soil conditions underneath the nest tree.

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 comprised of native vegetation account for approximately half (48%) of the known flycatcher territories in the Southwest. As of the 2007 breeding season, range-wide, 19% of breeding territories occurred in patches >50% exotic and 4% in patches >90% exotic (Durst *et al*. 2007). Although only 9% of territories occur at exotic sites, another 39% are located within sites where the habitat includes native and exotic mixtures. 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).

In the Middle Rio Grande, the degree to which flycatchers breed in habitat dominated by a particular tree species was summarized from nest data collected in 1999-2001. Over 76% (n = 119) of territories are found at sites where native species (*Salix* spp.) are the dominant tree species and 12% (n = 19) of the nests are in patches where saltcedar is the most common habitat component.

Data collected and analyzed on nest substrate and surrounding habitat patch communities in the Middle Rio Grande (specifically in the Sevilleta NWR/La Joya State WMA, and San Marcial river reaches) indicate that flycatchers may key in on areas dominated by native vegetation, but often select exotic vegetation, particularly saltcedar, as a nest substrate. Saltcedar may actually be the flycatchers' substrate of choice due to its dense and vertical twig structure. From 1999-2002, approximately 49% of 156 nests located in these river reaches were on exotic plants (Russian olive and saltcedar). In the Middle Rio Grande, between 1999 and 2007, 63 nests (6.3 %) were in saltcedar-dominated territories, 793 (79.5 %) were in *Salix*-dominated territories and 141 (14.1 %) were in mixed-dominance territories (Moore and Ahlers 2008).

Evidence gathered during multi-year studies of color-banded populations shows that, although most male flycatchers return to former breeding areas, Southwestern Willow Flycatchers regularly move among sites within and between years (Ellis *et al*. 2008). Between 1996 and 1997, 29% of banded Willow Flycatchers in Arizona returned to the breeding site of the previous year, while 11% moved to other breeding areas within the same major drainage (Paxton *et al*. 1997). The remaining 60% of flycatchers were not relocated in 1997 and may have died or moved to undiscovered breeding sites. Distance moved ranged from 66 to 2,950 feet (20 to 900 m). There were also two cases of movement (>1,640 ft [500 m]) within a breeding site during the course of a breeding season. Although most returning flycatchers showed site fidelity to breeding territories, a significant number move within and among sites. The mechanism controlling the decision to return or move, as well as the adaptive value of movement between sites, is unknown.

In two different situations, flycatchers were forced to move because of catastrophic habitat loss by fire. Occupied flycatcher habitat was destroyed because of fire along the San Pedro River in Arizona (Paxton *et al*. 1996) and along the Gunnison River in Colorado (Owen and Sogge 1997). In Arizona, occupied habitat was destroyed as nesting was underway on seven flycatcher territories. All flycatchers abandoned the site and were not seen again in the burned area. Displaced flycatchers had moved to unburned areas within the breeding site or to other breeding areas within 1.2 and 3 miles (2 and 28 km) of the original site. In Colorado, after a fire destroyed flycatcher habitat, some flycatchers returned to the burned area and attempted to breed even in an area without any live vegetation.

These situations demonstrate that some flycatcher pairs will return to the general breeding area to nest in subsequent years if previously occupied sites become unavailable.

Riparian Habitat Descriptions by Reach

Riparian habitat within all the reaches of the Middle Rio Grande where flycatcher population sites occur includes dense stands of willows and other woody riparian plants adjacent to or near the river channel.

The Velarde reach has a riparian zone with limited recruitment of natives, stands of willow in small fragmented patches, and exotic vegetation composed mostly of Russian olive. Habitat quality and vegetation varies considerably within this reach. Some bosque areas contain older, more mature trees that are 30-50 feet tall. Russian olive and Siberian elm (*Ulmus pumila*) trees occur on some bank lines and river bars. Other areas support stands of dense willows with canopy trees. Overbank flooding is localized but regular. The high potential for bank erosion may increase the dynamics of riparian vegetation loss and regeneration. All habitat patches within this reach where birds have been detected in the past were dominated by willow and were inundated by overbank flooding or irrigation return flows. Nearby habitat included mature cottonwoods, open areas, and Russian olives.

Riparian habitat between Otowi Bridge and Cochiti Dam is described in Section 6.1.3 within the context of effects of flood-control operation at Cochiti Lake.

The bosque in the Cochiti and Angostura reaches contains mainly single-aged stands of older cottonwoods and lack the diversity of a healthy, multi-aged riparian forest. Exotic vegetation such as Russian olive and Siberian elm also became widely established as of the mid-1900s; although non-native understory shrubs have been removed from approximately 1,500 acres of the Angostura reach floodway. Channel narrowing and the accumulation of sediment into relatively high overbank areas has significantly limited bosque flooding and reduced the potential for recruitment of native riparian vegetation, especially cottonwoods and willows. Small patches of suitable habitat occur within these reaches; however, no breeding flycatchers have been documented.

Known flycatcher habitat in the Isleta Reach consists of dense willow and cottonwood stands associated with floodplain marshes downstream from the Isleta Diversion Dam.

Known flycatcher habitat in the Rio Puerco reach (Sevilleta NWR / La Joya State WMA) occurs adjacent to the river and is dominated by saltcedar and Russian olive. The trend of current channel narrowing and degradation reduces the amount of overbank flooding and the potential to enhance existing sites or establish new native vegetation.

Modeling Habitat Characteristics

Development of a Geographic Information System (GIS)-based flycatcher habitat suitability model was initiated in 1998 for the Middle Rio Grande basin and continues to be refined based on changes in hydrology and updated vegetation maps. The model is currently limited to the Middle Rio Grande from Belen south to Elephant Butte.

Riparian vegetation in the Middle Rio Grande basin between San Acacia Diversion Dam and Elephant Butte Reservoir had been classified using the Hink and Ohmart (1984) classification system. 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's efforts, Reclamation personnel updated vegetation maps from Belen to San Marcial using a combination of ground-truthing and aerial photography analysis. In 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 during the summer of 2005. In 2008, the conservation pool of Elephant Butte Reservoir was reviewed and habitat mapping was updated based on ground-truthing and aerial photography flow in late summer of 2007. 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.

In the model, breeding habitat suitability was refined by identifying all areas that are within 328 feet (100 m) of existing watercourses, ponded water, or in the zone of peak inundation. The five categories of flycatcher habitat that lie within 328 feet of water are defined as:

- *Highly Suitable Native Riparian* - Stands dominated by willow and/or cottonwood.
- *Suitable Mixed Native/Non-native Riparian* - Includes stands of natives mixed with non-natives.
- *Marginally Suitable Non-native Riparian* - Stands composed of monotypic saltcedar or stands of saltcedar mixed with Russian olive.
- *Potential with Future Riparian Vegetation Growth and Development* - Includes stands of very young sparse riparian plants on river bars that could develop into stands of adequate structure with growth and/or additional recruitment. This category requires regular monitoring to ascertain which areas contain all the parameters to become flycatcher habitat.
- *Low Suitability* - Includes areas where native and/or non-native vegetation lacks the structure and density to support breeding flycatchers or exceeds the hydrologic parameter of greater than 100 meters from water. The presence of low suitability habitats may be important for migration and dispersal in areas where riparian habitats have been lost (*i.e.,* agricultural and urban areas).

Currently, the Service groups the first three categories listed above as equally suitable habitat for the flycatcher, because a large number of sites are currently occupied in all three categories. Suitable habitats with non-native vegetation are often defined as being less suitable for flycatchers than native habitat when native habitat is available in quantity and in the proper context (*i.e.*, with the proper density and structure and in close proximity to surface water at the onset of territory development and nest initiation). Ultimately, the structure and density of habitat is likely what is most attractive to flycatchers, rather than the plant species composition (Moore and Ahlers 2008, 2009)

Current Availability of Breeding Habitat for Flycatchers

Approximately 367 to perhaps 380 Southwestern Willow Flycatcher territories were found within the Rio Grande basin of New Mexico during the 2009 breeding season. Occupied sites were scattered from the Orilla Verde Recreation Area near Taos downstream to Selden Canyon and Radium Springs near Las Cruces. During the 2009 breeding season, most suitable habitat was surveyed within the main stem of the Rio Grande in New Mexico. It is highly unlikely that any large populations of Southwestern Willow Flycatchers have gone undetected; however, sites supporting a few undetected territories may exist in some isolated patches of habitat throughout the Rio Grande basin.

Since 1993, Southwestern Willow Flycatchers have been reported from 19 sites within the Rio Grande basin; however, several of these sites no longer support Southwestern Willow Flycatchers. The majority of sites within the Rio Grande basin support isolated populations of fewer than six territories. The only reach /site that has shown significant population increases over the past 8 to 10 years is at Elephant Butte Reservoir. This population was first detected in 1995 when two flycatcher territories were found. The population has steadily increased to 319 in 2009. Over 80% of the total territories found within the Rio Grande basin during the 2008 season were within Elephant Butte Reservoir. Sites such as Tierra Azul, Ohkay Owingeh, Pueblo of Isleta, Sevilleta/La Joya, and Selden Canyon/Radium Springs have been fairly consistent in territory numbers since 1993, which is indicative of somewhat stable populations within these sites. Several sites such as La Canova, La Rinconada, and Garcia Acequia within the Velarde reach no longer support breeding flycatchers, although structurally suitable habitat still exists.

Southwestern Willow Flycatcher Habitat Use during Migration

Flycatchers and many other species of Neotropical migrant land birds also use the Rio Grande riparian corridor as stop-over 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 (Yong and Finch 1997). These birds utilize a variety of vegetation types during migration, many of which are classified as “low suitability” for breeding habitat (Ahlers and White 1997).

The Cochiti and Angostura reaches in the Middle Rio Grande support local areas of suitable flycatcher habitat; however, no birds have been documented establishing territories. The Corps has conducted flycatcher surveys at many locations in the Angostura reach in 2004 through 2009 (USACE 2010a). Two areas of suitable breeding habitat have been consistently surveyed since 2004: the Tingley Bar and the San Antonio Oxbow. As stated, only migrant flycatchers were detected.

Southwestern Willow Flycatcher Population Trends 1994-2009

In general, the flycatcher population of the Middle Rio Grande within the action area has remained relatively stable since 2003, although the number of territories has fluctuated between 40 and 64 (Table 5.4). Occupied territories are more abundant in the southern half of the Middle Rio Grande (from the Sevilleta NWR south) than in the northern half.

The following discussion summarizes the first formal surveys for flycatcher in the San Marcial reach of the Middle Rio Grande, and generally moves upstream to address other portions of the action area.

The San Marcial reach of the Middle Rio Grande was among the first area surveyed for flycatchers (Mehlhop and Tonne 1994; Henry *et al*. 1996) and has been surveyed for flycatchers regularly since 1994 (Ahlers and White 1995, 1996, 1997, 1999, 2000; Ahlers *et al*. 2001, 2002; Ahlers and Moore 2003; Moore and Ahlers 2004, 2005, 2006, 2008; Reclamation 2010). The population in this area steadily increased and expanded since the initial surveys in 1994 detected 11 flycatcher territories located south of the Bosque del Apache NWR (all near the railroad bridge above San Marcial). The population in that river reach remained between 9 and 12 territories through 1999. By 2000, the birds had dispersed and expanded southward following the development of new riparian vegetation in the receding pool of Elephant Butte Reservoir.

Table 5.4. Southwestern Willow Flycatcher territories[a] detected by surveys during 2003 to 2010 in various reaches of the Rio Grande within the action area.

River reach	2003	2004	2005	2006	2007	2008	2009	2010
Rio Chama confluence to Otowi Bridge	NS[b]	0	0	0	0	0	0	0
Frijoles Canyon confluence to Bland Canyon confluence	NS	NS	NS	NS	NS	0	0	NS
Cochiti Dam to Isleta Diversion Dam [c]	0	0	0	0	0	0	0	0
Isleta Diversion Dam to Sevilleta NWR	6	7	7	9	19	12	3	6
Sevilleta NWR through La Joya State WMA	17	19	20	21	14	32	18	13
San Acacia Div. Dam to Bosque del Apache NWR	0	0	0	1	0	0	1	4
Bosque del Apache NWR	3	1	0	4	7	5	20	34
Tiffany / San Marcial to RM 62	34	16	3	16	11	15	5	5
Total	60	43	40[d]	51	51	64	47	62

[a] "Territories" = pair or single male present in June and July surveys.
[b] NS = Not surveyed.
[c] Protocol surveys were performed only in limited areas. Anecdotal information supports its absence throughout the reach.
[d] High flows hampered access during surveys throughout the Middle Rio Grande.

The upper area of Elephant Butte Reservoir—which is not within the action area of this consultation—has experienced significant colonization of flycatchers, from 3 territories in 1995 (Ahlers and White 1996) to 323 territories in 2009 (Reclamation 2010; see the references cited above for intervening years). Elephant Butte Reservoir doubtlessly serves as a source area for flycatchers nesting in the San Acacia reach.

Although Elephant Butte Reservoir is not within the action area of this consultation, it is within the Middle Rio Grande Management Unit defined in the recovery plan for the Southwestern Willow Flycatcher (USFES 2002a). Based on territory numbers detected between 2003 and 2010, the recovery goals of the Middle Rio Grande Management Unit—100 territories—have been reached and sustained for seven breeding seasons thus far. These goals are for reclassification from endangered to threatened and must be sustained for a minimum of five years. However, for reclassification to take place, recovery goals must be met throughout the range of the subspecies (USFWS 2002a).

North of the San Marcial reach, portions of the Bosque del Apache NWR have been surveyed for flycatchers annually since 1993. The wetland areas within the inactive floodplain outside of the levees have variably attracted between 1 and 7 territories annually during this period. When the active floodplain channel, or river corridor within the refuge, was surveyed in 2005, no territories were detected. However, in 2009 there were 20 territories detected within this same area, and 34 territories were present in 2010. Flows that were

Four flycatcher territories were discovered in the Sevilleta NWR and La Joya State WMA in 1999. Surveys have continued in this area since that time, with 8 territories detected in 2000, 11 territories in 2001, and 13 territories in 2002. The highest numbers to date for this reach—32 territories—were detected in 2008. In 2009 and 2010, there were 18 and 13 territories detected in this reach, respectively.

Further north, at the Pueblo of Isleta, 3 to 4 flycatcher territories were documented in a small area in 1994 and 1995 (Mund *et al.* 1994; Mehlman *et al.* 1995). In 2000, surveys in all suitable nesting habitats within the Pueblo found 14 territories (Johnson and Smith 2000). In 2003, only 6 territories were found (Smith and Johnson 2005), followed by seven territories were located in 2004 (Smith and Johnson 2005), six territories were identified on the Pueblo in 2005 (Smith and Johnson 2006), and 8 territories in 2008 (D. Hill, USFWS, *pers. comm.*).

Remoteness and limited accessibility make regular surveys for willow flycatchers very difficult along the Rio Grande within White Rock Canyon (from the Otowi Bridge to just upstream from Cochiti Dam). The National Park Service performed protocol surveys within the Bandelier National Monument portion of White Rock Canyon (approx. 5 river-miles) in 1994, 1995, 1997, and 2001. A small number of migrant flycatchers—but no breeding or resident birds—were observed within the reach during protocol surveys and other visits (S. Fettig, Bandelier Nat. Mon., *pers. comm.*, April 2007). Reclamation has performed protocol surveys along the Rio Grande between the confluence of Frijoles Canyon and the Pueblo de Cochiti (termed the 'Frijoles Reach') in 2008 and 2009 (Moore and Ahlers 2009; Reclamation 2010). In each year, several migrant flycatchers were encountered in May and June, and an unpaired male was present for a portion of the survey season. In 2011, Reclamation surveyed the area during two protocol periods, but had to abandon the remaining surveys due to dangerous conditions ensuing from the Las Conchas Wildfire in the adjacent Jemez Mountains (V. Ryan, Reclamation, *pers. comm.*, June 2011). During their June 13, 2011, survey, Reclamation documented a pair plus a single male flycatcher near the confluence of Medio Canyon. (The draft 2011 survey form is included as Appendix D of this BA). Although surveys were not conducted over the entire protocol period, the Corps has assumed that the Southwestern Willow Flycatcher resides within the flood pool of the Cochiti Dam and Lake project during this Section 7 consultation.

Upstream from the action area of this consultation, flycatcher surveys were initiated along the Rio Grande near Velarde, New Mexico, in 1994. Several areas along the river and adjacent community acequias have been periodically surveyed from 1994 to 2010. In 1995, this area supported a maximum of 6 territories (between 1 to 3 territories at each of the following sites: La Canova, La Rinconada, El Guique, and Garcia Inlet). In 2001, 2004, and 2006 this area supported only one territory while no territories were detected in 2007 through 2010. This local population appears to be the most unstable with limited success, possibly due to fragmented habitat near human development.

Along the Rio Grande at Ohkay Owingeh (formerly San Juan Pueblo)—immediately upstream from the Rio Chama confluence—16 flycatcher territories were documented in 2000. Between 2001 and 2003 no surveys were preformed for the species. In 2004, 11 territories were detected and 10 were detected in 2005 (N. Baczek, USFWS, *pers. comm.*). Population numbers of flycatchers since 2005 are not available.

Development of Suitable Flycatcher Breeding Habitat in the Middle Rio Grande

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 reason for this decline in riparian vegetation is due to the removal of the dynamic components of river systems.

The Rio Grande and associated riparian areas have historically been a dynamic system in constant change and, without this change, the plant diversity and productivity has decreased. Sediment deposition, scouring flows, inundation, and irregular flows are natural dynamic processes that occurred frequently enough in concert to shape the characteristics of the Rio Grande channel and floodplain. Through the development of dams, irrigation systems, and controlled flows, the dynamics of the river system have been significantly reduced except at localized areas such as the reservoirs where water storage levels frequently change with releases and inflows.

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 Middle Rio Grande. To recreate these dynamic processes in a very static river system, man-made procedures have been developed and implemented including mechanical disturbance, herbicide treatments, prescribed fire, channel realignment, operational flows, avulsions, and river realignment. These man-made processes manipulate the river and floodplain in an attempt to restore the diversity of a healthy river system. It is no coincidence that flycatchers have expanded and dispersed within the delta of the Elephant Butte Reservoir. In the previous several years, this area has had the most dynamic components within the Middle Rio Grande as a result of changing reservoir elevations. Since cottonwoods and willows are aggressive colonizers of disturbed sites (Reichenbacher 1984), the dynamic scouring and deposition process provides the potential for the development of new habitat.

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 surface-water inundation, such as that occurring in the headwaters of Elephant Butte Reservoir, have been documented as important factors affecting seedling survival (Sprenger *et al*. 2002).

Several years of prolonged inundation have killed many saltcedar stands within the Elephant Butte Reservoir pool. The receding reservoir pool has exposed new areas for establishment of native vegetation. Newly scoured areas of the river channel or floodplain and areas where sediment has been deposited also provide conditions for regeneration of native species.

In the San Marcial reach, as part of ongoing reviewed and approved projects, Reclamation is conducting non-native vegetation clearing, floodplain expansion, riparian vegetation plantings, channel avulsions, channel widening, and bank destabilization, all of which are man-induced processes to provide the dynamic conditions to enhance the recruitment of cottonwoods and willows, and indirectly increasing the quantity of available flycatcher habitat.

Cowbird Parasitism and Breeding Southwestern Willow Flycatchers

Brood parasitism by Brown-headed Cowbirds (*Molothrus ater*) may be a contributing factor to the decline of the flycatcher, as well as other Neotropical migrant land birds. Reclamation implemented a cowbird control program from 1996 through 2001 in the San Marcial area. This was an effort to reduce brood parasitism on the endangered Southwestern Willow Flycatcher as mitigation for the presence of cattle within Elephant Butte public lands. From 1997 through 2001, approximately 3,599 cowbirds were captured in the San Acacia reach in the absence of cattle (except trespass cattle). During this time, the number of cowbirds trapped during the summer resident period remained constant, which appeared to indicate that trapping did not reduce the breeding population of cowbirds at Elephant Butte Reservoir over time. However, the number of cowbirds was reduced on a seasonal basis.

Factors influencing cowbird density include host nest availability, habitat quality, presence of livestock, and availability of forage areas such as grain fields. Cowbird and Neotropical bird observations along the riparian corridor of the Middle Rio Grande were compared between sites with different land-use practices using the point-count methodology. These counts indicate that Sevilleta NWR attracted the highest number of nesting Neotropical bird species likely to provide host nests for cowbirds. This reach is also characterized by the narrowest riparian corridor of the four reaches. Point counts indicate that Sevilleta NWR and Bosque del Apache NWR attracted the highest number of cowbirds. Neither of these refuges are grazed. Increased cowbird numbers may be in response to better habitat or the availability of Neotropical bird host nests.

The effects of cowbird trapping on the success of breeding flycatchers and other Neotropical birds on Elephant Butte public lands was assessed for the period 1999-2001. In the Elephant Butte public lands study area, parasitism was observed in 31% of nests of all Neotropical bird species, but was only 5% in flycatcher nests, according to data sets combining nests monitored from 1999 through 2001 (D. Ahlers, Reclamation, *pers. comm.*, 2001). These data indicate that factors other than trapping might possibly be responsible for the low incidence of parasitism on the flycatcher nests. Within the reservoir delta, a dramatic increase in the number of breeding flycatchers has occurred since 1999. In 2001, nest success for the breeding flycatchers in the delta was 75% in comparison to a 50% nest success of Neotropical birds in the same area. No parasitism occurred in the flycatcher nests from 1999 through 2001. The increase of breeding pairs and the absence of parasitism in this specific area most likely is a response to high quality habitat. When comparing the Neotropical bird nest data between Elephant Butte public lands with cowbird trapping, and San Acacia and Bosque del Apache NWR reaches where no trapping occurs, there was no statistical difference between nest success observed within the trapped *versus* untrapped areas. These data indicate that trapping cowbirds does not affect Neotropical bird nest success in the Middle Rio Grande, and, therefore, cowbird trapping was stopped.

Addling or removal of Brown-headed Cowbird eggs from parasitized flycatcher nests is a practice that was begun in the San Acacia reach in 2002 and continued through 2005. Of the 79 flycatcher nests parasitized during that period with known outcomes, cowbird eggs were addled or removed from 38 nests, 7 of which successfully fledged flycatcher young (18.4% success). Parasitized nests over the past six seasons in the Middle Rio Grande that were unaltered were as successful. Of 41 parasitized nests monitored, 32 failed, and 9 successfully fledged young (a 22% success rate).

Other Factors Potentially Affecting Flycatchers and Critical Habitat

In the Middle Rio Grande, past and present Federal, State, and private activities that may affect the flycatcher include irrigated agriculture, river maintenance, flood control, dam operation, water diversions, and downstream Rio Grande Compact deliveries. The Rio Grande and associated riparian areas are a dynamic system in constant change. Sediment deposition, scouring flows, inundation, base flows, and channel and river realignment are processes that help to maintain and restore the riparian community diversity. Without these dynamic processes, the riparian community will likely decrease in diversity and productivity. 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 (USFWS 2005).

The Rio Grande historically had highly variable annual and seasonal discharge patterns (Platania 1993). Since 1973, flows in the Middle Rio Grande have been determined mainly by regulation of dam facilities and irrigation diversions. The highest flows generally result from snowmelt (April-June), irrigation water releases from the upstream reservoirs, and variable thunderstorms. Lowest flows generally occur from July to October, when most of the available river flow is diverted for irrigation. Summer monsoons can elevate river flows during this time period depending on their frequency and intensity. Water and sediment management have resulted in a large reduction of suitable habitat for the flycatcher, as a result of the reduction of peak flows that helped to create and maintain habitat for this species. Overbank flooding is needed to create shallow, low-velocity backwaters and to maintain and restore native riparian vegetation for flycatcher habitat. Overbank flooding is also currently restricted by the safe channel capacity at the San Marcial Railroad Bridge and for Isleta Reach spoilbank levees.

Levees have greatly restricted the floodplain width and, along with their attendant riverside drains, have functionally disconnected the river from most of the historical floodplain. 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). Between Cochiti Dam and Elephant Butte Reservoir headwaters, there are 235 miles (378 km) of levees including distances on both sides of the river (USFWS 2005).

The Middle Rio Grande channel width has narrowed over the last century. The trend can be attributed to reduced peak flows, channelization, and reduced sediment supply. Channelization in the 1950s and 1960s is primarily responsible for the elimination of thousands of acres of the shallow, low-velocity habitats required by the flycatcher. Flow regulation below Abiquiu Reservoir and Cochiti Dam has further decreased channel capacity and reduced peak flows. Flood events greater than 10,000 cfs have not occurred since the 1940s. The lack of large peak flows combined with the effects of channelization contributes significantly to channel narrowing and the reduction of overbank flooding. These factors severely limit the development of backwater habitats essential to the survival of the flycatcher (USFWS 2005).

5.3 PECOS SUNFLOWER

5.3.1 Status and Distribution

The Pecos sunflower (*Helianthus paradoxus* Heiser) was listed as a threatened species by the Service on October 20, 1999 (64 Federal Register 56582-56590). Critical habitat for the species was designated effective May 8, 2008 (USFWS 2008). The State of New Mexico lists the Pecos sunflower as endangered under the regulations of the New Mexico Endangered Plant Species Act (19 NMAC 21.2). This species is also listed as threatened by the State of Texas (31 TAC 2.69(A)).

The Pecos sunflower is a wetland plant that 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 Federal Register 82480). Subsequent field surveys for this plant found additional populations in New Mexico and Texas. It is presently known to occur in two widely separated locations in the Pecos River valley in eastern New Mexico, two locations on the Rio San Jose, two locations on the

Rio Grande in west-central New Mexico, and at two desert springs in west Texas. Little is known about the historic distribution of the Pecos sunflower. The plant is associated with spring seeps and wet meadow (cienega) habitats, which are very rare in the dry regions of New Mexico and west Texas. There is evidence these habitats were originally more widespread, but have been historically reduced or eliminated by aquifer depletion, or severely impacted by agricultural activities and encroachment by alien plants (Hendrickson and Minckley 1984; Poole 1992: Sivinski 1996). Existing Pecos sunflower populations occur on a variety of state and Federal lands and several private land holdings, and face a moderate degree of threat. Incompatible land uses, habitat degradation and loss, and groundwater withdrawals are historic and current threats to the survival of the Pecos sunflower (Poole 1992; Sivinski 1996; USFWS 2005). In addition, 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 the 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 (USFWS 2005).

The Pecos sunflower is presently known from only seven naturally occurring populations, two in west Texas and five in New Mexico (Figure 5.6), and one reintroduced population in New Mexico. The type locality (the location at which the species was first described) is near Fort Stockton in Pecos County, Texas. Here a large population with several hundred thousand plants currently exists at the Nature Conservancy's (TNC) Diamond Y Spring Preserve, with a smaller group of plants downstream at a nearby highway right-of-way. A second Texas population occurs at the TNC Sandia Spring Preserve in the Balmorhea area of Reeves County, Texas.

In New Mexico, the six Pecos sunflower populations are located in the Roswell/Dexter region, Santa Rosa, two locations in the Rio San Jose valley, and two on the Middle Rio Grande. 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 are 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 several 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 are especially large populations.

In the Middle Rio Grande, the only known naturally occurring population of Pecos sunflower exists within the La Joya Unit of the Ladd S. Gordon Waterfowl Complex (Figure 5.7). It represents one of the largest populations of *H. paradoxus* in the range of the species (USFWS 2005), consisting of 100,000 to 1,000,000 plants. This property is owned by the New Mexico State Game Commission. It is managed by the NMDGF for migratory waterfowl habitat, which is compatible with preservation of wetlands for *H. paradoxus*. The site was determined to be essential to the conservation of the species resulting from encroachment of non-native species, degradation of habitat, or a catastrophic event because it is occupied by a very large, stable population, that 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 (USFWS 2005). As such, it may contain genetic variation not found anywhere else in the range of the species. This naturally occurring population of Pecos sunflower contains all of the Primary Constituent Elements (PCEs) in the appropriate spatial arrangement and quantity, but is threatened by encroachment of non-native vegetation. Because the water source for this population is stable, this population can be expected to persist in very large numbers every year.

Figure 5.6. Distribution of naturally occurring populations of Pecos sunflower (USFWS 2005).

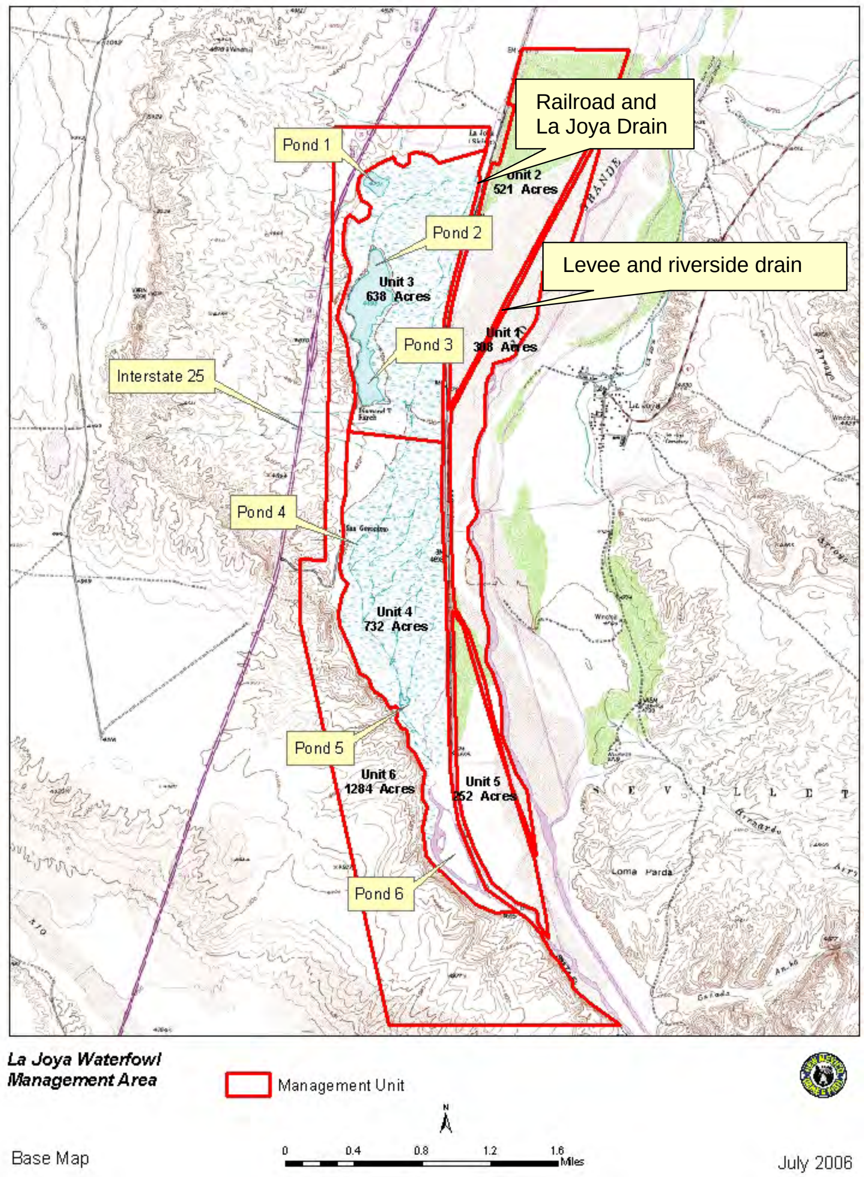


Figure 5.7. Map of La Joya Unit, Ladd S. Gordon Waterfowl Complex (courtesy of NMDGF). Pecos sunflower occurs adjacent to Ponds 3 and 4 (NMDGF 2007).

The La Joya Wildlife Management Area was excluded from the critical habitat designation for *H. paradoxus* due to the development of a habitat management plan which adequately protects the species. The purpose of the management plan is to support conservation of the species on the La Joya Wildlife Management Area 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; and (5) restoring native habitat through re-vegetation.

The habitat management plan was developed in accordance with the recovery plan for *H. paradoxus* (NMDGF 2007, p. 1). The recovery plan identifies that the recovery objective for *H. paradoxus* is to protect and manage significant populations. Implementing appropriate management plans for *H. paradoxus* should reduce the identified threats (*e.g.*, controlling invasive plants, identifying and restricting incompatible land uses, and ensuring spring flows).

The Service has found that the management plan for La Joya is complete and provides for the conservation and protection of the physical and biological features essential to the conservation of the Pecos sunflower (73 Federal Register 17762-17807), consistent with the tenets identified in the recovery plan.

With the exception of the La Joya population, most Pecos sunflower habitats are limited to less than five acres (two hectares) 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 the 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; Bush 2006; Grunstra and Van Auken 2007). This sunflower is completely dependent on water-saturated soil conditions within the soil root zone. If a wetland habitat dries out permanently, even a large population of Pecos sunflower would disappear (USFWS 2005).

In 2008, seeds from the La Joya population were used to establish a reintroduced population on private property approximately 25 miles (40 km) to the south in Socorro County. This reintroduced population was established as a cooperative effort between the landowner, the U.S. Fish and Wildlife Service, and the New Mexico Energy, Minerals and Natural Resources Department, Forestry Division. The State of New Mexico and the Service consider this to be a reintroduction within the historic range of the Pecos sunflower. After identifying suitable habitat on the property, biologists planted seeds obtained from the La Joya population in several 1- or 2-m^2 patches. Although a current population estimate is unavailable, some of the original seeded patches have expanded in numbers and area. The population is protected from grazing by an exclosure, and the landowner is conducting habitat management work in cooperation with the Service (Robert Sivinski, NM Forestry Division, *pers. comm.*, Oct. 1, 2010). Due to its recent establishment, the population's long-term viability has not been assessed. This habitat and sunflower population belong to the landowner and neither have ESA protection from the actions of the landowner, unless an action is proposed that would have a Federal nexus (Robert Sivinski, NM Forestry Division, *pers. comm.*, Oct. 1, 2010). This population was not considered for critical habitat designation because it became established after the rulemaking process was complete. This reintroduced population must also demonstrate an ability to persist under current land use and environmental conditions.

5.3.2 Life History and Ecology

The Pecos sunflower is an annual, herbaceous plant. It grows 3.3 to 10 feet (1 to 3 m) tall and is branched at the top. The leaves are opposite on the lower part of the stem and alternate at the top. Each leaf is lance-shaped with three prominent veins and up to 6.9 inches (17.5 cm) long by 3.3 inches (8.5 cm) wide. The stem and leaf surfaces have a few short, stiff hairs. Flower heads are 2.0 to 2.8 inches (5 to 7 cm) in diameter with bright yellow rays around a dark purplish brown center (the disc flowers). The Pecos sunflower looks much like the common sunflower (*Helianthus annuus*) seen along roadsides throughout the West, but differs from 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 to 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.

The Pecos sunflower grows in areas with permanently saturated soils in the root zone. These wet soil areas are most commonly associated with desert springs and seeps that form wet meadows called cienegas. Such wetland habitats are rare in the arid southwest region and have decreased historically (Hendrickson and Minckley 1984). This 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 soils 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 sunflowers grow 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 the Pecos sunflower include *Distichlis spicata* (saltgrass), *Sporobolus airoides* (alkali sacaton), *Phragmites australis* (common reed), *Schoenoplectus americanus* (chairmaker's bullrush), *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 sunflowers often occur with saltgrass between the saturated soils occupied by bullrush and the relatively drier soils with alkali sacaton (Van Auken and Bush 1998).

5.3.3 Reasons for Decline

Spring seeps and wet meadow (*cienega*) habitats are rare in the dry regions of New Mexico and Texas. There is evidence these habitats have historically, 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 the 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 (USFWS 2005).

5.4 INTERIOR LEAST TERN

5.4.1 Status and Distribution

The Interior Least Tern (*Sternula antillarum athalassos*) was listed as endangered by the Service in 1985 (USFWS 1985). This subspecies historically bred along the Colorado River (in Texas), Red River, Rio Grande (in Texas), Arkansas River, Missouri River, Ohio River, 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 Interior Least Tern was first recorded (including nesting) at Bitter Lake National Wildlife Refuge in 1949, and since then, it remained present essentially annually (Marlatt 1984). The species also occurs as an occasional breeder in Eddy

County, New Mexico (Doster 2007). The Interior Least Tern is a vagrant elsewhere in New Mexico, including locations such as Española, Sumner Lake, Bosque del Apache National Wildlife Refuge, and in wetlands near Glenwood, Las Cruces, and Alamogordo (NMDGF 1988).

5.4.2 Life History and Ecology

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 to 75 nests. Although most nesting occurs along rivers, the tern also nests on barren flats of saline lakes and ponds.

5.4.3 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 (USFWS 1985). Alteration of natural river and lake dynamics has caused unfavorable vegetation succession on many remaining islands, curtailing their use as nesting sites by terns. Releases of water from upstream reservoirs and annual spring floods often inundate nests. Recreational use of sandbars may cause destruction of nesting habitat, nests, and eggs by trampling.

6. ANALYSIS OF EFFECTS OF PROPOSED ACTIONS

This chapter provides an analysis of the effects of the Corps' proposed actions on listed species and their designated and proposed critical habitat. The phrase "effects of proposed actions" refers to the direct and indirect effects of the proposed action on listed species or critical habitat together with the effects of other activities that are interrelated or interdependent with that action.

This chapter first addresses the analysis of effects on the Rio Grande silvery minnow, the Southwestern Willow Flycatcher, and the designated and/or proposed critical habitat for each species. This is followed by two sections addressing effects on the Pecos sunflower and the Interior Least Tern, respectively, and a final summary of all effects.

In each section of this chapter, the discretionary activity associated with each component of the proposed action is briefly summarized. This brief summary is intended as a reminder to the reader, and does not supplant the formal description of proposed actions in Chapter 3 of this BA.

6.1 RIO GRANDE SILVERY MINNOW, SOUTHWESTERN WILLOW FLYCATCHER, AND THEIR CRITICAL HABITAT

The following sections focus on effects to the minnow and flycatcher and their designated critical habitat. Effects to listed species and critical habitat are analyzed individually, and with respect to specific activities within the overall the proposed action.

6.1.1 Discretionary Flood-control Operation During Spring Runoff

As described previously, P.L. 86-645 directs that flood-control releases from Corps dams "will be at the maximum rate of flow that can be carried at the time . . . without causing flooding of areas protected by levees or unreasonable damage to channel protective works." Stated in another way, the Corps lacks the discretion <u>not</u> to operate in such a manner. Four dams in the Middle Rio Grande system—Abiquiu, Cochiti, Galisteo, and Jemez Canyon—are operated in concert to the non-damaging channel capacity, as measured at the Albuquerque (Central Avenue Bridge) streamflow gage. From 1975 through 1995, the stated channel capacity at Albuquerque was 5,000 cfs. In eight years between 1979 and 1995, the Corps deviated from operations to temporarily increase the safe channel capacity at Albuquerque above 5,000 cfs. These operations clarified the non-damaging limits to flood-control releases. In 1996, the safe channel capacity for Middle Rio Grande flood-control operation was formally increased to 7,000 cfs at Albuquerque (USACE 1996).

Table 6.1 summarizes snowmelt-runoff period flood-control operations in the Middle Rio Grande after Cochiti Dam was placed in operation. In 24 of the 37 years between 1975 and 2011, no flood-control operation was required (other than ramping up flows at a safe rate at the beginning of the season). Non-discretionary flood-control operation was implemented in 10 of the 37 years to prevent unreasonable damages to levees in the Middle Rio Grande (8 years) or in the reach between Caballo Dam and Fort Quitman, Texas (2 years). Pursuant to P.L. 86-645, these activities are non-discretionary and, therefore, are not included in the current consultation.

The Corps' only discretion in the scope of its flood-control operations entails limiting the peak discharge to prevent damage to non-protective structures. In three of the 37 years (1994, 1995, and 1997), releases from flood-control dams were increased to the point of potentially damaging the historic railroad bridge (Van Citters 2000) crossing the Rio Grande at San Marcial, approximately 164 miles downstream from

Cochiti Dam. Consideration of potential damages included both physical damage to the structure and its abutments, as well as cessations in rail traffic along this route due to safety concerns about the structure. The bridge is located 6.6 river-miles upstream from Elephant Butte Reservoir, which was filled to capacity in 1986. The high lake levels and above-average runoff volumes from 1984 through 1987 exacerbated sediment aggradation in the vicinity of the bridge, and led to periods of reduced flow capacity at the bridge crossing for several years afterwards. Pilot channels constructed by Reclamation were crucial in maintaining the channel capacity in the reach during this period.

In 1994 and 1995, operational deviations allowed the Corps to experimentally increase flood regulation release above the stated 5,000 cfs safe channel capacity at Albuquerque. Flows were increased to the maximum level without causing damage to the San Marcial railroad bridge; that is. 6,250 and 6,370 cfs at Albuquerque, in the respective years.

During the 1997 snowmelt runoff period, flood-control releases were incrementally increased to bring the water surface to just below the steel span of the San Marcial railroad bridge and allow flows to scour the bed. This was repeated as needed until no additional capacity could be gained. The peak release from Cochiti Dam was 6,830 cfs, which was approximately 110 cfs less than the maximum discharge at the Otowi gage. After accounting for irrigation diversions and transit losses, the peak discharge at the Albuquerque was 5,980 cfs. Therefore, the additional 110 cfs could have been realized if operations disregarded potential damage to the San Marcial railroad bridge.

To determine the relative effect this operation, the Corps conducted two-dimensional hydraulic modeling to estimate the area of inundation of a range of flows within the floodway of the Middle Rio Grande (see Appendix C of this BA). When flow at Albuquerque is a sustained 7,000 cfs, the maximum area of inundated overbank between Cochiti Dam and Elephant Butte Reservoir was estimated to be approximately 14,000 acres. At a discharge of 5,980 cfs at Albuquerque, approximately 10,914 acres of the overbank area was estimated to be inundated. In 1997, an additional 110 cfs in the peak discharge would have resulted in only 342 acres of additional inundation.

High storage in Elephant Butte Reservoir was a factor in the channel's reduced capacity at the San Marcial railroad bridge during the mid-1980s to mid-1990s. These years were a period of unprecedented storage in the reservoir (Figure 6.1). The only previous time such storage was reached was for a brief period following a major flood event in 1941. Storage levels in Elephant Butte Reservoir have been very low for the past few years, and, as a result, channel capacity has increased at the headwaters area. Specifically, the river bed at the San Marcial railroad bridge has incised approximately three feet.

Summarizing, in only one of 37 years has the Corps discretionarily limited the peak discharge to less than the stated safe channel capacity in order to prevent damages to non-protective structures downstream. The San Marcial railroad bridge has not limited flood-control operations since 1997, including the extended, above-average runoff experienced in 2005.

Table 6.1. Summary of Middle Rio Grande discharge and reservoir operation during Spring runoff, 1975-2010.

Year	Peak discharge (mean daily cfs) Otowi Bridge gage	Cochiti Dam release[a]	Albu-querque gage	Channel capacity at Albuq.	Flood-control operation	Limit to reaching Otowi peak
1975	4,670	5,365	5,800	5,000	No flood-control regulation.	
1976	3,420	4,012	3,170	5,000	No flood-control regulation.	
1977	1,540	1,525	1,640	5,000	No flood-control regulation.	
1978	3,780	3,735	4,320	5,000	No flood-control regulation.	
1979	11,500	6,585	7,870	6,000[b]	Deviation to increase flows to 6,000 cfs at Albuquerque (daily monitoring of levee system, sand boils, and sloughing front and back side of levees — numerous locations throughout the Albuquerque area).	Levees, per P.L. 86-645.
1980	7,980	7,055	7,130	6,000 [b]	Deviation to increase flows to 6,000 cfs at Albuquerque.	Levees, per P.L. 86-645.
1981	1,950	1,640	2,170	5,000	No flood-control regulation.	
1982	5,030	5,530	4,630	5,000	No flood-control regulation.	
1983	8,600	7,000	7,330	7,330 [b]	Deviation to increase flows to 7,000 cfs from Cochiti Dam.	Levees, per P.L. 86-645.
1984	9,450	8,405	8,500	8,500 [b]	Deviation to increase flows to 8,400 cfs from Cochiti Dam.	Levees, per P.L. 86-645.
1985	12,000	8,390	8,650	8,650 [b]	Deviation to increase flows above 5,000 cfs at Albuquerque; then reduced to conform to 5,000-cfs capacity downstream from Caballo Dam.	Levees, per P.L. 86-645.
1986	7,850	4,115	4,670	5,000	Elephant Butte Reservoir full. Albuquerque discharge held to maximum of 5,000 cfs to conform to 5,000-cfs capacity downstream from Caballo Dam.	Levees, per P.L. 86-645.
1987	9,280	6,315	6,120	5,000	Elephant Butte Reservoir full. Albuquerque discharge held to maximum of 5,000 cfs to conform to 5,000-cfs capacity downstream from Caballo Dam.	Levees, per P.L. 86-645.
1988	2,570	3,610	3,880	5,000	No flood-control regulation.	
1989	4,070	3,790	3,710	5,000	No flood-control regulation.	
1990	2,980	2,530	2,420	5,000	No flood-control regulation.	
1991	8,400	5,010	4,800	5,000	Max. release at Albuquerque 4,500 cfs to prevent overtopping levees in the vicinity of San Marcial.	Levees, per P.L. 86-645.
1992	5,840	5,850	5,900	5,000	No flood-control regulation. (Water on low steel of railroad bridge.)	

Continued

Table 6.1, concluded.

Year	Peak discharge (mean daily cfs) Otowi Bridge gage	Cochiti Dam release [a]	Albu-querque gage	Channel capacity at Albuq.	Flood-control operation	Limit to reaching Otowi peak
1993	7,990	7,350	7,000	7,000 [b]	Deviation to increase flows to 7,000 cfs at Albuquerque.	Levees, per P.L. 86-645.
1994	8,560	6,535	6,250	7,000 [b]	Deviation to increase flows to 7,000 cfs at Albuquerque. Water on low steel of railroad bridge.	San Marcial RR Bridge, per Corps policy.
1995	8,650	6,700	6,370	7,000 [b]	Deviation to increase flows to 7,000 cfs at Albuquerque. Water on low steel of railroad bridge.	San Marcial RR Bridge, per Corps policy.
1996	1,750	1,650	1,770	7,000	No flood-control regulation.	
1997	6,940	6,830	5,980	7,000	Water on low steel of railroad bridge.	San Marcial RR Bridge, per Corps policy
1998	4,130	4,280	3,940	7,000	No flood-control regulation.	
1999	5,090	5,020	4,550	7,000	No flood-control regulation.	
2000	1,950	1,725	1,500	7,000	No flood-control regulation.	
2001	3,700	4,160	4,760	7,000	No flood-control regulation.	
2002	1,710	1,830	1,240	7,000	No flood-control regulation.	
2003	1,820	1,610	1,260	7,000	No flood-control regulation.	
2004	3,400	3,275	3,120	7,000	No flood-control regulation.	
2005	8,970	6,855	6,510	7,000	Problems with levees downstream from Isleta Diversion. Water on low steel of San Marcial railroad bridge; 2 inches of freeboard on levees in San Marcial area.	Levees, per P.L. 86-645.
2006	1,610	1,340	1,490	7,000	No flood-control regulation.	
2007	3,740	3,730	3,700	7,000	No flood-control regulation. Deviation to store & release Rio Grande water at Cochiti Lake for silvery minnow recruitment.	
2008	5,970	5,990	5,150	7,000	No flood-control regulation; but levee safety concerns arose at the Bosque del Apache sediment plug near RM 79.	
2009	5,890	5,650	4,940	7,000	No flood-control regulation.	
2010	4,490	6,250	4,900	7,000	No flood-control regulation. Deviation to store & release Rio Grande water at Cochiti Lake for overbank inundation.	
2011	2,400	2,181	1,360	7,000	No flood-control regulation.	

[a] Cochiti Dam release does not include diversions into the Cochiti and Sile canals.
[b] Channel capacity was temporarily increased per an operational deviation.

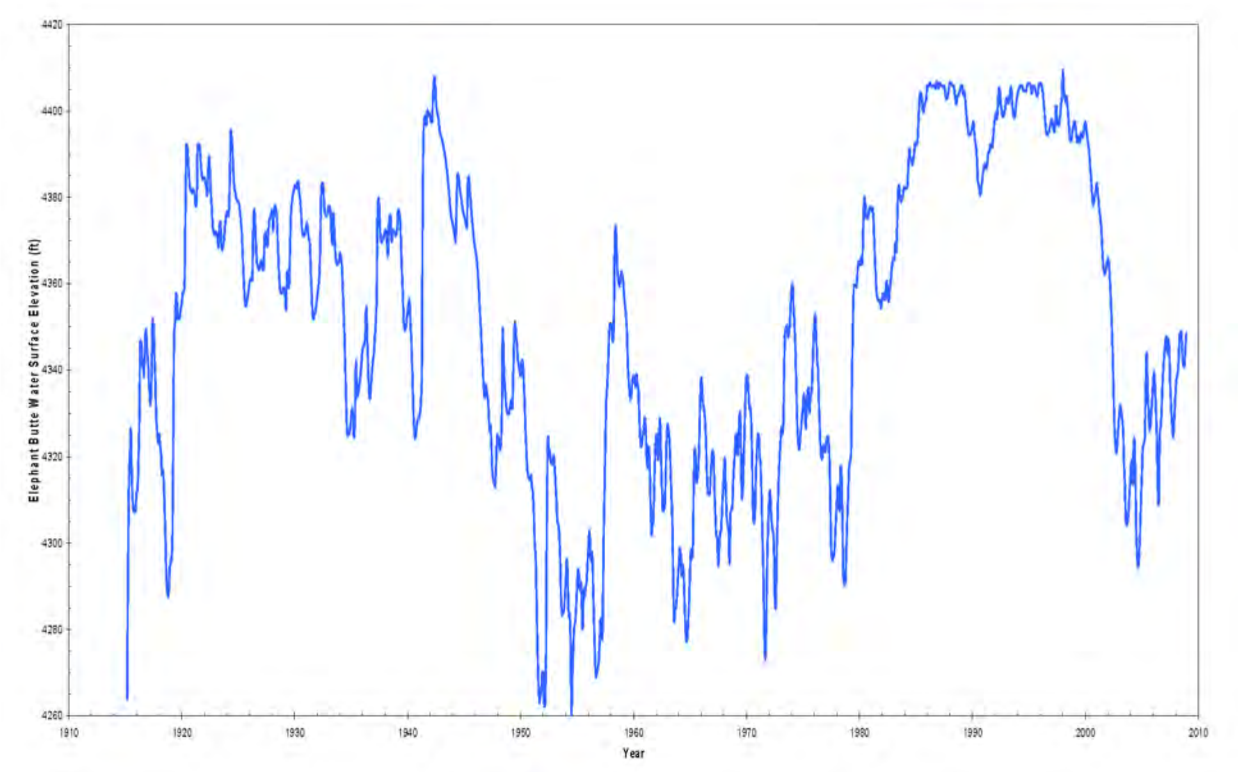


Figure 6.1. Elevation of Elephant Butte Reservoir at end-of-month, 1917 to 2009.

Rio Grande Silvery Minnow

Flood-control operation of the Corps' Middle Rio Grande facilities has limited peak flows in 13 of the past 37 years for both discretionary and non-discretionary reasons. Flood control operations are the responsibility of the Corps. Non-discretionary flood operation detentions the difference between lake inflow and downstream safe channel capacity. Regardless, this flood-control operation during spring runoff has provided the appropriate hydrographic conditions for successful spawning and recruitment of young-of-year silvery minnows (USACE 2008a). The high level of recruitment documented in 2005 indicates that these flood-control operations are unlikely to adversely affect silvery minnow populations in the Middle Rio Grande. The Corps has discretion for ramping flow up and down during flood control operations. Flood control operation may be initiated by ramping up flows when the discharge at Albuquerque reaches 4,500 cfs. At this discharge, approximately 6,630 acres (94%) of the main stem channel area is inundated, as well as 5,200 acres of the adjacent riparian zone (see Appendix C). Although flood-control operation reduces the potential maximum extent of inundated floodplain habitat, it increases the duration of beneficial floodplain inundation.

Flood-control actions in the Middle Rio Grande — regardless of discretion — do not directly result in adverse effects to the silvery minnow. When there is sufficient reservoir inflow for initiating flood-control operation, the regulated flows still produce suitable habitat conditions for the silvery minnow. Flood-control is initiated when flows are already sufficiently large to inundate overbank areas and in-channel bars (USACE 2010b) that may be used by silvery minnows as nursery habitat. This suitable habitat supports increased recruitment of silvery minnows. The total area of inundated habitat at the safe channel capacity of 7,000 cfs is sufficiently large during flood-control operations—approximately 21,000 acres—that there is no evidence of it limiting silvery minnow populations.

Habitat restoration monitoring studies have documented silvery minnows using inundated habitat (Hatch and Gonzales 2008a). The presence of adults, eggs, and larvae are indicators that inundated floodplain provides important habitat (Gonzales 2011; Pease *et al*. 2006; Turner *et al*. 2010). The patchy distribution of adults and larvae indicate that densities are below the threshold to fully exploit the inundated area provided by even moderate flow peaks. The patchy occurrence and low densities of these life stages supports qualitative inference of the value of inundated floodplain. However, quantitative analysis will depend on focused studies. Longer inundation of terrestrial habitat allow young-of-year silvery minnows more time to feed and grow prior to moving into the main river channel during the summer irrigation season (Magaña 2012). Flood-control operations benefit the silvery minnow by providing a longer duration of inundated riparian habitat supporting spawning and recruitment.

Middle Rio Grande flood-control operations—regardless of discretion—have small effects on the silvery minnow critical habitat Primary Constituent Elements (PCEs). Flood-control operations produce hydrographs that may affect, but are not likely to adversely affect the silvery minnow PCEs. The hydrologic regime (PCE (i)) upstream of Cochiti Lake determines water operations. Flood-control operations regulate the peak flow from exceeding channel capacity. The resulting hydrographs form a diversity of aquatic habitats within the floodway, including a variety of instream refuge habitats (PCE (ii)). Cochiti Dam flood-control operations would not change downstream substrate composition (PCE (iii)), while the outflow would be within the prescribed water temperature range of 1 to 30°C (PCE (iv)), and would not decrease dissolved oxygen nor increase pH of the river water (PCE (v)).

As described above, the differential in the peak discharge between discretionary and non-discretionary flood-control operation is slight. **Based on hydraulic conditions, the Corps' discretionary spring runoff flood-control operation may affect, but is not likely to adversely affect, silvery minnow populations in the Middle Rio Grande. The Corps' discretionary flood-control operation during spring runoff may affect, but is not likely to adversely modify, silvery minnow critical habitat based on the minimal effect on the Primary Constituent Elements.**

The cumulative effects on downstream habitat degradation (*i.e.*, channel incision) are indirect to flood-control operations because they operate on a time scale over years as a result of sediment retention by the dams. The adverse effects of channel incision are discussed in Section 6.1.5.

Southwestern Willow Flycatcher

The combined operation of Middle Rio Grande flood-control dams has included the discretionary action of limiting flood-control peak discharges to prevent damage to the San Marcial railroad bridge in 1 of 37 years of operation. Based on the discussion above, and because of the relatively infrequent occurrence and the relatively small amount of riparian inundation prevented, **this action may affect, but is not likely to adversely affect, the Southwestern Willow Flycatcher, and is not likely to adversely modify its critical habitat**.

The cumulative effects on within-reservoir flycatcher habitat at Cochiti Lake are primarily related to the presence of the permanent pool and are indirect to discretionary flood-control operation. These adverse, cumulative effects of are evaluated in Section 6.1.4.

6.1.2 Discretionary Flood-control Operation During Summer Thunderstorms

The Corps has responsibility for managing flood waters resulting from summer thunderstorms in accordance with P.L. 86-645 to protect downstream life and structures in the event of summer floods. Similar to flood flows during the spring runoff period, the law explicitly requires that the Corps prevent the "flooding of areas protected by levees or unreasonable damage to channel protective works." Large flood events with the potential for widespread damage can occur during the summer monsoon season; however, most thunderstorm activity results in a brief spike in flow. The Corps manages large thunderstorm events to reduce the risk of flood damage from the peak discharge, as well as from the rapid increase in flow.

Rio Grande Silvery Minnow

The Corps' Middle Rio Grande flood-control operations have small effects on the silvery minnow critical habitat PCEs. The hydrologic regime (element (i)) upstream of Cochiti Lake determines water operations. The short-term detention of summer thunderstorm inflow replaces high spike flows with lower, longer duration flows downstream of dams. These flood-control operations contribute to a more consistent downstream flow providing stable instream refuge habitats (element (ii)) within the channel. Summer flood-control operations do not affect the channel substrate (element (iii)). Flood-control operations maintain water temperatures within the prescribed 1-30°C range (element (iv)), and do not decrease dissolved oxygen or increase pH water conditions (element (v)) downstream from the dams.

The operational criteria for summer thunderstorms described in Section 3.2.1 minimize changes to the natural hydrologic regime (element (i)) downstream of Cochiti Lake would principally reduce peaks with potential to cause flood damages. The short-term detention of summer thunderstorm inflow replaces high spike flows with lower, longer duration flows downstream of dams. The operational criteria for summer thunderstorms described in Section 3.2.1 minimize alteration of the natural hydrograph and provide more consistent downstream flow for stable instream refuge habitats (element (ii)) within the channel under whatever flow is present in the system. In contrast, thunderstorm events that produce inflow from arroyos or other tributaries producing natural hydrographs have greater potential to transport fish downstream away from refuge habitats into reaches that may become rapidly intermittent following the storm event. See Service reports on minnow salvage for the effects of unregulated storm events on downstream fish movement. The operational criteria for summer thunderstorms described in Section 3.2.1 bracket the range of flow for sediment transport. These operations would not change the substrate composition (element (iii)) downstream of the dams. The effects of sediment retention are addressed separately. The operational criteria for summer thunderstorms described in Section 3.2.1 would maintain water temperatures within the prescribed 1-30°C range (element (iv)), and not decrease dissolved oxygen or increase pH water conditions (element (v)) downstream from the dams for upstream thunderstorm events. In contrast, thunderstorm events that produce inflow from arroyos or other tributaries would have natural, highly variable effects to water quality parameters (temperature, oxygen, pH).

Summer thunderstorm flood-control operations are similar to natural rainstorms with a reduced magnitude with a longer duration producing slightly more stable habitat for silvery minnows to use. **Summer flood-control operations of Corps' dams may affect, but are not likely to adversely affect, silvery minnow populations in the Middle Rio Grande.**

Thunderstorm events would produce in micro-scale, beneficial changes to in-channel habitat complexity. **The Corps discretionary flood-control operation following summer thunderstorms may affect, but is not likely to adversely modify, silvery minnow critical habitat based on the minimal effect on the Primary Constituent Elements.**

Southwestern Willow Flycatcher

The short-term increases in flow from summer storms upstream from the four flood-control dams attenuate rapidly and, if not subject to flood-control detention, would only rarely induce brief (less than one day) overbank inundation along the mainstem of the Rio Grande. This irregular, short, and late-season inundation is not crucial to the long-term maintenance and growth of riparian vegetation. **Limiting the magnitude of summer flood flows would not affect Southwestern Willow Flycatchers that are present within the floodway of the Middle Rio Grande. Discretionary summer flood-control operation may affect, but is not likely to adversely modify critical habitat for the flycatcher**.

The cumulative effects of summer flood control operation on flycatcher habitat within the flood pool of Cochiti Lake, and on downstream channel incision are discussed in Sections 6.1.3 and 6.1.4, respectively.

6.1.3 Within-reservoir Effects of Reservoir Operation at Cochiti Lake

As described in Section 5.2.4, a pair of Southwestern Willow Flycatchers is believed to have nested within the delta of Cochiti Lake in 2011. Suitable nesting habitat for flycatchers has developed in the reservoir's delta primarily as a result of the presence of the permanent (recreation) pool, and secondarily as a result of flood-control operations. This section describes the development of riparian and wetland habitat in the delta, and the effects of continuing reservoir operations of flycatchers that may nest there in the future. (Neither the silvery minnow nor designated critical habitat for listed species occur within the flood pool of Cochiti Lake.)

At Cochiti Lake, the permanent pool and the majority of the flood pool lie along the border of the Great Basin Grassland biotic community (to the north) and the Plains and Great Basin Grassland biotic community (to the south) as defined by Brown (1982). Uplands adjacent to the Rio Grande and Cochiti Lake are vegetated by one-seed (*Juniperus monosperma*) and Rocky Mountain juniper (*J. virginiana* var. *scopulorum*), pinyon pine (*Pinus edulis*), Apache plume (*Fallugia paradoxa*), rabbitbrush (*Chrysothamnus depressus*), four-wing saltbush (*Atriplex canescens*), cholla and prickly pear (*Opuntia* spp.), and a variety of forbs and grasses including asters (*Aster* spp.), grama grasses (*Bouteloua* spp.), dropseeds (*Sporobolus* spp.), muhly (*Muhlenbergia torreyi*), and western wheatgrass (*Agropyron occidentale*).

The 23-mile-long White Rock Canyon begins just downstream from the Otowi Bridge, and attains a maximum depth of about 1,000 feet. Cochiti Dam is situated about 2.4 miles downstream from the southern end of the canyon. The maximum flood pool of the project extends 20 miles up White Rock Canyon, to a point approximately one mile upstream from the confluence of Cañada Ancha arroyo at Buckman. The permanent pool itself inundates the lower 3.5 miles of the canyon. This continuous inundation, along with periodic flood detention, has caused the vast majority of accumulated sediment to settle within the narrow canyon, rather than in the main body of the lake. As of 2005, the point of maximum sediment deposition—about 60 feet deep—is 5 miles upstream from the dam; that is, about 2.6 miles upstream from the mouth of White Rock Canyon.

Prior to dam construction and the establishment of the permanent pool, vegetation within the riparian zone of White Rock Canyon was very limited, consisting of approximately 23 acres of woody vegetation at the mouths of the larger tributary canyons in 1935 (Fort Collins Science Center 1994) and in 1963 (based on Corps evaluation of aerial photography). After the filling of the permanent pool in October 1975 and subsequent, periodic floodwater detention, riparian and wetland vegetation began developing throughout the lake's delta in White Rock Canyon. Potter (1981) mapped 57 acres of mixed juniper, Rio Grande cottonwood, and ponderosa pine (*Pinus ponderosa*) stands at the mouths of larger tributary canyons, and noted that non-persistent pioneer vegetation was present on some portion of the nearly 85 acres of sandbars that had developed after dam closure. During the 1990s (Allen *et al*. 1993, NWI 2002), approximately 200 acres of persistent or woody riparian and wetland vegetation occurred within White Rock Canyon downstream from the confluence of Frijoles Canyon. Currently, approximately 291 acres of riparian and wetland vegetation occur within this reach based on vegetation mapping by the Corps in 2010.

Vegetation within this reach consists of approximately 31 acres of emergent wetland dominated by cattail (*Typha latifolia*), northern reedgrass (*Calamagrostis stricta* var. *inexpansa*), barnyard grass (*Echinochloa crus-galli*), and various rushes and bulrushes. The majority of vegetation (255 acres) within the riparian zone consists of willow stands dominated by Goodding's willow (*Salix gooddingii*) and coyote willow (*S. exigua*) ranging from less than 5- to about 24-feet tall. The remaining 5 acres consists of small areas of mature Goodding's willow and Rio Grande cottonwood.

In 2009, Reclamation (2009) classified the suitability of Southwestern Willow Flycatcher nesting habitat between Velarde and the Pueblo de Cochiti. Based on recent vegetation mapping, the Corps updated this classification for the vegetated stands within the Frijoles reach of White Rock Canyon, and similarly classified the vegetation surrounding Cochiti Lake and along the Santa Fe River upstream from the dam. Approximately 53 acres were classified as Highly Suitable flycatcher habitat, exhibiting dense, vigorous growth and structural diversity. These stands occupy the zone at, and just upstream from, the limits of the permanent pool (Figure 6.2). Suitable flycatcher nesting habitat (Class 4), which is structurally more uniform than Class 5, comprises about 135 acres. Class 4 habitat type comprises the majority of the riparian-zone vegetation along 6.5 river-miles of the channel within White Rock Canyon, and also occurs in two patches along the shore of the permanent pool. Approximately 65 acres was classified as Marginal flycatcher nesting habitat (Class 3), which lacks sufficient structure or stand size to be deemed suitable. Class 3 stands were interspersed with Class 4 stands along the channel in the canyon. Some of the Class 3 stands may become suitable habitat as they mature; however, most consist of relatively narrow bands along the bank. The remaining vegetation surrounding the permanent pool and within White Rock Canyon was unsuitable flycatcher habitat (depicted in Figure 6.2 as combined Classes 0, 1 and 2). Riparian vegetation along the Santa Fe River upstream from the dam also was not suitable flycatcher nesting habitat. Regardless of their suitability as nesting habitat, flycatchers may utilize any of these vegetation types during migration.

Because Corps flood-control operations are optimized to reduce the risk of loss of life and flood damage downstream, the Corps will continue current flood-control operations at the Cochiti Dam and Lake project. It is likely that such flood-control operation could immerse and drown the eggs or nestlings of flycatchers breeding within the flood pool of Cochiti Lake.

To determine their probability of inundation due to reservoir operation, the substrate elevation of all Class 3, 4 and 5 stands was estimated using 2-foot contour-mapping. Given that the current elevation of the permanent pool is at 5,341.5 feet (NGVD, 1929), all 188 acres of Suitable and Highly Suitable nesting habitat (Classes 4 and 5) occur within a 15-foot zone above the permanent pool (Figure 6.3). Approximately 50% of Class 4 and 5 stands have developed in the 2-foot zone immediately above the level of the permanent pool. Based on the current elevation probability curve for Cochiti Lake, there is a 50% (at elev. 5,342 ft) to 38% (at elev. 5,356 ft) probability that the ground surface in Class 4 and 5 stands would be inundated in a given year.

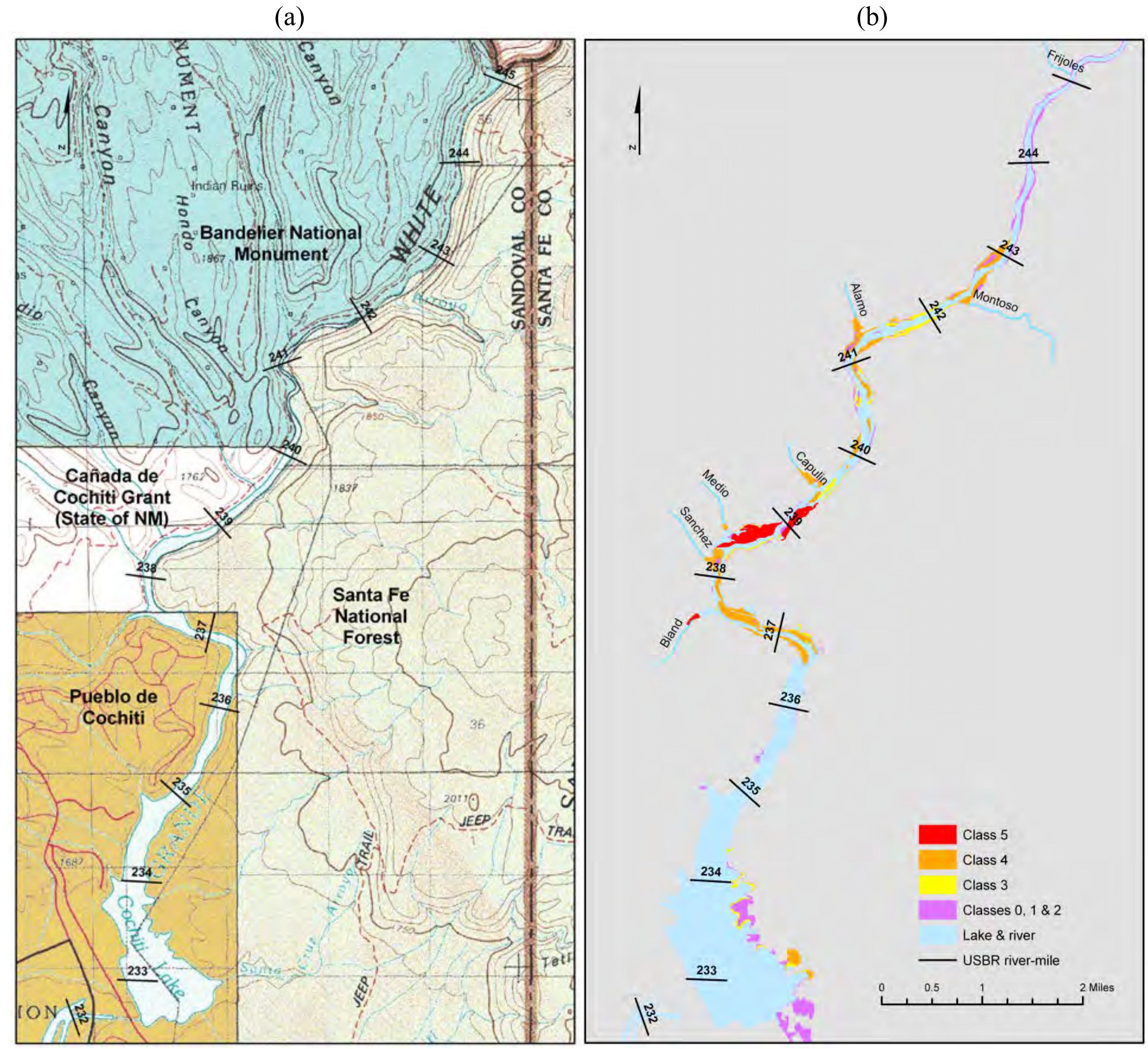


Figure 6.2. (a) Location of Cochiti Lake and neighboring lands. (b) Spatial distribution of Southwestern Willow Flycatcher habitat at Cochiti Lake and the Frijoles Reach of the Rio Grande.

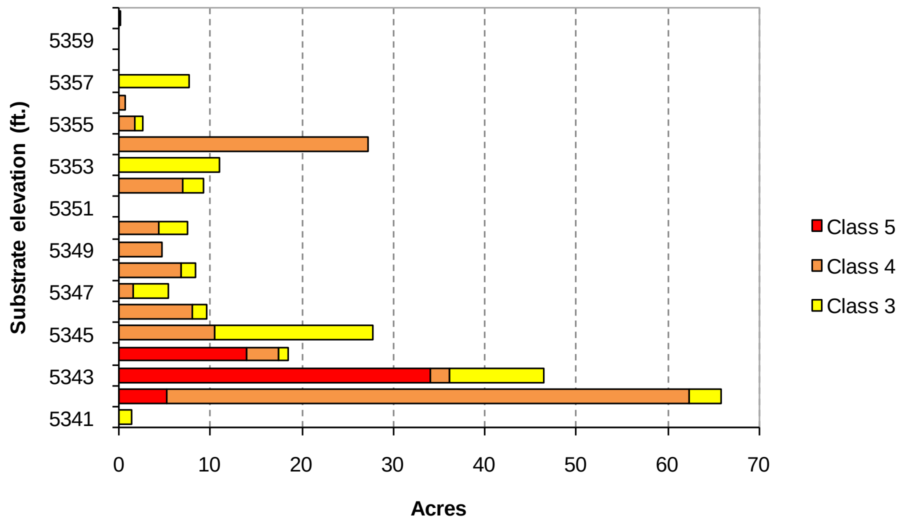


Figure 6.3. Elevational distribution of Highly Suitable (Class 5), Suitable (Class 4) and Marginal (Class 3) nesting habitat for the Southwestern Willow Flycatcher at Cochiti Lake and within White Rock Canyon.

Adult and flighted young flycatchers are, of course, capable of avoiding drowning; however, eggs and nestlings are susceptible to inundation by rising floodwaters. Therefore, the probability of inundation also is dependent on the height of the nest above the substrate. At Elephant Butte Reservoir during 2004 through 2008, the average flycatcher nest height in stands with a dry substrate was 10.7 ft (3.27 m; n = 31), but was lower, 8.2 feet (2.49 m; n = 52), at nest sites with saturated substrate (Ahlers and Moore 2009). Generally, flycatcher nest height appears to be lower in stands with dense vegetation closer to the ground (Ahlers and Moore 2009, Paxton et al. 2007). In a review of recent literature, the minimum flycatcher nest height that was reported was 4.6 ft (1.40 m) at Roosevelt Lake in Arizona (Graber et al. 2007).

Assuming that future flycatcher nests at Cochiti Lake are a minimum of 4 feet above the ground surface, the probability of inundating eggs or nestlings is somewhat less than that of substrate inundation. As shown in Figure 6.4, there is a 43% to 35% probability, depending on elevation, that nests in Class 4 or 5 stands would be inundated in a given year.

The timing of nest construction and egg-laying relative to the pattern of floodwater detention also affects the probability of nest inundation at Cochiti Lake. Flycatchers generally begin arriving in the Middle Rio Grande in mid-May and begin nest construction in mid-May through mid-June. To determine the likelihood of experiencing rising floodwater levels, the elevation of Cochiti Lake was analyzed during the May 15 through June 30 period over the past 36 years relative to its elevation on May 15 (Figure 6.5). In 15 of 36 years, the lake level decreased or fluctuated one foot or less in either direction. Lake levels increased 1 to 3 feet after May 15 in 4 of 36 years. In 17 of 36 years, the lake increased 4 to 65 feet in elevation during the May 15 to June 30 period, and, therefore, could potentially have inundated the contents of flycatchers nests had any been initiated during that period. Thus, historically, in 47% of the years that Cochiti Dam has been in operation, detained floodwater rose high enough during the incubation and nestling periods of flycatchers to inundate the minimum elevation at which nests would likely be established in the reach today. Because this probability estimates the risk of inundation regardless of the absolute pool elevation on May 15, it may be a better indicator of the potential for future “take” than the substrate or nest inundation probabilities discussed previously.

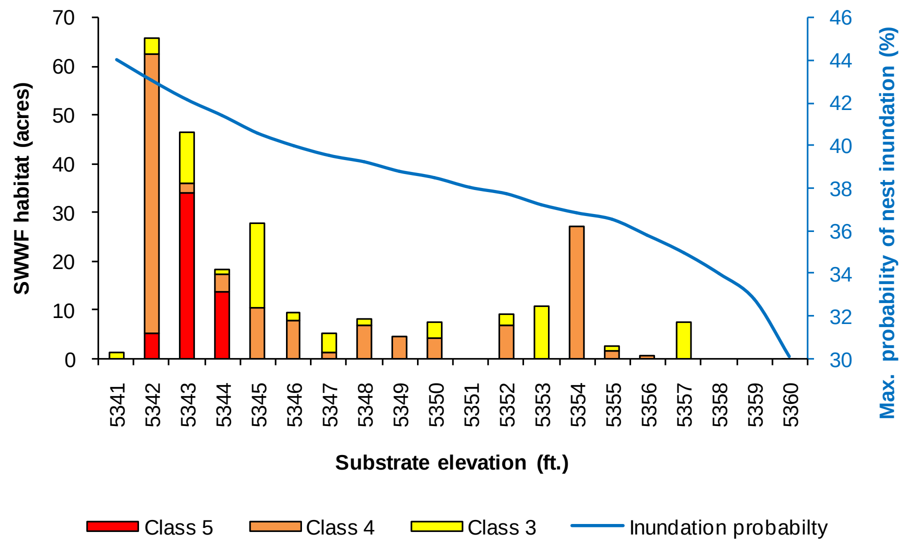


Figure 6.4. Elevational distribution of flycatcher habitat at Cochiti Lake (as depicted in Figure 6.2) and the probability of inundation of a nest placed 4 ft above the ground surface.

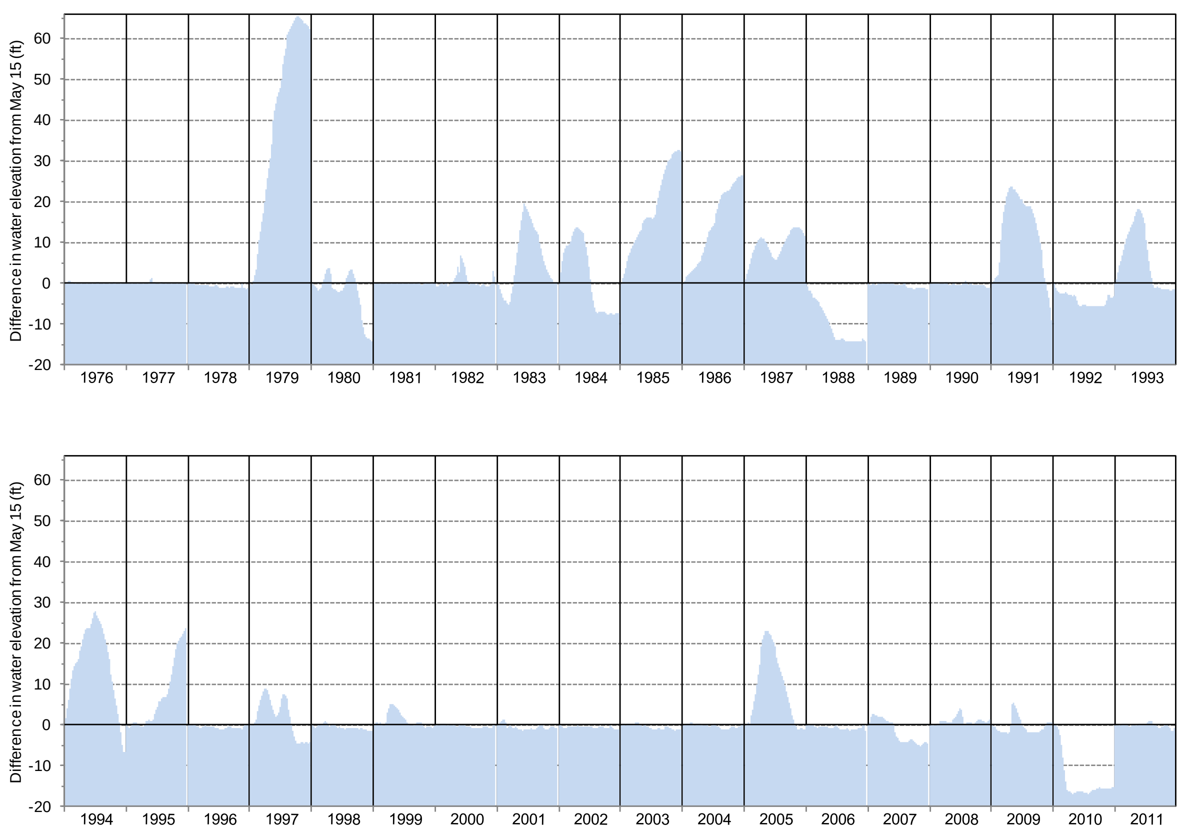


Figure 6.5. Cochiti Lake elevation during May 15 through June 30 relative to its elevation on May 15.

The riparian and wetland vegetation in the Cochiti Lake delta has been steadily developing since 1980. At least 40 acres of suitable nesting habitat has been present for approximately 10 years. While flycatchers have been known to use the area during spring migration since 1995, the first pair of birds was not detected until 2011. The future occurrence of breeding flycatchers in the Cochiti Lake delta is very difficult to predict.

Cochiti Lake is an isolated location relative to existing flycatcher breeding areas. The nearest known breeding flycatchers occur along the Rio Grande at Ohkay Owingeh, approximately 33 river-miles upstream, and at Isleta Pueblo approximately 64 river-miles downstream of Cochiti Lake. In a study of flycatcher populations in Arizona, Paxton *et al*. (2007) documented adult movements ranging 30 to 133 miles (49 to 214 km), and natal dispersal of young ranging 32 to 275 miles (52 to 444 km). Therefore, colonization of the Cochiti Lake site by flycatchers from other Rio Grande locations is certainly possible.

A rapid increase in the number of territorial flycatchers has been documented at several locations, including those along Rio Grande (see references for Reclamation's Middle Rio Grande surveys since 1995). Receding reservoir storage at Elephant Butte Reservoir and the development of suitable vegetation has resulted in an increasing number of territorial flycatchers, from 2 in 1995 to 323 in 2010. Somewhat similar increases have been observed at Roosevelt Lake in Arizona where the flycatcher increased from 48 territories in 1998 to 209 territories in 2005 in response to receding lake levels and expanding riparian vegetation (Paxton *et al*. 2007). While these examples are not analogous to conditions at Cochiti Lake, they do illustrate the high potential for rapid colonization of specific locations. Flycatcher colonization of the Cochiti Lake delta might follow the pattern observed at a smaller locale. For example, changed flow conditions and increased growth of riparian vegetation along the Rio Grande at Bosque del Apache NWR resulted in an increase of territorial flycatchers from 5 in 2008, to 20 in 2009, and 34 in 2010 (see Table 5.4).

Although the relative risk to nesting flycatchers at Cochiti Lake has been estimated above, and there is a strong probability for an increasing number of breeding birds, there is insufficient data at this time to accurately estimate the magnitude of potential take that may result from the inundation of eggs or nestlings by rising reservoir levels. The Corps is requesting incidental take coverage for this aspect of the proposed action. The Corps is also requesting the Service’s assistance to meaningfully estimate that incidental take.

Based on the discussion above, **this action may affect, and is likely to adversely affect, the Southwestern Willow Flycatcher; and may likely result in take of eggs or nestlings of flycatchers within the flood pool at Cochiti Lake.**

6.1.4 Effects of Sediment Control

Sediment control is an authorized purpose of all four Corps dams in the middle Rio Grande basin. Since the evacuation of the sediment retention pool at Jemez Canyon Reservoir, the Corps has not purposely operated to detain sediment at their facilities. However, sediment is trapped behind Cochiti and Abiquiu dams as a result of the pools maintained for other project purposes. This section evaluates the expected future conditions of the downstream channels and potential indirect effects on listed species and their critical habitat.

As described in Section 4.3.2, the channel bed elevation of the Rio Chama downstream from Abiquiu Dam is expected to remain stable in the future due to sediment contributions from tributaries. Additionally, the channel of the Rio Grande downstream from the confluence of the Rio Chama is currently stable—except in an area of previous sand-and-gravel extraction—and is not expected to develop marked aggradational or degradational trends in the future (Massong *et al*. 2008).

The invert of the uncontrolled gate at Galisteo Dam is the same as the pre-dam channel, and no incision of the downstream channel is expected to occur in the future.

As described in Section 2.5.1, the sediment retention pool at Jemez Canyon Dam was discontinued in 2001. Since that the downstream reach of the Jemez River has aggraded (within the previously incised channel) approximately 6 vertical feet due to bedload material being passed through the dam. The Corps estimates that up to 191 ac-ft of sediment may pass through the dam annually, which will continue this aggradational trend in the lower Jemez River and the Rio Grande mainstem.

Downstream from Cochiti Dam, future channel incision was estimated after a literature review, and bank height analysis (see Section 4.3.1). A HEC-RAS model was built using the 2002 aggradation/degradation cross sections as the base condition. The thalweg elevation was then lowered by the predicted future incision amount. Only the lowest points in the cross section were lowered, leaving any islands or bars that were above water at the time of the 2002 survey at their existing elevation. In reality, the actual location of bed or bank erosion may be spread across the cross section, rather than concentrated at the thalweg elevation.

The magnitude of post-Cochiti Dam incision in the now-stable reach upstream from Angostura Diversion Dam appears to be approximately 6 feet, and is not expected to increase in the future. Incision has continued downstream from Angostura Diversion Dam, but is progressively reduced, in part, due to sediment supplied by intervening tributary (mostly arroyos). It is expected that incision will continue in the downstream direction, but its vertical extent will be reduced proportional to the sediment supplied by intervening tributaries (see Table 4.1). This relationship is expected to continue downstream to the South Diversion Channel outlet, beyond which no future incision is expected.

In this analysis it was assumed that the Jemez River would supply at least 50 acre-feet of sediment annually—a conservative estimate since there are indications that an average of nearly 200 acre-feet per year may pass through the dam in the absence of a pool. No further incision should occur along the Rio Grande within the Pueblo of Santa Ana due to three grade control facilities that have been constructed by Reclamation (1999) and the Corps (USACE 2002). In addition, local grade control was accounted for at a bedrock outcrop underlying the channel upstream from the Bernalillo Bridge.

The maximum magnitude of future incision downstream from the Bernalillo Bridge is estimated to be approximately 2.3 feet (Figure 6.6). Three intervening tributaries—Baranca Arroyo, Montoyas Arroyo, and the North Diversion Channel—contribute sediment in this portion of the river. The Albuquerque Drinking Water Diversion Dam, just downstream from the Alameda Bridge, will function as a grade control, and Calabacillas Arroyo and the South Diversion Channel provide sediment to limit future incision to approximately one foot or less through the central Albuquerque reach. Finally, the Isleta Diversion Dam provides a grade control to further limit future downstream incision. Local scouring immediately below the diversion dam will be dependent on sediment management at that facility.

The expected bed incision would slightly reduce the extent of channel and bar inundation between the Highway 550 bridge in Bernalillo and Tijeras Arroyo for a given rate of flow. The estimated change in acreage was determined from HEC-RAS modeling and is presented in Figure 6.7. The reduction in wetted surface area within the channel ranges from 50 to 200 acres depending on the discharge rate. Specifically, incision may reduce the wetted surface area—including shallow foraging areas for the minnow—by a maximum of 200 acres at a discharge of 2,000 cfs.

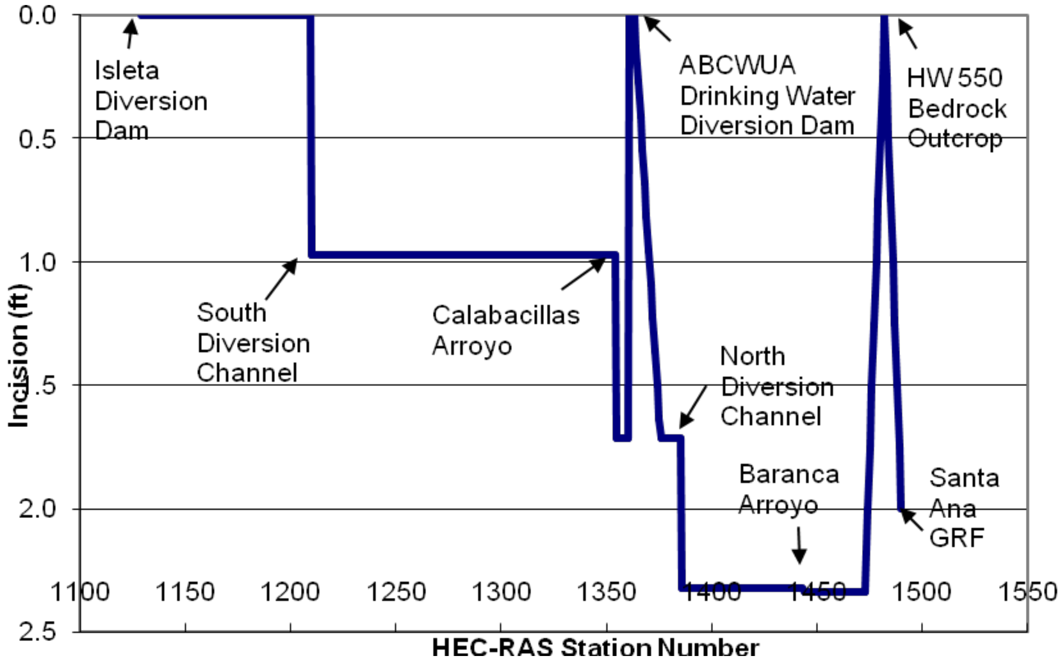


Figure 6.6. Maximum expected channel incision from the Pueblo of Santa Ana to the Isleta Diversion Dam. Rio Grande flow direction is from right to left.

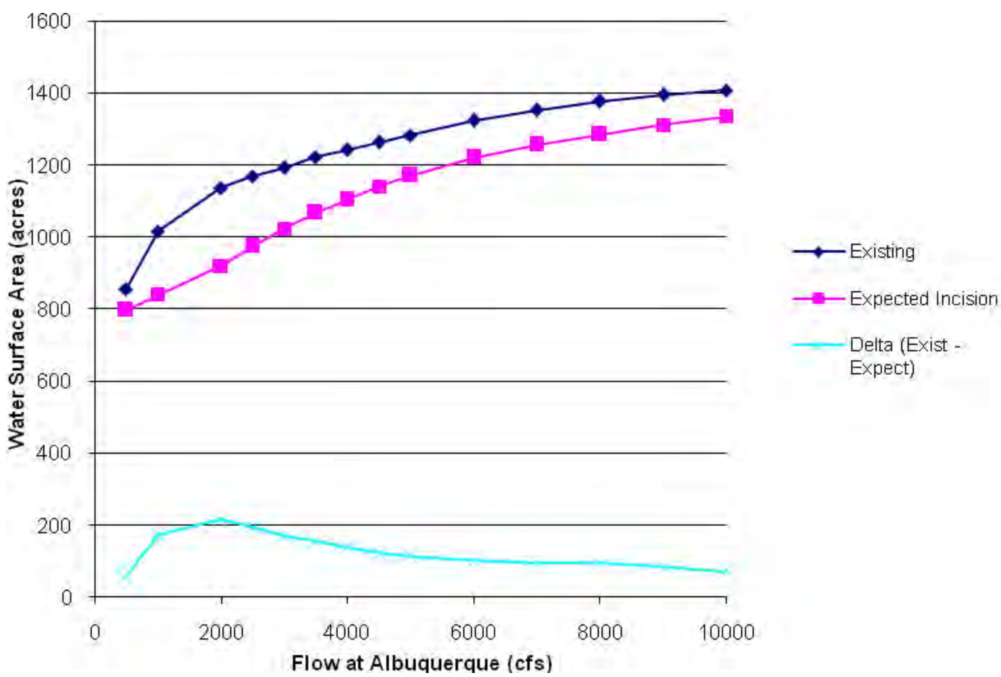


Figure 6.7. Existing and expected future channel wetted surface area in the reach from Bernalillo to Isleta Diversion Dam, and the expected reduction between Bernalillo and Tijeras Arroyo.

The expected annual rate of incision is difficult to predict because both main stem erosion and the influx of offsetting sediment supply are dependent on the timing of a series of flow events. However, it is not expected that the incision transition zone would progress past Calabacillas Arroyo within 10 years. The rate of incision in the vertical direction within the transition zone may be approximately 0.1 feet per year.

Rio Grande Silvery Minnow

The silvery minnow no longer occurs in the Rio Grande basin upstream of Cochiti Dam (Buntjer and Remshardt 2005). Currently, the operation of Abiquiu Dam would have no effect on silvery minnows or their habitat upstream of Cochiti Lake.

Cochiti Dam influences sediment transport in the downstream channel. The inflow of sediment from various arroyos between Cochiti Dam and Isleta Diversion Dam reduces the impact of sediment control moving downstream. Tijeras Arroyo is a major sediment source marking the endpoint for the effects of sediment control on channel morphology in the Angostura Reach.

Operation of Cochiti Lake and other Middle Rio Grande Corps facilities decreases sediment load (through trapping in the reservoir) leading to increasing channel incision, and decreasing surface water inundation downstream. Flood-control operations downstream of Cochiti Lake during spring runoff mobilize sediment and deposit it on point bars and islands, expanding the channel area stabilized by riparian vegetation. Stabilized islands result in a loss of instream habitat area (element (ii)), with narrower, deeper incised channels, increased water velocities and decreased shallow water areas for primary productivity (diatoms, algae). Channel substrate (element (iii)) downstream from Cochiti Dam to Bernalillo is hardened and not suitable, and is variable between Bernalillo and Isleta Diversion Dam. Channel incision from 1974 to 1992 reduced surface water inundation at all flows between Cochiti Dam and Isleta Diversion Dam. The rate of channel incision has slowed due to sediment inputs between the Jemez River and Tijeras Arroyo. Incision has variable local effects from Isleta Diversion Dam downstream to Elephant Butte Reservoir. Sediment control does not affect silvery minnow critical habitat constituent elements for water temperature (iv) or water conditions (v).

The effects of Cochiti Lake sediment control on silvery minnow critical habitat PCEs are gradual channel incision over time (indirect effect on critical habitat). Sediment control and channel incision do not affect the hydrologic regime (element (i)), water temperature (element (iv)) or water conditions (element (v)).

Channel incision reduces the variety of instream habitats (element (ii)) with increasing depth and water velocity, and decreasing wetted surface area (Figure 6.7). The increasing depth and water velocity have limiting effects on the silvery minnow food supply and population. Decreased sediment load and channel incision changes the substrate (element (iii)) from sand or silt to gravel or cobble.

The future impacts of sediment control to critical habitat are relatively small compared to the current baseline condition. The formation of islands and pointbars are compensating for decreasing surface water inundation (USACE 2010b). Since 1992, the decrease in wetted channel surface area from incision has produced minimal changes in water surface elevations for inundation of silvery minnow nursery habitat (including islands and pointbars).

Silvery minnows have demonstrated recruitment under minimal hydrological conditions (Dudley and Platania 2011, unpublished data). Analysis of silvery minnow recruitment data from the Middle Rio Grande is anticipated to be conducted by the Collaborative Program using Population Viability Analysis (PVA) modeling. PVA modeling may provide analyses for understanding population responses to management actions and delineating the interactions with PCEs of critical habitat.

Therefore, the future effect of channel incision as a result of sediment control by Middle Rio Grande flood-control facilities:

- **Will not adversely modify silvery minnow critical habitat in the stabilized reach between Cochiti Dam and the Highway 550 bridge at Bernalillo;**
- **May affect, likely to adversely modify silvery minnow critical habitat by channel incision and reducing surface water inundation in the actively incising reach between the Highway 550 bridge and Tijeras Arroyo;**
- **Will not adversely modify silvery minnow critical habitat in the reach downstream from Tijeras Arroyo; and**
- **May affect, and is likely to adversely affect silvery minnow populations in the Middle Rio Grande.**

Southwestern Willow Flycatcher

No breeding flycatchers are known to occur along the Rio Chama downstream from Abiquiu Dam and the mainstem Rio Grande downstream from its confluence to Cochiti Lake. (Flycatchers are known to nest along the Rio Grande immediately upstream from the Rio Chama confluence.) A small area of critical habitat has been designated along 0.4 mil of the Rio Grande near Española. As described above, and in Section 4.3.2, the bed elevation of the lower Rio Chama and the mainstem Rio Grande downstream from its confluence is expected to remain stable in the future.

The reach of the Rio Grande that will be affected by future channel incision extends from the Highway 550 Bridge at Bernalillo downstream to the Isleta Diversion Dam. There is no designated critical habitat for the flycatcher within this reach. No breeding Southwestern Willow Flycatchers are known to occur within the reach likely to be affected by future channel incision; however, migrant flycatchers have been regularly detected (USACE 2010a).

The only area of suitable flycatcher habitat within the Albuquerque reach occurs at the San Antonio Oxbow (USACE 2010a). This vegetation has developed primarily as a result of locally high groundwater conditions and surface water inflow from the riverside drain returning to the Rio Grande channel. The predicted one-foot of future incision in the channel adjacent to this area is not expected to alter vegetation conditions within the oxbow.

Even at the maximum regulated discharge of 7,000 cfs at the Albuquerque gage, river flow does not inundate riparian areas outside of the well-defined channel and its attendant bars through the Albuquerque reach. Therefore, the areas with the highest potential to develop into suitable breeding habitat in the future are limited to these river bars. Future channel incision 1 to 2.3 feet is expected to decrease the open water surface area within the channel at a given flow rate (Figure 6.7), and may concomitantly encourage the colonization of woody vegetation at a lower elevation on these bars. Therefore, the development of potential Southwestern Willow Flycatcher habitat is not expected to decrease due to future channel incision. Therefore, future channel incision between Bernalillo and the Isleta Diversion Dam **may affect, but is not likely to adversely affect, the Southwestern Willow Flycatcher**.

6.1.5 Delivery of "Carryover" Flood Water

Summarizing from Chapter 2, P.L. 86-645 specifies: 1) that flood waters shall be retained behind Corps dams after July 1 when flow at Otowi is less than 1,500 cfs; and 2) that such retained water shall be delivered downstream in the months of November through March. The Corps' only discretionary action in this regard is the rate at which such waters may be delivered in November through March. The Corps proposes to deliver future carryover water from Abiquiu Dam and/or Cochiti Dam to Elephant Butte

Reservoir at a constant rate above the base flow of Rio Grande basin discharge during the period from November 1 through March 31 (152-153 days). The rate and duration of carryover releases will depend on the actual volume to be evacuated.

Rio Grande Silvery Minnow

The release of carryover water during November through March increases the winter flow, but does not appreciably benefit, nor adversely affect the silvery minnow, or any primary constituent element of designated critical habitat. Carryover water does not adversely affect the hydrologic regime (element (i)), instream habitat (element (ii)), substrate (element (iii)), water temperature (element (iv)) or water conditions (element (v)). **The delivery of carryover flood water during from November 1 to March 31, may affect, but is not likely to adversely affect, the silvery minnow, or adversely modify silvery minnow critical habitat.**

Southwestern Willow Flycatcher

Willow Flycatchers are not present in the action area during November through March. Woody vegetation within the riparian zone (PCE 1) is dormant during this period (except, perhaps, one-seed juniper). Similarly, invertebrate prey species of the flycatcher (PCE 2) are inactive during the winter. The release of carryover water during the specified period does not measurably benefit, nor adversely affect, the constituent elements of designated critical habitat for the flycatcher. Therefore, **the proposed discretionary manner of carryover delivery would have no effect on the flycatcher or its critical habitat.**

6.1.6 Storage for San Juan-Chama Contractors at Abiquiu Reservoir

Up to approximately 180,000 acre-feet of San Juan-Chama (SJ-C) Project water may be stored Abiquiu Reservoir according to agreements between the Corps and project contractors. Reclamation releases SJ-C Project water from Heron Dam for delivery to Abiquiu Reservoir. No listed species or designated critical habitat occurs between Heron Dam and Abiquiu Dam.

The ultimate release of SJ-C water stored in Abiquiu Reservoir is up to the discretion of the owner, not the Corps. The release of this water is an interrelated and interdependent effect of the Corps' proposed action of providing storage space. Categorically, the transport of SJ-C project water within the Rio Grande basin is potentially beneficial to listed species and designated critical habitat because it increases both the discharge rate and volume above that of Rio Grande system flow.

The Albuquerque-Bernalillo County Water Utility Authority (ABCWUA) manages the majority (approximately 94%) of the 180,000 ac-ft that can be stored at Abiquiu Reservoir. The ABCWUA's primary use of SJ-C project water is to support the Drinking Water Project in Albuquerque. In 2004, Reclamation, in concert with ABCWUA, consulted with the Service on this project (Consultation #2-22-03-F-0146). The Service determined that this action, along with the proponent's environmental commitments and the Service's Reasonable and Prudent Measures, would not likely jeopardize the continued existence of the silvery minnow and will not adversely modify its designated critical habitat (USFWS 2004a).

Similarly, the City and County of Santa Fe use their SJ-C allotments to support their municipal water supply through the Buckman Diversion Project. The Santa Fe National Forest, in concert with the City and County, consulted with the Service (Consultation #22420-2006-F-0045) on the construction and operation of this project. The Service determined that this action, along with the proponents' environmental commitments and the Service's Reasonable and Prudent Measures, would not likely jeopardize the continued existence of the silvery minnow and will not adversely modify its designated critical habitat (USFWS 2007c).

By agreement with the ABCWUA, Reclamation stores up to 20,000 ac-ft within ABCWUA's space in Abiquiu Reservoir to support Reclamation's Supplemental Water Program. This water is used solely to benefit listed species, primarily to maintain flow rates specified in the 2003 BO.

Water stored by non-Federal entities in Abiquiu Reservoir also has been used, at their discretion, to offset groundwater depletions, or has been made available for purchase or lease by others, including Reclamation for their Supplemental Water Program. The Corps expects these uses to continue in the future.

The discretionary storage of San Juan-Chama Project water in Abiquiu Reservoir and its subsequent release may affect, but is not likely to adversely affect, the Rio Grande silvery minnow, Southwestern Willow Flycatcher, or modify critical habitat of either of these species. The release of such water—at the discretion of other entities—is benign or beneficial to the minnow, flycatcher, and their designated critical habitat.

6.1.7 Delivery of Cochiti Lake Permanent Pool Replacement Water

The discretionary schedule for the delivery of replacement water to the Cochiti Lake permanent pool from Heron Reservoir at the end of spring runoff, and during winter, follows recommendations from a multi-agency biological advisory group in order to maximize the benefits to the wetland and riparian vegetation in the delta area of Cochiti Lake (Allen *et al*. 1993). The elevation of the recreation pool increases approximately 1 to 1.5 feet with partial delivery of replacement water, and up to 4 feet after all replacement water is delivered in a given year. The delivery of water for the recreation pool does not change the hydrograph downstream from Cochiti Dam.

Rio Grande Silvery Minnow

The Rio Grande silvery minnow does not occur between Heron Dam and Cochiti Lake, nor does designated critical habitat for this species. The delivery of Cochiti recreation pool water does not affect the hydrologic regime (element (i)), instream habitat (element (ii)), substrate (element (iii)), water temperature (element (iv)) or water conditions (element (v)) for designated critical habitat downstream of Cochiti Dam. Therefore, **the delivery of recreation pool water would have no effect on the silvery minnow, or adversely modify its critical habitat.**

Southwestern Willow Flycatcher

Between Heron Dam and Cochiti Lake, a small area of designated critical habitat occurs along 0.4 mile of the Rio Grande channel spanning the Fairview Bridge in Española. Willow Flycatchers are known to use the river corridor upstream from Cochiti Lake during spring migration (Reclamation 2010), and are presumed to be similarly present during fall migration. Flycatchers are not known to breed along the Rio Chama and the main stem of the Rio Grande downstream from its confluences (see Section 5.2.4). In 2001 (see Appendix D), a pair of flycatchers is believed to have nested within the flood pool of Cochiti Lake. The annual replenishment of evaporation losses at Cochiti Lake maintains existing riparian and wetland habitat immediately adjacent to, and upstream from, the permanent pool, which flycatchers may utilize during migration or for nesting. Therefore, **the delivery of permanent pool water may affect, but is not likely to adversely affect, the Southwestern Willow Flycatcher.**

This action may have an indirect, beneficial effect by maintaining riparian habitat used by migrating and nesting flycatchers. The delivery of permanent pool water during the winter occurs when riparian vegetation between Heron Dam and Cochiti Dam is dormant, and, therefore, **does not measurably benefit, nor adversely modify, the constituent elements of critical habitat for the flycatcher.**

6.1.8 Cochiti Dam Outlet Fish Screen Replacement

To exclude fish from passing from the Cochiti Dam stilling basin into adjacent irrigation canals, fish screens and solid bulkheads are normally placed and exchanged in the outlet works two times each year (March and November). Fish screens are installed prior to irrigation season each year, later the screens are removed and replaced by solid bulkhead gates to minimize leakage into the irrigation outlets during the winter. Unusually high amounts of debris or sediment may require temporary removal of the screens using the same protocol during irrigation season for cleaning.

Figure 6.8 illustrates the change in flow downstream of Cochiti Dam following fish screen installation and removal at three gage locations (Cochiti, San Felipe, and Albuquerque). Fish screen replacement on the Cochiti and Sile irrigation canals reduces Rio Grande flow to approximately 100 cfs immediately downstream of the dam for three hours. The flow attenuates as it moves downstream and remains above the 100 cfs minimum target flow at the Albuquerque gage (USFWS 2003b). In 2008, the Corps installed hoists to reduce the time spent replacing screens on the irrigation canal inlets compared to previous years.

Rio Grande Silvery Minnow

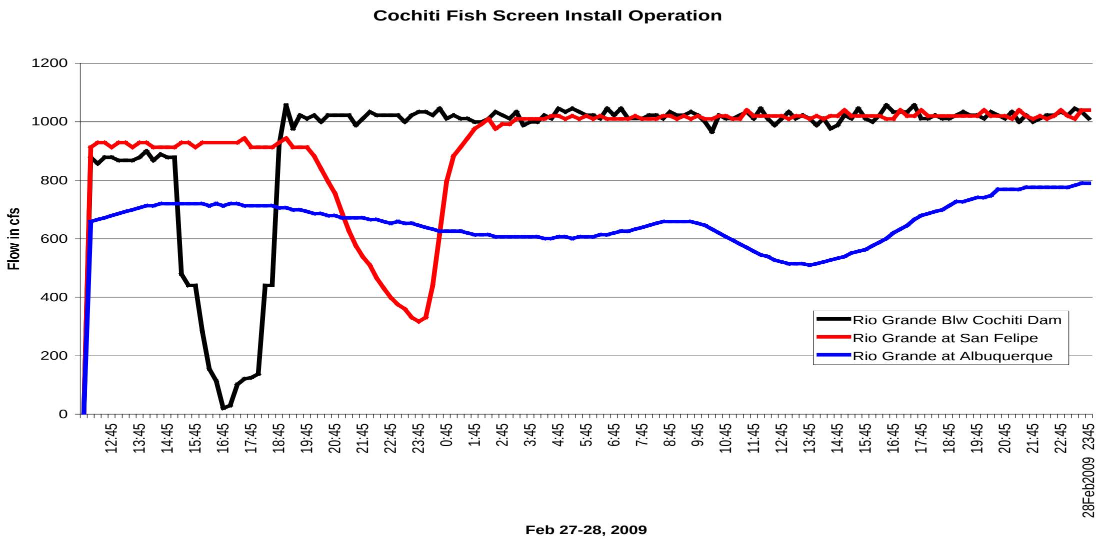
The change in flow magnitude and water surface elevations during fish screen installation and removal has a sufficiently short duration to resemble inverted thunderstorm flow pulses (magnitude and duration) from tributaries during the summer. The flow effects are rapidly attenuated downstream between the San Felipe and Albuquerque Gages. Attenuation of the negative flow spike reduces the effects on the hydrograph downstream of Angostura Diversion Dam.

Rapid changes in flow and water surface elevations have similar potential for fish stranding (including silvery minnows) regardless of whether they positive spikes (thunderstorms) or negative spikes (temporary flow suspensions). Fish screen replacement and thunderstorm events both produce rapid changes in water surface elevations that silvery minnows and other fish must respond to behaviorally. From a fish perspective, the likelihood of becoming stranded has a higher probability during a thunderstorm event when rapidly moving peak flows have the potential to leave fish on a terrace as the water recedes.

The principle difference is stranding during a negative spike (fish screen removal) is less likely to cause mortality because the flow will return to previous levels within a couple of hours. Stranding during a positive spike (thunderstorm event) may leave fish in pools that dry out prior to reconnecting with the river. Using a probabilistic approach, a naturally occurring thunderstorm event has a higher potential for mortality than replacing fish screens. Habitat restoration site monitoring reports have documented few fish (negative data) become stranded under rapidly changing flows during spring runoff or following rainstorm events (SWCA 2007, 2008a,b,c, 2009, 2011). The observations of these reports have not been compiled or analyzed by the Collaborative Program or the Service.

Behaviorally, fish (including silvery minnows) have been selected through evolution to respond appropriately to rapidly changing riverine water surface elevations (positive and negative spikes). Fish behavior reduces the probability of stranding during rapid changes in water surface elevations to undetectable levels under most flow conditions.

The attenuation of the flow changes (Figure 6.8) at Albuquerque is less than the descending hydrograph from a thunderstorm or normal water operations, which allows fish sufficient time to respond appropriately to avoid becoming stranded along the shoreline. The short duration change in flow does not adversely affect the hydrologic regime (element (i)), instream habitat (element (ii)), substrate (element (iii)), water temperature (element (iv)) or water conditions (element (v)).



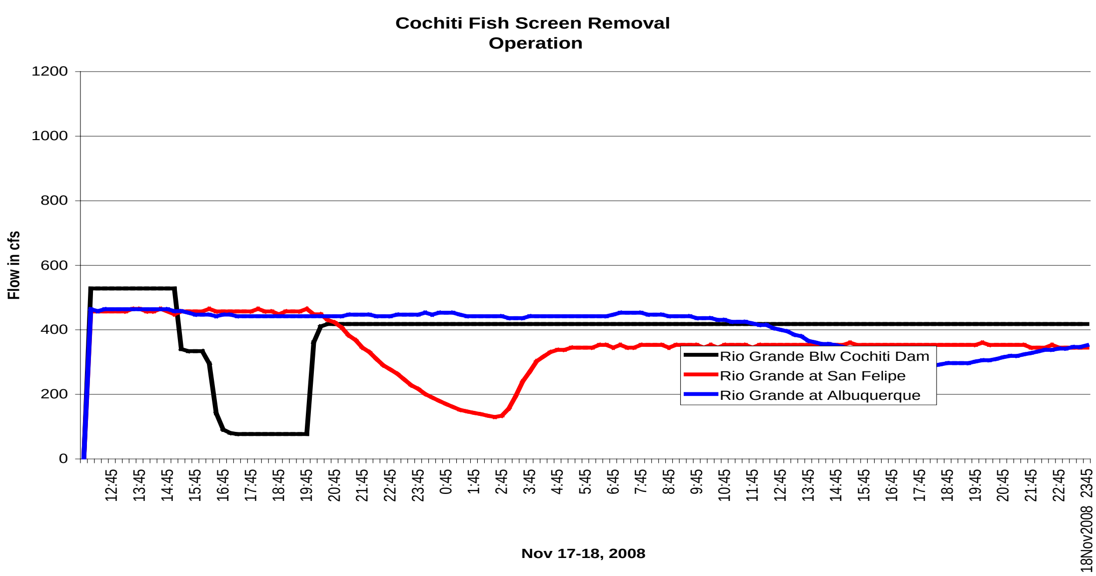


Figure 6.8. Typical range of changes in downstream hydrograph following fish screen operations at Cochiti Dam.

Due to the temporally short period of flow reduction, the exchange of the fish screens at the Cochiti Dam outlet may affect, but is not likely to adversely affect, the silvery minnow, and would have no effect on its designated critical habitat.

Southwestern Willow Flycatcher

The flycatcher does not occur in New Mexico in either March or November when the screens and bulkheads are exchanged at the Cochiti Dam outlet. The brief decrease in flow associated with this action attenuates before reaching designated critical habitat for the flycatcher approximately 67 river-miles downstream from the dam (near Bosque Farms). Therefore, **the annual replacement of fish screens at Cochiti Dam will have no effect on the flycatcher and its critical habitat.**

6.1.9 Abiquiu Dam Tunnel Inspection

To maintain the safety and structural integrity of the facility, periodic inspections are made of the outlet tunnel at Abiquiu Dam. Flow is suspended for approximately one hour. Figure 6.9 illustrates the change in flow downstream of Abiquiu Dam at three gage locations (Abiquiu, Chamita, and Otowi gages) during and following these inspections. Flow immediately below the dam is reduced to zero cubic feet per second for approximately one hour. This reduction in flow is attenuated by the subsequent resumption of dam releases, such that a nominal decrease of about 30 cfs occurs at the Chamita and Otowi gages, 29 and 49 river-miles downstream from the dam, respectively.

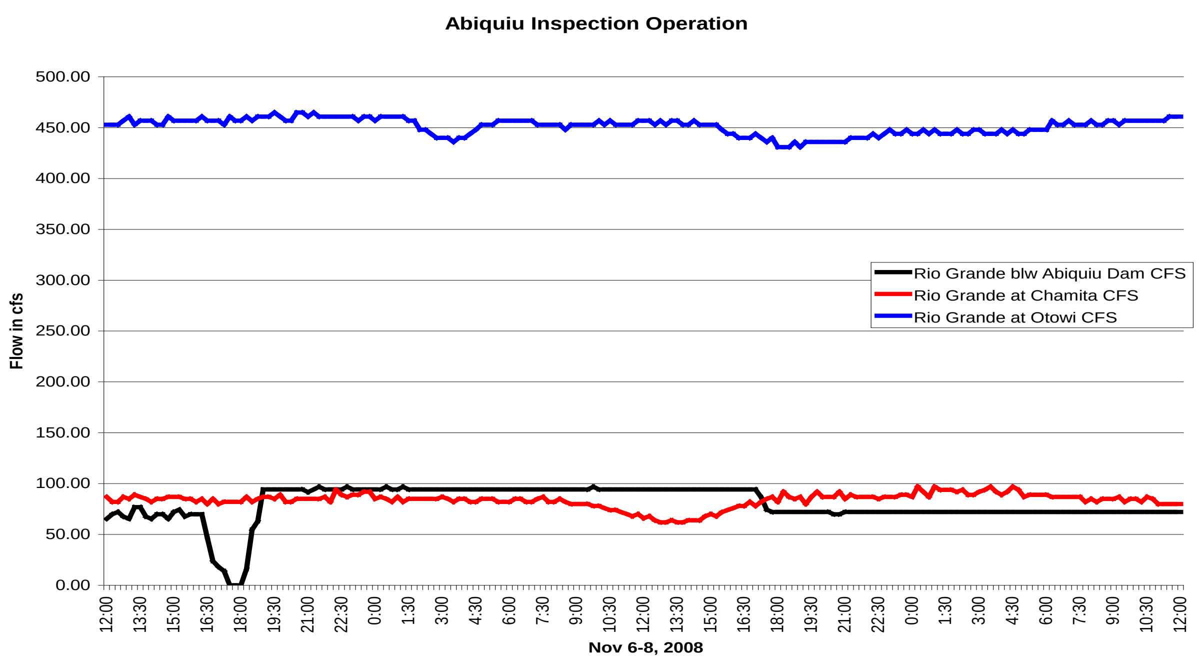


Figure 6.9. Typical example of discharge condition during Abiquiu Dam tunnel inspections.

Rio Grande Silvery Minnow

The silvery minnow does not occur in the Rio Grande basin upstream of Cochiti Dam. There is no designated critical habitat for this species between Abiquiu and Cochiti Dams. **The flow reduction would have no effect on the silvery minnow or its critical habitat.**

Southwestern Willow Flycatcher

A small population of breeding flycatchers is known to inhabit a riparian area along the Rio Grande immediately upstream from the Rio Chama confluence. Should breeding or migrating flycatchers be present during proposed tunnel inspections, the slight and temporary reduction in flows would not directly or indirectly affect these individuals.

A small area of designated critical habitat occurs along the Rio Grande channel in Española. The nearest downstream location of designated critical habitat for the flycatcher occurs near Bosque Farms, approximately 237 river-miles from Abiquiu Dam. The short decrease in flow from Abiquiu Dam resulting from this action is negligibly measurable at the Chamita gage, and virtually attenuates before reaching the USGS gage at the Otowi Bridge. **Therefore, the periodic tunnel inspection at Abiquiu Dam would have no effect on the flycatcher or its critical habitat.**

6.1.10 Flushing Jemez Canyon Dam Stilling Basin

To periodically flush sediment from the stilling basin, water will be stored behind the dam for up to 4 or 5 days and then released at approximately 600 cfs to flush out the sediment. During the entire period when water is being detained behind the dam, sufficient flow will be released to maintain continuous flow within the channel of the lower Jemez River from the dam to the Rio Grande (typically, 5 to 10 cfs).

The Jemez River drains a large portion of the Jemez Mountains, and is the largest tributary delivering sediment to the Rio Grande between Cochiti Dam and the Rio Salado. It is perennial in the upper reach and ephemeral in the lower reach (USACE 1994). The summer and fall periods are typified by low (or no) flow punctuated by thunderstorm-driven pulses, such as those depicted in Figure 6.10. The occasional flushing of the stilling basin would result in a brief increase in flow below the dam, similar to natural thunderstorm runoff. The discussion in Section 4.3.1 Rio Grande summarizes the current and ongoing geomorphologic conditions as they relate to the operation of Corps dams.

Rio Grande Silvery Minnow

Within the Pueblo of Santa Ana Reservation, the silvery minnow is known to occupy the Rio Grande and the Jemez River downstream from Jemez Canyon Dam. Surveys conducted in the Jemez River by the Pueblo of Santa Ana and the Service’s Fishery Resource Office in May 2000 netted 21 adult silvery minnows downstream from the dam. This reach has flood-prone benches which may provide suitable slackwater refugia for minnows during high discharges. During low-flow periods of the Jemez River, minnows likely move downstream to the perennially flowing Rio Grande.

Because the proposed flushing flows are similar to natural thunderstorm flows, continuous flow from the dam to the Rio Grande would be maintained. The sediment volume flushed from the stilling basin is included in the 191 acre-feet currently transported annually through Jemez Canyon Dam (Appendix E). The approximate 0.8 to 1.3 ac-ft of sediment flushed during this maintenance action equates to 0.4% to 0.7% of the 191 ac-ft of bedload material that currently passes through the dam annually. Flushing the Jemez Canyon Dam stilling basin would provide fine sediments for substrate (element (iii)). Flushing does not affect the hydrologic regime (element (i)), instream habitat (element (ii)), water temperature (element (iv)) or water conditions (element (v)). **Therefore, periodic flushing of the Jemez Canyon Dam stilling basin may affect, but is not likely to adversely affect, the silvery minnow, and would have no effect silvery minnow critical habitat.**

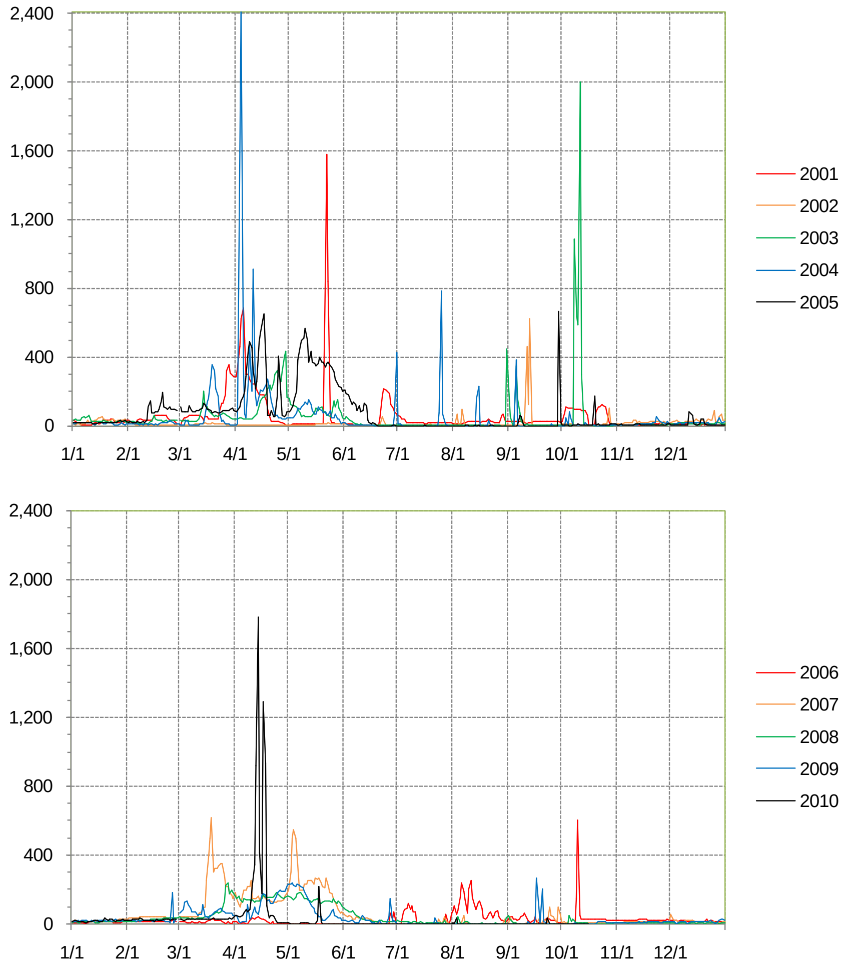


Figure 6.10. Mean daily discharge below Jemez Canyon Dam for calendar years 2001 through 2010.

Southwestern Willow Flycatcher

Small strings and patches of cottonwoods and coyote willows occur along the banks of the Jemez River downstream from the dam. While this vegetation may be used by migrating flycatchers, none of these stands comprise suitable breeding habitat. Therefore, **periodic flushing of the Jemez Canyon Dam stilling basin would have no effect on the flycatcher**. No designated critical habitat for the flycatcher occurs along the Jemez River, and none is present along the Rio Grande for 22 river-miles downstream from the Jemez River confluence.

6.2 PECOS SUNFLOWER

In the Middle Rio Grande, populations of Pecos sunflower exist at the La Joya Unit of the Ladd S. Gordon Waterfowl Complex and on private property south of Socorro in Socorro County. The NMDGF's habitat management plan for La Joya Wildlife Management Area preserves the ponds, springs, and wet soils within the La Joya Unit that influence the presence and distribution of Pecos sunflower. Two natural geomorphologic conditions and one man-made condition create these wet soil features. Hydraulic pressure from the upstream end of the Albuquerque basin causes movement of water to the surface near the downstream end, creating seeps or swampy areas within the La Joya Unit and adjacent areas. A second geomorphologic feature of the area, uplands of unconsolidated materials to the west of the La Joya Unit, allows precipitation to migrate downwards until intercepting either less permeable beds or local groundwater. At this point, water migrates horizontally, re-appearing at the surface as a seep or spring along the western edge of the La Joya Unit. Finally, a third source of water at the La Joya Unit is the managed ponds. An agreement between NMDGF, MRGCD, and Reclamation allows the diversion of water from the La Joya Drain, to the extent such water is available, to six man-made ponds on the La Joya Unit from October 1st to February 1st. Pecos sunflowers occur adjacent to most of these ponds. In general, water has been available to these ponds every year from October through March. The ponds are allowed to dry gradually, facilitating germination and growth of plants including Pecos sunflower (NMDGF 2007).

The privately owned population is located approximately 25 miles (40 km) south of the La Joya population. It is protected from grazing and the landowner is collaborating with the Service to manage the population. Natural geomorphologic conditions produce a high groundwater table at this site, making it well suited to Pecos sunflower.

The Corps has a limited discretionary authority relating to floodwater regulation on the Middle Rio Grande during spring runoff and summer thunderstorms, as described in Section 3, ‘Description of proposed actions.’ The Corps’ discretionary operations would not cause flooding of sunflower habitat at the La Joya Unit, nor would ground water be affected. The source of water for the seeps, springs, and ponds at La Joya does not depend on river water. Furthermore, the La Joya Unit is hydrologically separated from the river by the riverside drain (Unit 7 Drain Extension), the spoilbank levee, and the BNSF railroad berm, and the La Joya Drain (see map of La Joya, Figure 5.7). The privately-owned sunflower population is approximately 0.5 mile (880 meters) distant at its nearest point from the current active river channel and is separated from the river by higher ground. It would not be flooded by Corps’ discretionary operations, nor would groundwater at this site be affected. Neither population is within the areas inundated by the relatively large runoff discharge in 2005. Therefore, **the Corps’ discretionary reservoir operations would have no effect on the Pecos sunflower.**

6.3 INTERIOR LEAST TERN

The Interior Least Tern is a vagrant within the action area. The relative abundance of all Rio Grande fish species (October) varies spatially (within and between reaches) and temporally (monthly and annually) over an order of magnitude (Dudley and Platania 2012). Differences in reproductive behavior and spawning habitat may contribute to reliable prey densities while individual species fluctuate spatially and temporally. The vagrant status of the Interior Least Tern for the Middle Rio Grande does not justify additional analysis of prey fish densities. None of the proposed Corps reservoir operations would result in an altered flow regime that would measurably affect the density or availability of the tern’s prey species. Therefore, **the proposed actions would not affect the Interior Least Tern**.

6.4 SUMMARY OF EFFECTS

Table 6.2 summarizes Corps determination of the effects for all of the proposed actions. In consideration of all direct, indirect, and cumulative effects, the Corps' discretionary proposed actions would:

- **Have no effect on the Interior Least Tern and Pecos sunflower;**
- **May affect, and would likely adversely affect, the Rio Grande silvery minnow;**
- **May affect, but would not likely adversely modify critical habitat for the Rio Grande silvery minnow between Cochiti Dam and the Highway 550 bridge in Bernalillo, or between Tijeras Arroyo and Elephant Butte Reservoir;**
- **May affect, and would likely adversely modify critical habitat for the Rio Grande silvery minnow between the Highway 550 bridge in Bernalillo and the confluence of Tijeras Arroyo Diversion Dam;**
- **May affect, and would likely adversely affect, the Southwestern Willow Flycatcher; and**
- **May affect, but would not likely adversely modify critical habitat for the Southwestern Willow Flycatcher.**

Table. 6.2. Summary of determined effects to listed species and designated critical habitat.

Action	Rio Grande silvery minnow		Southwestern Willow Flycatcher		Pecos sunflower	Interior Least Tern
	Species	Critical habitat	Species	Critical habitat		
Discretionary flood control, spring runoff	Not likely adversely	Not likely adversely	Not likely adversely	Not likely adversely	No effect	No effect
Discretionary flood control, summer thunderstorm	Not likely adversely	Not likely adversely	No effect	Not likely adversely	No effect	No effect
Within-reservoir effects at Cochiti Lake	No effect	No effect	**Likely adversely**	No effect	No effect	No effect
Downstream effects of sediment retention	**Likely adversely**	**Likely adversely, Bernalillo to Isleta DD**.	Not likely adversely	No effect	No effect	No effect
Delivery of carryover flood water	Not likely adversely	Not likely adversely	No effect	No effect	No effect	No effect
Storage for San Juan-Chama contractors at Abiquiu Reservoir	Not likely adversely	Not likely adversely	Not likely adversely	Not likely adversely	No effect	No effect
Delivery of Cochiti recreation pool replacement water	No effect	No effect	Not likely adversely	No effect	No effect	No effect
Cochiti Dam outlet fish screen replacement	Not likely adversely	No effect	No effect	No effect	No effect	No effect
Abiquiu Dam tunnel inspection	No effect	No effect	No effect	No effect	No effect	No effect
Flushing Jemez Canyon Dam stilling basin	Not likely adversely	No effect	No effect	No effect	No effect	No effect
Cumulative	**Likely adversely**	**Likely adversely, Bernalillo to Tijeras Arroyo**	**Likely adversely**	Not likely adversely	No effect	No effect

7 LITERATURE CITED

Ahlers, D., and D. Moore. 2009. A Review of Vegetation and Hydrologic Parameters Associated with the Southwestern Willow Flycatcher – 2002 to 2008. Elephant Butte Reservoir Delta, NM. U.S. Department of the Interior, Bureau of Reclamation, Technical Services Center, Denver, CO.

Ahlers, D. and L. White. 1995. 1995 Southwestern Willow Flycatcher survey results: selected sites along the Rio Grande from Velarde, New Mexico, to the headwaters of Elephant Butte Reservoir. U.S. Bureau of Reclamation, Denver, CO. 41 pp.

Ahlers, D. and L. White. 1996. 1996 Southwestern Willow Flycatcher study results: selected sites along the Rio Grande from Velarde, New Mexico to the headwaters of Elephant Butte Reservoir and along the Pecos River from the headwaters of Lake McMillan to Avalon Dam. U.S. Bureau of Reclamation, Denver, CO. 92 pp.

Ahlers, D. and L. White. 1997. 1997 Southwestern Willow Flycatcher study results: selected sites along the Rio Grande from Velarde, New Mexico to the headwaters of Elephant Butte Reservoir. U.S. Bureau of Reclamation, Denver, CO. 38 pp.

Ahlers, D. and L. White. 1999. 1998 Southwestern Willow Flycatcher study results: selected sites along the Rio Grande from Velarde, New Mexico to the headwaters of Elephant Butte Reservoir. U.S. Bureau of Reclamation, Denver, CO. 72 pp.

Ahlers, D. and L. White. 2000. 1999 Southwestern Willow Flycatcher study results: selected sites along the Rio Grande from Velarde, New Mexico, to the headwaters of Elephant Butte Reservoir. U.S. Bureau of Reclamation, Denver, CO. 110 pp.

Ahlers, D., and D. Moore. 2003. 2002 Southwestern Willow Flycatcher study results: selected sites along the Rio Grande from Velarde, New Mexico, to the delta of Elephant Butte Reservoir. U.S. Bureau of Reclamation, Denver, CO. 45 pp.

Ahlers, D., C. Solohub, E. Best, and J. Sechrist. 2002. 2001 Southwestern Willow Flycatcher study results: selected sites along the Rio Grande from Velarde, New Mexico, to the delta of Elephant Butte Reservoir. U.S. Bureau of Reclamation, Denver, CO. 56 pp.

Ahlers, D., E. Best, and J. Sechrist. 2001. 2000 Southwestern Willow Flycatcher study results: selected sites along the Rio Grande from Velarde, New Mexico, to the delta of Elephant Butte Reservoir. U.S. Bureau of Reclamation, Denver, CO. 55 pp.

Allen, C., B. Hanson, and C. Mullins (eds.). 1993. Cochiti Reservoir Reregulation Interagency Biological Report. Final report prepared for the Rio Grande Initiatives Committee.

Alò, D., and T. F. Turner. 2005. Effects of habitat fragmentation on effective population size in the endangered Rio Grande silvery minnow. Conservation Biology 19:1138-1148.

American Ornithologists' Union. 1957. Checklist of North American Birds. Fifth ed. Baltimore, American Ornithologists' Union. 691 pp.

Archdeacon, T. P., W. J. Remshardt, and T. L. Knecht. 2009. Comparison of two methods for implanting passive integrated transponders in Rio Grande silvery minnow. North American Journal of Fisheries Management 29:346–351.

Archdeacon, T. P., and W. J. Remshardt. 2012. Observations of Hatchery-Reared Rio Grande Silvery Minnow Using a Fishway. North American Journal of Fisheries Management 32:648-655.

Bayley, P. B. and H. W. Li. 1996. Riverine fishes. In: River biota – diversity and dynamics. G. Petts and P. Calow (eds). Blackwell Science, Ltd. Cambridge, Mass.

Bestgen, K. R., and D. L. Propst. 1996. Redescription, geographic variation, and taxonomic status of Rio Grande silvery minnow, *Hybognathus amarus* (Girard, 1856). Copeia 1996:41-55.

Bestgen, K. R., and S.P. Platania. 1990. Extirpation of Notropis simus simus (Cope) and Notropis orca Woolman (Pisces: Cyprinidae) from the Rio Grande in New Mexico, with notes on their life history. Occasional Papers of the Museum of Southwestern Biology 6:1-8.

Bestgen, K. R., B. Mefford, J. Bundy, C. Walford, B. Compton, S. Seal, and T. Sorensen. 2003. Swimming performance of Rio Grande silvery minnow. Larval Fish Laboratory, Colorado State University, Fort Collins, Colorado.

Biella, B, and Chapman, R.C. (eds.), 1977, Archeological investigations in Cochiti Reservoir, New Mexico, Volume 1: A Survey of Regional Variability. Report submitted to National Park Survey, Santa Fe, for U. S. Army Corps of Engineers, Albuquerque.

Bovee, K.D., Waddle, T.J., and Spears, J.M., 2008. Streamflow and endangered species habitat in the lower Isleta reach of the middle Rio Grande. U.S. Geological Survey Open-File Report 2008-1323, 177 p.

Brittingham, M. C. and S. A. Temple. 1983. Have cowbirds caused forest songbirds to decline? Bioscience 33: 31-35.

Brown, B. 1988. Breeding Ecology of a Willow Flycatcher Population in Grand Canyon, Arizona. Western Birds 19:25–33.

Brown, D.E. 1982. Biotic communities of the American Southwest-United States and Mexico. Desert Plants 4:3-342. University of Arizona Press.

Brown, J.H. and M.V. Lomolino 1998. Biogeography. 692 pgs.

Bullard, T.F., and S.G. Wells. 1992. Hydrology of the Middle Rio Grande from Velarde to Elephant Butte Reservoir, New Mexico. U.S. Department of the Interior, U.S. Fish and Wildlife Service Research Publication 179.

Buntjer, M., and J. Remshardt. 2005. Final Report: Fish surveys and habitat assessment in the Rio Chama and Rio Grande upstream of Cochiti Lake. U.S. Fish and Wildlife Service, Albuquerque, New Mexico, 16 pgs.

Bush, J. K. 2006. Abiotic edaphic factors affecting the growth of a threatened North American Sunflower, Helianthus paradoxus (Asteraceae). Plant Ecology (2006) 183:215 –225

Caldwell, C. 2003. Hybridization potential and spawning behavior of Rio Grande silvery minnow (*Hybognathus amarus*) and plains minnow (*Hybognathus placitus*). U.S. Geological Survey, New Mexico Cooperative Fish and Wildlife Research Unit, Las Cruces, New Mexico.

Chernoff, B., R. R. Miller and C. R. Gilbert. 1982. *Notropis orca* and *Notropis simus*, cyprinid fishes form American Southwest, the description of a new subspecies. Occ. Pap. Mus. Zool. Univ. Mich. 618: 1-49.

Climatic Change, Vol. 78, No 2-4, pp. 293-315, October 2006.

Copes, F. 1975. Ecology of the brassy minnow, *Hybognathus hanhinsoni.* Univ. Wisconsin, Stevens Point, Mus. Nat. Hist. Fauna Flora Wis. Part Ill. Rep. 10:46-72.

Coutant, C.C. 2004. A riparian hypothesis for successful reproduction of white sturgeon. Reviews in Fisheries Science 12:23-73.

Cowley, D. E. 1979. Temporal and spatial distributions of fishes in the Black River, Eddy County, New Mexico. Eastern New Mexico State University.

Cowley, D. E., J. Alleman, R. L. McShane, P. D. Shirey, and R. Sallenave. 2005. Effects of salinity and suspended sediment on physical properties of the egg of the Rio Grande silvery minnow (*Hybognathus amarus*). New Mexico Water Resources Research Institute in cooperation with the Department of Fishery and Wildlife Sciences, New Mexico State University, Las Cruces, New Mexico.

Cowley, D. E., P. D. Shirey, and M. D. Hatch. 2006. Ecology of the Rio Grande silvery minnow (Cyprinidae: *Hybognathus amarus*) inferred from specimens collected in 1874. Reviews in Fisheries Science 14:111-125.

Cowley, D.E., R.C. Wissmar, and R. Sallenave. 2007. Fish assemblages and seasonal movements of fish in irrigation canals and river reaches of the middle Rio Grande, New Mexico (USA). Ecology of Freshwater Fish 16:548–558.

Crawford, C.S., A.C. Culley, R. Leutheuser, M.S. Sifuentes, L.H. White, and J.P. Wilber. 1993. Middle Rio Grande ecosystem: bosque biological management plan. U.S. Fish and Wildlife Service Report. 291 pp.

Dick-Peddie, W. A. 1993. New Mexico vegetation: past, present and future. University of New Mexico Press, Albuquerque, NM. 244 pp.

Doster, R.H. 2007. Interior Least Tern Monitoring Results 2007 - Brantley Lake New Mexico. U.S. Bureau of Reclamation, Albuquerque Area Office, Albuquerque, NM. 11 pp.

Ducey, J. E. 1981. Breeding of the least tern and piping plover on the lower Platte River, Nebraska. Nebr. Bird Rev. 49:45-51.

Dudley, R.K. and S.P. Platania 1996. Rio Grande silvery minnow winter population-habitat use monitoring project Summary of Four Trips (December 1995 - March 1996). Report to the U.S. Army Corps of Engineers, Albuquerque, NM, 11 pg.

Dudley, R.K. 2001. Sampling for larval Rio Grande silvery minnow near the mouth of Elephant Butte Reservoir. Division of Fishes, Museum of Southwestern Biology, Albuquerque, New Mexico.

Dudley, R.K., and S.P. Platania. 1997. Habitat use of Rio Grande silvery minnow. Museum of Southwestern Biology, Department of Biology, University of New Mexico.

Dudley, R.K., and S.P. Platania. 1999. Imitating physical properties of drifting semibuoyant fish (Cyprinidae) eggs with artificial eggs. Journal of Freshwater Ecology 14:423-430.

Dudley, R.K., and S.P. Platania. 2007a. Rio Grande Silvery Minnow Population Monitoring Program Results from October 2005 to October 2006**.** American Southwest Ichthyological Research Foundation, Albuquerque, New Mexico.

Dudley, R.K., and S.P. Platania. 2007b. Flow regulation and fragmentation imperil pelagic-spawning riverine fishes. Ecological Applications 17:2074-2086.

Dudley, R.K. and S.P. Platania. 2008. Rio Grande silvery minnow population monitoring program results from December 2006 to October 2007. American Southwest Ichthyological Researchers LLC , Albuquerque, New Mexico. 159 pgs.

Dudley, R.K. and S.P. Platania. 2010. Summary of Rio Grande silvery minnow population monitoring program results from July 2010. American Southwest Ichthyological Researchers LLC , Albuquerque, New Mexico. 35 pgs.

Dudley, R.K., S.P. Platania, and S.J. Gottlieb. 2005. Rio Grande silvery minnow population monitoring program results from 2004. American Southwest Ichthyological Research Foundation, Albuquerque, New Mexico.

Dudley, R.K., S.P. Platania, and S.J. Gottlieb. 2006. Summary of the 2005 Rio Grande silvery minnow population monitoring program results (January - December 2005). American Southwest Ichthyological Researchers, Albuquerque, New Mexico.

Dudley, R.K., G. C. White, S.P. Platania, and D. A. Helfrich. 2008. Rio Grande silvery minnow population estimation program Results from October 2007. American Southwest Ichthyological Researchers, Albuquerque, NM.

Durham, B.W. and G.R. Wilde 2008. Composition and Abundance of Drifting Fish Larvae in the Canadian River, Texas. Journal of Freshwater Ecology 23(2):273-280.

Durst, S.L., M. K. Sogge, S. D. Stump, S. O. Williams, B. E. Kus, and S. J. Sferra. 2007. Southwestern willow flycatcher breeding site and territory summary – 2006. Open File Report 2007-1391. USGS, Southwest Biological Science Center, Colorado Plateau Research Station. Flagstaff, AZ.

Edwards, R. J., and S. Contreras-Balderas. 1991. Historical changes in the ichthyofauna of the lower Rio Grande (Rio Bravo del Norte), Texas and Mexico. The Southwestern Naturalist 36:201-212.

Ellis, S.R., G.W. Levings, L.F. Carter, S.F. Richey, and M.J. Radell. 1993. Rio Grande Valley, Colorado, New Mexico, and Texas. Water Resource Bulletin 29:617-646.

Ellis, L.A., D.M. Weddle, S.D. Stump, H.C. English, and A.E. Graber. 2008. Southwestern Willow Flycatcher final survey and monitoring report. Arizona Game and Fish Department, Research Technical Guidance Bulletin #10, Phoenix, Arizona.

Facey, D.E., and G.D. Grossman. 1992. The relationship between water velocity, energetic costs, and microhabitat in four North American stream fishes. Hydrobiologica 239:1–6.

Ficke, A.D. and C.A. Myrick 2009. A method for monitoring movements of small fishes in urban streams. North American Journal of Fisheries Management 29:1444-1453 .

Finch, D. M., and W. Yong. 1997. Use of willow habitat along the Low Flow Conveyance Channel by willow flycatchers and other migratory birds. 1996 progress report to the Bureau of Reclamation.

Fluder, J., M.D. Porter, and B. McAlpine. 2007. Analyzing floodplain and aquatic nursery habitat of the Rio Grande silvery minnow at different hydrologic flows. Proceedings Third International Symposium GIS/Spatial analyses in Fishery and Aquatic Sciences. pp 387-398.

Fort Collins Science Center. 1994. 1935 National Wetland Inventory landcover dataset. U.S. Department of the Interior, U.S. Geological Survey, Fort Collins. CO. <http://www.fort.usgs.gov/Products/GIS/GIS_theme.asp?ThemeNo=23> Last accessed 3 Oct 2011.

Franklin, I. R. 1980. Evolutionary Change in Small Populations. In Conservation Biology: an evolutionary-ecological perspective, edited by M. E. Soulé and B. A. Wilcox. Sinauer Associates, Inc. Sunderland, Massachusetts. Pages 135 – 148

Gaines, D. 1974. A new look at the nesting riparian avifauna of the Sacramento Valley, California. Western Birds 5:61-80.

Gaines, D. 1977. Birds of the Yosemite Sierra. California Syllabus, Oakland, CA.

Gellis, A.C., 1992, Decreasing trends of suspended-sediment loads in selected streamflow stations in New Mexico: New Mexico Water Resources Research Institute Report No. 265, Proceedings of the 36th Annual New Mexico Water Conference, Las Cruces, N.Mex., p. 77-93.

Gilpin, M.E. and M.E. Soulé. 1986. Minimum viable populations: processes of species extinction. Pp. 19-34 in Soulé, M.E., ed. Conservation Biology: the Science of Scarcity and Diversity. Sinauer, Sunderland, MA.

Goldwasser, S., D. A. Gaines and S. Wilbur. 1980. The Least Bell's Vireo in California: a de facto endangered race. American Birds 34:742-745.

Graber, A.E., D.M. Weddle, H.C. English, S.D. Stump, H.E. Telle, and L.A. Ellis. 2007. Southwestern Willow Flycatcher 2006 Survey and Nest Monitoring Report. Technical Report 249, Nongame and Endangered Wildlife Program, Arizona Game and Fish Department, Phoenix, AZ. 96 pp.

Grand, T.C, S. F. Railsback, J. W. Hayse and K. E. Lagory. 2006. A physical habitat model for predicting the effects of flow fluctuations in nursery habitats of the endangered Colorado Pikeminnow (Ptychocheilus lucius). River Research and Applications. 22: 1125–1142.

Grunstra, M. and O.W. Van Auken. 2007. Factors that influence the distribution and cover of *Helianthus paradoxus* in a west Texas salt marsh. Phytologia 89(1):24-42.

Hatch, M.D. and E. Gonzales 2008a. Los Lunas Habitat Restoration Fisheries Monitoring. Report to the U.S. Bureau of Reclamation, Albuquerque Area Office. 85 pgs.

Hatch, M.D. and E. Gonzales 2008b. Middle Rio Grande Nursery Habitat Monitoring — 2008. Report to the U.S. Bureau of Reclamation, Albuquerque Area Office. 77 pgs.

Hendrickson, D., and W.L. Minckley. 1984. Cienegas: Vanishing climax communities of the American southwest. Desert Plants 6:131-175.

Henry, A., P. Mehlhop, and C. Black. 1996. 1995 surveys for the Southwestern Willow Flycatcher (*Empidonax traillii extimus*), near San Marcial, New Mexico. Report to the U.S. Army Corps of Engineers, Albuquerque District by the New Mexico Natural Heritage Program. 68 pp.

Hink, V.C., and R.D. Ohmart. 1984. Middle Rio Grande Biological Survey. Center for environmental Studies, Arizona State University, Tempe, AZ. Prepared for the U.S. Army Corps of Engineers, Albuquerque District, NM. 193 pp + app.

Hoagstrom, C. W., and J. E. Brooks. 2005. Distribution and status of Arkansas River shiner Notropis girardi and Rio Grande shiner *Notropis jemezanus*, Pecos River, New Mexico. Texas Journal of Science 57:35–58.

Hoagstrom, C.W., J.E. Brooks, and S.R. Davenport 2008. Spatiotemporal Population Trends of *Notropis simus pecosensis* in Relation to Habitat Conditions and the Annual Flow Regime of the Pecos River, 1992–2005. Copeia 2008, No. 1, 5–15.

Horwitz, R.J., D. H. Keller, P. F. Overbeck, S. P. Platania, and R. K. Dudley 2011. Age and growth of Rio Grande silvery minnow. Report submitted to the U.S. Bureau of Reclamation, Albuquerque, NM. 74 pgs.

Hubbard , J. P. 1987 The Status of Willow Flycatchers in New Mexico. Endangered Species Program, New Mexico Department of Game and Fish, Santa Fe, NM 29pp.

Hubbs, C., R. Rush Miller, R. J. Edwards, K. W. Thompson, E. Marsh, G. P. Garrett, G. L. Powell, D. J. Morris, and R. W. Zerr. 1977. Fishes inhabiting the Rio Grande between New Mexico and the Pecos confluence. Symposium on Importance, Preservation and Management of Riparian Habitat: 91-97.

Hubbs, C. 1958. List of fishes known or expected to belong to the fauna of Big Bend National Park. Mimeograph report to Big Bend National History Association.

Hydrologic Engineering Center (HEC). 2006. Middle Rio Grande Flow Frequency Study. U.S. Army Corps of Engineers, Davis, CA. 43 pp.

International Boundary and Water Commission (IBWC). 2003. 2003 Regional Assessment of Water Quality in the Rio Grande Basin. Texas Clean Rivers Program United States Section, International Boundary and Water Commission. 142 pp.3

Johnson, K., and H. Smith. 2000. Southwestern Willow Flycatcher Surveys at Isleta Pueblo, New Mexico. New Mexico Natural Heritage Program, Biology Dept., Univ. of New Mexico. Report prepared for U.S. Army Corps of Engineers, Albuquerque District. 11pp. + app.

Koster, W. J. 1955. Outline for an Ecological Life History Study of a Fish. Ecology 36:141-153.

Langman, J.B and E. O. Nolan 2005. Streamflow and Water-Quality Trends of the Rio Chama and Rio Grande, Northern and Central New Mexico, Water Years 1985 to 2002. Scientific Investigations Report 2005-5118, U.S. Geological Survey, 36 pp.

Lagasse, P. F. 1980. An assessment of the response of the Rio Grande to dam construction – Cochiti to Isleta Reach. U.S. Army Corps of Engineers, Albuquerque District, Albuquerque, NM. 113 pp. + appendices.

Lagasse, P.F., 1994. Variable response of the Rio Grande to dam construction. Pages 395-422 *in* Schumm, S.A., and B.R. Winkley (eds.). The Variability of Large Alluvial Rivers, Amer. Soc. Civil Engineers Press, New York, NY.

Lang, B.K. and C.S. Altenbach 1994. Ichthyofauna of the Middle Rio Grande Conservancy District irrigation system: Cochiti Dam to Elephant Butte State Park, July-August 1993. Report to the U.S. Bureau of Reclamation, 83 pgs.

Laymon, S. A. 1987. Brown-headed Cowbirds in California: historical perspective and management opportunities in riparian habitats. Western Birds 18:1-96.

Lee, Songweon; Klein, Andrew; Over, Thomas. 2004. Effects of the El Niño-southern oscillation on temperature, precipitation, snow water equivalent and resulting streamflow in the Upper Rio Grande river basin. Hydrological Processes. Vol. 18. Issue 6. March 24, 2004. Pp.1053-1071.

Levings, G. W., D. F. Healy, S. F. Richey, and L. F. Carter. 1998. Water quality in the Rio Grande Valley, Colorado, New Mexico, and Texas, 1992-95. U.S. Geological Survey, Department of the Interior, Albuquerque, New Mexico.

Lewis, K., and D. Hathaway. 2002. Summary: 40-year synthetic flow sequence for URGWOPS alternatives analysis. S.S. Papadapoulos and Associates, Albuquerque, NM. 10 pp.

Lewis, W.M., R.C. Heidinger, M.H. Paller, and L.J. Wawronowicz. 1981. Effects of municipal sewage on fish communities in selected Illinois streams. The Warmwater Streams Symposium: A National Symposium on Fisheries Aspects of Waterwater Streams: 224-240.

Lovejoy, T. 1983. Tropical deforestation and North American migrant birds. Bird Conservation 1:126-128.

Lynch, J. F. and D. F. Whigham. 1984. Effects of forest fragmentation on breeding bird communities in Maryland, USA. Biological Conservation 28:287-324.

MacDonald, D. D., C. G. Ingersoll, and T. A. Berger. 2000. Development and evaluation of consensus-based sediment quality guidelines for freshwater ecosystems. Archives of Environmental Toxicology and Chemistry 39:20-31.

Magaña, H.A. 2012. Habitat use of the Rio Grande silvery minnow (*Hybognathus amarus*) during a long-term flood pulse in the Middle Rio Grande, New Mexico. Environ Biol Fish (2012) 95:201–212.

Makar, P.W. 2010. Channel Characteristics of the Middle Rio Grande, NM. Report No. SRH-2011-05. Bureau of Reclamation, Technical Service Center, Sedimentation and River Hydraulics Group, Denver, CO.

Makar, P., Massong, T., Bauer, T., Tashjian, P., and Oliver, K J. (2006). Channel Width and Flow Regime Changes along the Middle Rio Grande NM. Joint 8th Federal Interagency Sedimentation Conference and 3rd Federal Interagency Hydrologic Modeling Conference, Reno, Nevada.

Makar, P., and J. AuBuchon. 2012. Channel Conditions and Dynamics of the Middle Rio Grande. U.S. Department of the Interior, Bureau of Reclamation, Technical Service Center, Sedimentation and River Hydraulics Group, Denver, Colorado, and Upper Colorado Region, Albuquerque Area Office, Technical Services Division, Albuquerque, NM.

Marcus, M.D., Covington S, and Smith N. 2005. Using Existing Data from The Middle Rio Grande To Screen Water Quality Risks To Rio Grande Silvery Minnow, VOLUME 1 – FINAL REPORT. Report to the Middle Rio Grande Endangered Species Act Collaborative Program.

Marcus M.D., Covington S., B. Liu and Smith N. R. 2010. Use of existing water, sediment, and tissue data to screen ecological risks to the endangered Rio Grande silvery minnow. Science of the Total Environment 409 (2010) 83–94.

Marlatt, S. L. 1984. History and Management Recommendations for the Interior Least Tern in New Mexico. New Mexico Department of Game and Fish Endangered Species Program.

Massong, T., P. Makar, and T. Bauer. 2008. 2007 Rio Grande Geomorphic Summary, Final. U.S. Department of the Interior, Bureau of Reclamation DRAFT FINAL Technical Report, Albuquerque Area Office, Albuquerque, New Mexico. 31 pp.

Massong, T.M., P. Tashjian, and P. Makar. 2006. Recent Channel Incision and Floodplain Evolution within the Middle Rio Grande, NM. Joint 8th Federal Interagency Sedimentation Conference and 3rd Federal Interagency Hydrologic Modeling Conference, Reno, Nevada. 8 pp.

Matthews, W. J. 1998. Patterns in Freshwater Fish Ecology. Chapman and Hall, New York.

Mayfield, H. F. 1977. Brown-headed Cowbird: agent of extermination? American Birds 31: 107-113.

Maynard, W. 1995. Summary of 1994 Survey Efforts in New Mexico for Southwestern Willow Flycatcher (Empidonax traillii extimus). Contract # 94-516-69. New Mexico Department of Game and Fish, Santa Fe, New Mexico. 48 pp.

Mehlhop, P. and P. Tonne. 1994. Results for surveys for the Southwestern Willow Flycatcher - Rio Grande floodway, San Acacia to Bosque del Apache Unit, Socorro County, New Mexico. Report submitted to U.S. Army Corps of Engineers, Albuquerque District.

Mehlman, D., K. Gordon, D, Gray, R. Kimball, and M.J. Mund-Meyerson. 1995. 1995 Survey for and habitat characteristics if the Southwestern Willow Flycatcher (*Empidonax traillii extimus*) in the Isleta-Belen reach of the Rio Grande, New Mexico. Final report to U.S. Army Corps of Engineers, Albuquerque District. 14 pp. + app.

Minckley, W.L., P. C. Marsh, J. E. Deacon, T. E. Dowling, P. W. Hedrick, W. J. Matthews, and G. Mueller 2003. A Conservation Plan for Native Fishes of the Lower Colorado River. BioScience 53(3):219-234.

Modde, T., and D.B. Irving. 1998. Use of multiple spawning sites and seasonal movement by razorback sucker in the middle Green River, Utah. North American Journal of Fisheries Management 18: 318–326.

Modde, T., G.J. Birchell, and K.D. Christopheson. 2004. Comparison of the Distribution and Recapture Rates of Acclimated and Nonacclimated Razorback Sucker Stocked in the Green River. Pages 349-356 *in* M.J. Nickum, P.M. Mazik, J.G. Nickum, and D.D. MacKinlay, editors. Propagated fish in resource management. Americn Fisheries Society, Symposium 44, American Fisheries Society, Bethesda, Maryland.

Modde, T., K.P. Burnham, and E.J. Wick. 1996. Population status of the razorback sucker in the middle Green River. Conservation Biology 10: 110–119.

Moore, D. and D. Ahlers 2004. 2003 Southwestern Willow Flycatcher study results: selected sites along the Rio Grande from highway 60 to Elephant Butte Reservoir. U.S. Department of the Interior, Bureau of Reclamation, Technical Services Center, Denver, CO.

Moore, D. and D. Ahlers 2005. 2004 Southwestern Willow Flycatcher study results: selected sites along the Rio Grande from Velarde to Elephant Butte Reservoir, New Mexico. U.S. Department of the Interior, Bureau of Reclamation, Technical Services Center, Denver, CO.

Moore, D. and D. Ahlers 2006. 2005 Southwestern Willow Flycatcher study results: selected sites along the Rio Grande from Velarde to Elephant Butte Reservoir, New Mexico. U.S. Department of the Interior, Bureau of Reclamation, Technical Services Center, Denver, CO.

Moore, D. and D. Ahlers 2007. 2006 Southwestern Willow Flycatcher study results: selected sites along the Rio Grande from Velarde to Elephant Butte Reservoir, New Mexico. U.S. Department of the Interior, Bureau of Reclamation, Technical Services Center, Denver, CO.

Moore, D. and D. Ahlers 2008. 2007 Southwestern Willow Flycatcher study results: selected sites along the Rio Grande from Velarde to Elephant Butte Reservoir, New Mexico. U.S. Department of the Interior, Bureau of Reclamation, Technical Services Center, Denver, CO.

Moore, D. and D. Ahlers 2009. 2008 Southwestern Willow Flycatcher study results: selected sites along the Rio Grande from Velarde to Elephant Butte Reservoir, New Mexico. U.S. Department of the Interior, Bureau of Reclamation, Technical Services Center, Denver, CO. 71 pp.

Moyer, G. R., M. Osborne, and T. F. Turner. 2005. Genetic and ecological dynamics of species replacement in an arid-land river system. Molecular Ecology 14:1263-1273.

Mueller, G. and J. Carpenter. 2008. Bringing back the bonytail and the razorback. FWS Endangered Species Bulletin 33(3): 20-22.

Mund, M.J., R. Kimball, D. Mehlman, K. Gordon, J. Travis, and D. Gray. 1994. Survey for the Southwestern Willow Flycatcher, *Empidonax traillii extimus*, in the Middle Rio Grande Flood Protection Project area, Isleta Pueblo to south of Belen. Final report to U.S. Army Corps of Engineers, Albuquerque District. 26 pp.

Mussetter Engineering Inc. (MEI). 2002. Geomorphic and sedimentological investigations of the Middle Rio Grande between Cochiti Dam and Elephant Butte Reservoir. Mussetter Engineering, Fort Collins, CO.

Mussetter Engineering, Inc. (MEI). 2004. Sediment-continuity Analysis of the Rio Grande between Cochiti Dam and Elephant Butte Reservoir. MEI Project Number 00-10 T657. Prepared for New Mexico Interstate Stream Commission, Santa Fe, NM.

Mussetter Engineering, Inc. (MEI). 2008. FLO-2D Model Development – Existing Conditions and Restoration Alternatives 1 to 5 Albuquerque Reach, New Mexico. Prepared for U.S. Army Corps of Engineers. Albuquerque, NM.

National Oceanic and Atmospheric Administration (NOAA). 2002. Climatological Data Annual Summary, New Mexico, 2002. Volume 106. No. 13.

National Wetlands Inventory (NWI). 2002. National Wetland Inventorey geodata base for New Mexico. U.S. Fish and Wildlife Service. <http://www.fws.gov/wetlands/Data/DataDownload.html#State> Last accessed: 3 Oct 2011.

Natural Resources Journal, 2007, Summer edition. Vol. 47, No. 3.

New Mexico Department of Game and Fish (NMDGF). 2007. Pecos sunflower (*Helianthus paradoxus*) Habitat Management Plan on the La Joya Unit of the Ladd S. Gordon Waterfowl Complex. Santa Fe, NM. 11pp. + appendices.

New Mexico Department of Game and Fish (NMDGF). 1988. Handbook of species endangered in New Mexico. Santa Fe, New Mexico.

New Mexico Department of Game and Fish (NMDGF). 2007. Pecos sunflower (Helianthus paradoxus) Habitat Management Plan on the La Joya Unit of the Ladd S. Gordon Waterfowl Complex. Santa Fe, NM. 11pp. + appendices.

New Mexico Environment Department (NMED). 2001. Middle Rio Grande Total Maximum Daily Load (TMDL) for Fecal Coliform. Santa Fe, NM. November 2001. <http://www.nmenv.state.nm.us/swqb/Fecal_Coliform_TMDL_in_Middle_Rio_Grande_11-05-01.pdf>New Mexico Environment Department (NMED). 2009. Water Quality Monitoring of the Middle Rio Grande, Annual Baseline Condition and Trends of Key Water Quality Parameters, October 2006–July 2008, Final Report. Santa Fe, NM. 2009. <ftp://ftp.nmenv.state.nm.us/www/swqb/MAS/Surveys/MiddleRioGrande-2009.pdf>

New Mexico Environment Department (NMED). 2010. US EPA-approved total maximum daily load (TMDL) for the Middle Rio Grande. Santa Fe, NM. 2010. <http://www.nmenv.state.nm.us/swqb/Rio_Grande/Middle/index.html>. Accessed 2010 Jan 6.

Oberdorff, T., J.F. Guegan, and B. Hugueny. 1995. Global scale patterns of fish species richness in rivers. Ecography 18(4):345-352.

O'Donnell, M.J., G. E. Horton and B. H. Letcher 2010. Use of Portable Antennas to Estimate Abundance of PIT-Tagged Fish in Small Streams: Factors Affecting Detection Probability, North American Journal of Fisheries Management, 30:323-336.

Ong, K., T. F. O'Brien, and M. D. Rucker. 1991. Reconnaissance investigation of water quality, bottom sediment, and biota associated with irrigation drainage in the middle Rio Grande Valley and Bosque del Apache National Wildlife Refuge, New Mexico, 1988-1989. U.S. Geological Survey, Albuquerque, New Mexico.

Ortiz, Richard M., 2004. A river in transition: Geomorphic and bed sediment response to Cochiti Dam on the Middle Rio Grande, Bernalillo to Albuquerque, New Mexico. Masters thesis, University of New Mexico, Albuquerque.

Osborne, M. J., M. A. Benavides, and T. F. Turner. 2005. Genetic heterogeneity among pelagic egg samples and variance in reproductive success in an endangered freshwater fish, Hybognathus amarus (Cyprinidae). Environmental Biology of Fishes 73:463-472.

Osborne, M. J., M. A. Benavides, D. Alo, and T. F. Turner. 2006. Genetic effects of hatchery propagation and rearing in the endangered Rio Grande silvery minnow, Hybognathus amarus. Reviews in Fisheries Science 14:127-138.

Owen, J.C. and M.K. Sogge. 1997. Banding and genetic sampling of Willow Flycatchers in Colorado - 1996 & 1997summary report. U.S.G.S. Colorado Plateau Field Station/Northern Arizona University report.

Owen, J.C., and M.K. Sogge. 2002. Physiological Condition of Southwestern Willow Flycatchers in Native and Saltcedar Habitats. U.S. Geological Survey report to the Arizona Department of Transportation.

Paxton, E., J. Owen and M. K. Sogge. 1996. Southwestern willow flycatcher response to catastrophic habitat loss. U.S.G.S. Colorado Plateau Research Station/Northern Arizona University report. 12 pp.

Paxton, E.H., M.K. Sogge, S.L. Durst, T.C. Theimer, and J.R. Hatten. 2007. The Ecology of the Southwestern Willow Flycatcher in Central Arizona—a 10-year Synthesis Report. Open-File Report 2007-1381. U.S. Geological Survey, Southwest Biological Science Center, Colorado Plateau Research Station, Flagstaff, AZ. 143 pp.

Paxton, E., S.M. Langridge, and M.K. Sogge. 1997. Banding and Population Genetics of Southwestern Willow Flycatchers in Arizona–1997 Summary Report. Colorado Plateau Research Station. U.S. Geological Survey Biological Resources Division. Northern Arizona University, Flagstaff, AZ. 63 pp.

Pease, A. A., J. J. Davis, M. S. Edwards, and T. F. Turner. 2006. Habitat and resource use by larval and juvenile fishes in an arid-land river (Rio Grande, New Mexico). Freshwater Biology 51:475-486.

Peterson, B. J., W. M. Wollheim, P. J. Mulholland, J. R. Webster, J. L. Meyer, J. L. Tank, E. Marti, W. B. Bowden, H. M. Valett, A. E. Hershey, W. H. McDowell, W. K. Dodds, S. K. Hamilton, S. Gregory, and D. D. Morrall. 2001. Control of nitrogen export from watersheds by headwater streams. Science 292:86-90.

Platania, S.P. 1993. The fishes of the Rio Grande between Velarde and Elephant Butte Reservoir and their habitat associations. U.S. Bureau of Reclamation, Albuquerque, New Mexico. 188 pp.

Platania, S. P. 2000. Effects of four water temperature treatments on survival, growth, and developmental rates of Rio Grande silvery minnow (Hybognathus amarus) eggs and larvae. Report to U. S. Fish and Wildlife Service, New Mexico Ecological Services Field Office, Albuquerque, New Mexico. 35 pp.

Platania, S. P., and C. S. Altenbach. 1996. Reproductive Ecology of the Rio Grande Silvery Minnow *Hybognathus amarus*: Clutch and batch production fecundity estimates. Report to U.S. Army Corps of Engineers, Albuquerque District. Pp.

Platania, S. P., and C. S. Altenbach. 1998. Reproductive strategies and egg types of seven Rio Grande cyprinids. Copeia 1998:559-569.

Platania, S. P., and R.K. Dudley. 1999. Draft summary of aquatic conditions in the Middle Rio Grande between San Acacia Diversion Dam and San Marcial Railroad bridge crossing for the period 14 through 26 April 1999. Division of Fishes, Museum of Southwestern Biology, University of New Mexico, Albuquerque, New Mexico.

Platania, S.P. and R. Dudley. 2000. Draft Summary of Aquatic Conditions in the Middle Rio Grande between San Acacia Diversion Dam and San Marcial Railroad Bridge Crossing. Prepared for the Bureau of Reclamation and New Mexico Ecological Services Field Office.

Platania, S. P., and R.K. Dudley. 2001. Summary of population monitoring of Rio Grande silvery minnow (21-27 February 2001). Division of Fishes, Museum of Southwestern Biology, Albuquerque, New Mexico.

Platania, S. P., and R.K. Dudley. 2002. Spawning periodicity of Rio Grande silvery minnow during 2001. American Southwest Ichthyological Research Foundation, Albuquerque, New Mexico.

Platania, S. P., and R.K. Dudley. 2003. Spawning periodicity of Rio Grande silvery minnow, Hybognathus amarus, during 2002. American Southwest Ichthyological Research Foundation, Albuquerque, New Mexico.

Platania, S. P., and R.K. Dudley. 2004. Spawning periodicity of Rio Grande silvery minnow during 2003. American Southwest Ichthyological Research Foundation, Albuquerque, New Mexico.

Platania, S. P., and R.K. Dudley. 2005. Spawning periodicity of Rio Grande silvery minnow during 2004. American Southwest Ichthyological Research Foundation, Albuquerque, New Mexico.

Platania, S. P., and R.K. Dudley. 2008. Spawning periodicity of Rio Grande silvery minnow during 2008. American Southwest Ichthyological Research Foundation, Albuquerque, New Mexico.

Platania, S. P., and R.K. Dudley. 2009. Spawning periodicity of Rio Grande silvery minnow during 2009. American Southwest Ichthyological Research Foundation, Albuquerque, New Mexico.

Platania, S. P., and R.K. Dudley. 2010. Spawning periodicity of Rio Grande silvery minnow during 2010. American Southwest Ichthyological Research Foundation, Albuquerque, New Mexico.

Platania, S. P., and R.K. Dudley. 2011. Spawning periodicity of Rio Grande silvery minnow during 2011. American Southwest Ichthyological Research Foundation, Albuquerque, New Mexico.

Poole, J. M. 1992. Puzzle sunflower (Helianthus paradoxus), a status report update. Performance Report for Section 6 Grant No. E-1-3, Job No. 2.3, Texas Parks and Wildlife Department, Austin.

Porter, M.D. and G.L. Dean 2007. Annual Report-2007, Rio Grande Fish Community Surveys. U.S. Bureau of Reclamation, Albuquerque, New Mexico, 11 pp.

Porter, M.D., G.L. Dean, and T.M. Massong 2004. Annual Report-2004, Rio Grande Fish Community Surveys. U.S. Bureau of Reclamation, Albuquerque, New Mexico, 11 pp.

Porter, M. D., and T. Massong. 2004a. Habitat fragmentation and modifications affecting distribution of the Rio Grande silvery minnow. GIS/Spatial Analyses in Fishery and Aquatic Sciences:421-432.

Porter, M. D., and T. Massong. 2004b. Analyzing changes in river channel morphology using GIS for Rio Grande silvery minnow habitat assessment. GIS/Spatial Analyses in Fishery and Aquatic Sciences: 433-446.

Porter, M. D., and T. Massong. 2005. Progress Report 2005: Contributions to delisting Rio Grande silvery minnow: Egg habitat identification. U.S. Bureau of Reclamation, Albuquerque, New Mexico.

Potter, L.D. 1981. Plant ecology of shoreline zone of Rio Grand – Cochiti Lake, Bandelier National Monument. Dept. of Biology, Univ. of New Mexico, Albuquerque, NM. 73 pp.

Public Law 86-645 (1960), Title II – Flood Control, Section 201, Rio Grande Basin, July 14, 1960.

Public Law 88-293 (1964) An Act – To Make Water Available for a Permanent Pool for Fish and Wildlife and Recreation Purposes at Cochiti Reservoir from the San Juan-Chama unit of the Colorado River Storage Project, March 26, 1964.

Rand, G.M., and Petrocelli, S.R. 1985. Fundamentals of Aquatic Toxicology – Methods and Applications. Hemisphere Publishing Corporation, New York. 666 pp.

Raney, E. C. 1939. The breeding habits of the silvery minnow, *Hybognathus regius* Girard. American Midland Naturalist 21:674-680.

Rappole, J. H. and M. V. McDonald. 1994. Cause and effect in population declines of migratory birds. Auk 111:652-660.

Reichenbacher, F. W. 1884. Ecology and evolution of southwestern riparian plant communities. Desert Plants, Volume 6.

Remshardt, J.W. 2008. Rio Grande silvery minnow Rescue and Salvage – 2007. U.S. Fish and Wildlife Service, Albuquerque, New Mexico. 30 pp.

Riada Engineering, Inc. 2007. FLO-2D Flood Routing Model Development, Middle Rio Grande, Cochiti Dam to Elephant Butte Reservoir, 250 foot Grid System. Submitted to the U.S. Army Corps of Engineers, Albuquerque, NM.

Robbins, C. S., J. R. Sauer, R. S. Greenberg, and S. Droege. 1989. Population declines in North American birds that migrate to the Neotropics. Proceedings of the National Academy of Sciences 86:7658-7662.

Rodriguez, M.A. 2010. A modeling framework for assessing long-distance dispersal and loss of connectivity in stream fish. Pages 263-279 in K.B. Gido and D.A. Jackson, editors. Community ecology of stream fishes: concepts, approaches, and techniques. American Fisheries Society, Symposium 73, Bethesda, Maryland.

Rothstein, S. I., J. Verner, and E. Stevens. 1980. Range expansion and diurnal changes in dispersion of the Brown-headed Cowbird in the Sierra Nevada. Auk 97:253-267.

Roy R., T.F. O'Brien, and M. Rusk-Maghini. 1992. Organochlorine and Trace Element Contaminant Investigation of the Rio Grande, New Mexico. United States Fish and Wildlife Service Contaminants Report, Albuquerque, New Mexico.

S.S. Papadopulos & Associates, Inc. 2000. Middle Rio Grande Water Supply Study. Boulder, CO: August 4, 2000.

Schlosser, I.J. 1988. Predation Rates and the Behavioral Response of Adult Brassy Minnows (*Hybognathus hankinsoni*) to Creek Chub and Smallmouth Bass Predators. Copeia, 1988(3), pp. 691-697.

Schmidt, J. C., B. L. Everitt, and G. A. Richard. 2003. Hydrology and geomorphology of the Rio Grande and implications for river rehabilitation. Pages 22 in G. P. Garrett and N. L. Allan, editors. Contributed Papers from a Special Session Within the Thirty-Third Annual Symposium of the Desert Fishes Council, Sul Ross State University, Alpine, Texas.

Scurlock, D. 1998. From the Rio to the Serria: An Environmental History of the Middle Rio Grande Basin. USDA Rocky Mountain Research Station, Fort Collins, Colorado, 80526.

Sferra, S. J., T. E. Corman, C. E. Paradzick, J. W. Rourke, 1. A. Spencer and M. W. Sumner. 1997. Arizona Partners in Flight Southwestern Willow Flycatcher survey: 1993-1996 summary report. Technical Report 113. Arizona Game and Fish Department, Nongame and Endangered Wildlife Program. Phoenix, Arizona. 46 pp.

Shirey, P. D., D. E. Cowley, and R. Sallenave. 2007. Diatoms from gut contents of museum specimens of an endangered minnow suggest long-term ecological changes in the Rio Grande (USA). Journal of Paleolimnology 40(1):263-272.

Sivinski, R. C. 1992. Section 6 Report, Helianthus paradoxus. 124-127. New Mexico Forestry Division, Santa Fe.

Sivinski, R. C. 1996. New Mexico status of Helianthus paradoxus. Performance Report for Section 6 Grant No. E9, Segment 10, New Mexico Forestry Division, Santa Fe.

Skaggs, R. 1996. Population Size, Breeding Biology, and Habitat of Willow Flycatcher in the Cliff-Gila Valley, New Mexico. Final Report. Contract #95-516-91. New Mexico Department of Game and Fish. 38 pp.

Smith, H. and K. Johnson. 2006. Water requirements for Southwestern Willow Flycatcher habitat and nesting at the Pueblo of Isleta. 2006 Report. Natural Heritage New Mexico.

Smith, J., and K. Johnson. 2005. Southwestern Willow Flycatcher Nesting Success, Cowbird Parasitism, and Habitat Characteristics at the Pueblo of Isleta, New Mexico. 2004 Report. Natural Heritage Publication No. 05-GTR-283. Natural Heritage New Mexico, Museum of Southwestern Biology, Univ. of NM, Albuquerque. 29 pp.

Smith, J.R. 1999. Summary of Easy Egg Catching in the LFCC in the 9 Mile Study Reach during Spring 1998 Operation. U.S. Fish and Wildlife Service Report Submitted to the U.S. Bureau of Reclamation, Albuquerque, New Mexico on April 28, 1999.

Sogge, M. K. 1995. Southwestern willow flycatcher (Empidonax traillii extimus) monitoring at Tuzigoot National Monument. 1995 progress report to the National Park Service. National Biological Service Colorado Plateau Research Station/Northern Arizona University report. 20 p.

Sogge, M.K., R.M. Marshall, S.J. Sferra, and T.J. Tibbitts. 1997. A southwestern willow flycatcher natural history summary and survey protocol. National Park Service Technical Report NPS/NAUCPRS/NRTR-97/12. 37 pp.

Sogge, M. K., J. S. Sferra, T. McCarthey, S. O. Willimas, and B. E. Kus. 2001. Southwestern Willow Flycatcher breeding site and territory summary-2000. U.S. Geological Survey, Flagstaff, AZ.

Sogge, M. K., J. S. Sferra, T. McCarthey, S. O. Willimas, and B. E. Kus. 2002. Southwestern Willow Flycatcher breeding site and territory summary-2001. USGS Report to the Southwestern Willow Flycatcher Recovery Team, U.S. Fish and Wildlife Service, Region 2, Albuquerque NM. 20pp

Sogge, M. K., T. J. Tibbitts, and S. J. Sferra. 1993. Status of the Southwestern Willow Flycatcher along the Colorado River between Glen Canyon Dam and Lake Mead - 1993. Summary report. National Park Service Cooperative Park Studies Unit/Northern Arizona University, U.S. Fish and Wildlife Service and Arizona Game and Fish Department Report. 69 pp.

Sprenger, M. D., L. M. Smith and J. P. Taylor. 2002. Restoration of riparian habitat using experimental flooding. Wetlands Vvo.22, No 1. 9 pp.

Sublette, J. E., M. D. Hatch, and M. Sublette. 1990. Hybognathus amarus (Girard) Rio Grande silvery minnow. The Fishes of New Mexico. University of New Mexico Press, Albuquerque, New Mexico.

SWCA Environmental Consultants. 2008a. Silvery Minnow Egg and Larval Fish Monitoring in Nursery Habitats 2007. Report to the U.S. Bureau of Reclamation, Albuquerque Area Office. 19 pgs.

SWCA Environmental Consultants. 2008b. Middle Rio Grande Nursery Habitat Monitoring - 2008. Report to the U.S. Bureau of Reclamation, Albuquerque Area Office. 77 pgs.

SWCA Environmental Consultants. 2008c. Los Lunas Habitat Restoration Fisheries Monitoring. Report to the U.S. Bureau of Reclamation, Albuquerque Area Office. 85 pgs.

SWCA Environmental Consultants. 2009.Los Lunas Habitat Restoration Fisheries Monitoring - 2009. Report to the U.S. Bureau of Reclamation, Albuquerque Area Office. 95 pgs.

SWCA Environmental Consultants. 2011. Middle Rio Grande Riverine Habitat Restoration Fisheries Monitoring Spring 2011 Final Report. . Report prepared for the New Mexico Interstate Stream Commission, 69 pages.

Tashjian, P., and T. Massong. 2006. The Implications of Recent Floodplain Evolution on Habitat. Joint 8th Federal Interagency Sedimentation Conference and 3rd Federal Interagency Hydrologic Modeling Conference, Reno, Nevada.

Texas Natural Resource Conservation Commission. 1994. 1994 Regional Assessment of Water Quality in the Rio Grande Basin including the Pecos River, the Devils River, the Arroyo Colorado and the Lower Laguna Madre. AS 34.

Tibbits, T. J., M. K. Sogge, and S. J. Sferra. 1994. A survey protocol for the Southwestern Willow Flycatcher (*Empidonax traillii extimus*). Technical Report NPS/NAUCPRS/NRTR-94/04. U.S. Department of the Interior. National Park Service. Colorado Plateau Research Station. Flagstaff, AZ. 20 pp.

Trevino-Robinson, D. 1959. The ichthyofauna of the lower Rio Grande, Texas and Mexico. Copeia 1959:253-256.

Turner, T. F., T. E. Dowling, R. E. Broughton, and J. R. Gold. 2004. Variable microsatellite markers amplify across divergent lineages of cyprinid fishes (subfamily Leusicinae). Conservation Genetics 5:279-281.

Turner, T.F., T.J. Krabbenhoft, A.S. Burdett 2010. Reproductive phenology and fish community structure in an arid-land river. Pages 427-446 in K.B. Gido and D.A. Jackson, editors. Community ecology of stream fishes: concepts, approaches, and techniques. American Fisheries Society, Symposium 73, Bethesda, Maryland.

Turner, T.F., M.J. Osborne, G.R. Moyer, M.A. Benavides, and D. Alò. 2006. Life history and environmental variation interact to determine effective census size ratio. Proceedings of the Royal Society B 273:3065-3073.

Tyus, H.M. 1987. Distribution, reproduction, and habitat use of the razorback sucker in the Green River, Utah, 1979-1986. Transactions of the American Fisheries Society 116:111-116.

Tyus, H.M., and C.A. Karp. 1990. Spawning and movements of razorback sucker, *Xyrauchen texanus*, in the Green River Basin of Colorado and Utah. Southwestern Naturalist 35:427–433.

U.S. Army Corps of Engineers (USACE). 1987. Acequias Irrigation System, New Mexico – Proposed Plan of Project Report (603a). Albuquerque District. 43 pp. + appendices.

U.S. Army Corps of Engineers (USACE). 1993. Interagency Biological Working Group (1993) Cochiti Reservoir Reregulation Interagency Biological Report, June 30, 1993.

U.S. Army Corps of Engineers (USACE). 1994. Jemez Canyon Dam and Reservoir, Jemez River, New Mexico, Water Control Manual. Appendix D to Rio Grande Basin Master Water Control Manual. Albuquerque District.

U.S. Army Corps of Engineers (USACE). 1995. Abiquiu Dam and Reservoir, Rio Chama, New Mexico, Water Control Manual. Appendix A to Rio Grande Basin Master Water Control Manual. Albuquerque District.

U.S. Army Corps of Engineers (USACE). 1996a. Cochiti Lake, Rio Grande Basin, New Mexico, Water Control Manual. Appendix C to Rio Grande Basin Master Water Control Manual. Albuquerque District, Albuquerque, NM.

U.S. Army Corps of Engineers (USACE). 1996b. Reconnaissance Report: Rio Chama, Abiquiu to Española, New Mexico, Albuquerque District, July 1996.

U.S. Army Corps of Engineers (USACE). 1996c. Finding of No Significant Impact and Environmental Assessment: Revision of the Channel Capacity for the Rio Grande at Albuquerque, New Mexico. USACE, Albuquerque District, Albuquerque, NM. 26 pp.

U.S. Army Corps of Engineers (USACE). 2000. Finding of No Significant Impact and Environmental Assessment for the partial evacuation of the sediment pool at Jemez Canyon Reservoir, Sandoval County, New Mexico. USACE, Albuquerque District, Albuquerque, NM. 48 pp + appendices.

U.S. Army Corps of Engineers (USACE). 2001a. Finding of No Significant Impact and Environmental Assessment: Abiquiu and Jemez Canyon Reservoirs, Supplemental Water Storage and Release. USACE, Albuquerque

District, Albuquerque, NM. 4p pp + appendices.

U.S. Army Corps of Engineers (USACE). 2001b. Galisteo Dam and Reservoir Water Control Manual, Galisteo Creek, New Mexico. Appendix B to Rio Grande Basin Master Water Control Manual. USACE, Albuquerque District, Albuquerque, NM.

U.S. Army Corps of Engineers (USACE). 2002. Detailed Project Report and Environmental Assessment for Riparian and Wetland Restoration, Pueblo of Santa Ana Reservation, New Mexico. Albuquerque District. 84 pp. + app.

U.S. Army Corps of Engineers (USACE). 2007. Environmental Assessment for a Temporary Deviation in the Operation of Cochiti Dam, Sandoval County, New Mexico. Albuquerque District, Albuquerque, NM.

U.S. Army Corps of Engineers (USACE). 2008a. Biological Assessment for a Temporary Deviation in the Operation of Cochiti Lake and Jemez Canyon Reservoir, Sandoval County, New Mexico. 13 pp.

U.S. Army Corps of Engineers (USACE). 2008b. Detailed Project Report and Environmental Assessment for Aquatic Habitat Restoration at Santa Ana Pueblo, New Mexico. Albuquerque District. 72 pp. + app.

U.S. Army Corps of Engineers (USACE). 2009. Final Environmental Assessment for a Temporary Deviation in the Operation of Cochiti Lake and Jemez Canyon Reservoir, Sandoval County, New Mexico. Albuquerque District, Albuquerque, NM.

U.S. Army Corps of Engineers (USACE). 2010a. Biological Assessment for the Middle Rio Grande Bosque Restoration Project, Albuquerque, Bernalillo County, New Mexico. 22 pp.

U.S. Army Corps of Engineers (USACE). 2010b. Historic Inundation Analysis along the Middle Rio Grande for the Period 1990 to 2009. Report prepared for the Middle Rio Grande Endangered Species Act Collaborative Program, Population Viability Analysis Work Group. October 2010. 33 pgs.

U.S. Army Corps of Engineers (USACE). 2011. Draft Biological Assessment of U.S. Army Corps of Engineers Reservoir Operation on the Middle Rio Grande of New Mexico [dated April 30,2011]. Albuquerque District. 112 pp. + appendices.

U.S. Army Corps of Engineers (USACE), Bureau of Reclamation, and New Mexico Interstate Stream Commission. 2007. Upper Rio Grande Water Operations Review. Final Environmental Impact Statement, April 2007.

U.S. Bureau Reclamation (Reclamation). 1993. Final Supplement to the Final Environmental Impact Statement-River Maintenance program for the Rio Grande-Velarde to Caballo Dam-Rio Grande and Middle Rio Grande projects, New Mexico. U.S. Department of the Interior, Bureau of Reclamation, Albuquerque, New Mexico. 140 pp.

U.S. Bureau of Reclamation (Reclamation). 1999. Biological assessment, Rio Grande restoration at Santa Ana Pueblo, terrestrial habitat enhancement plan. U.S. Department of Interior, Bureau of Reclamation, Albuquerque Area Office, Albuquerque, New Mexico. 27 pp.

U.S. Bureau Reclamation (Reclamation). 2002. Letter to U.S. Fish and Wildlife Service reporting survey results. U.S. Department of the Interior, Bureau of Reclamation, Albuquerque, New Mexico, 3 pp.

U.S. Bureau of Reclamation (Reclamation). 2003. Letter to U.S. Fish and Wildlife Service reporting survey results. U.S. Department of the Interior, Bureau of Reclamation, Albuquerque, New Mexico, 5 pp.

U.S. Bureau of Reclamation (Reclamation). 2006. Middle Rio Grande Project, Sandia Priority Site, Biological Assessment. U.S. Department of the Interior, Bureau of Reclamation, Albuquerque, New Mexico, 19 pp.

U.S. Bureau of Reclamation (Reclamation). 2007. Elephant Butte Reservoir Temporary Channel Maintenance Project Biological Assessment. U.S. Department of the Interior, Bureau of Reclamation, Albuquerque, New Mexico, 33 pp.

U.S. Bureau of Reclamation (Reclamation). 2009. Southwestern Willow Flycatcher Habitat Reconnaissance - Upper Rio Grande from the Colorado State Line to Cochiti Reservoir, New Mexico. U.S. Department of the Interior, Bureau of Reclamation, Technical Services Center, Denver, CO. 73 pp. + app.

U.S. Bureau of Reclamation (Reclamation). 2010. 2009 Southwestern Willow Flycatcher study results: selected sites along the Rio Grande from Velarde to Elephant Butte Reservoir, New Mexico. U.S. Department of the Interior, Bureau of Reclamation, Technical Services Center, Denver, CO. 71 pp. + app.

U.S. Bureau of Reclamation (Reclamation). 2011a. 2010 Southwestern Willow Flycatcher study results: selected sites along the Rio Grande from Belen to Elephant Butte Reservoir, New Mexico. U.S. Department of the Interior, Bureau of Reclamation, Technical Services Center, Denver, CO. 76 pp..

U.S. Bureau of Reclamation (Reclamation). 2011b. Draft Biological Assessment of Bureau of Reclamation and Associated Non-federal Water Management Actions on the Middle Rio Grande, New Mexico [08/18/2011]. U.S. Department of the Interior, Bureau of Reclamation, Albuquerque Area Office, Albuquerque, NM.

U.S. Bureau of Reclamation (Reclamation). 2013. Joint Biological Assessment: Bureau of Reclamation and Non-Federal Water Management and Maintenance Activities on the Middle Rio Grande, New Mexico (Amended January 2013). U.S. Department of the Interior, Bureau of Reclamation, Albuquerque Area Office, Albuquerque, NM.

U.S. Bureau of Reclamation and U.S. Army Corps of Engineers (Reclamation and USACE). 1996. Biological Assessment, water operations of the middle Rio Grande during the 1996 irrigation season, Rio Grande silvery minnow, southwestern Willow flycatcher, and bald eagle. 78 pp.

U.S. Bureau of Reclamation and U.S. Army Corps of Engineers (Reclamation and USACE). 1997. Biological Assessment, water operations of the middle Rio Grande during the 1997 irrigation season, Rio Grande silvery minnow, southwestern willow flycatcher. 67 pp.

U.S. Bureau of Reclamation and U.S. Army Corps of Engineers (Reclamation and USACE). 2001. U.S. Bureau of Reclamation's Discretionary Actions Related to Water Management, U.S. Army Corps of Engineers Water Operations Rules, and Non-Federal Actions Related to Ordinary Operations on the Middle Rio Grande, New Mexico: June 30, 2001, through December 31, 2003. June 8, 2001.

U.S. Bureau of Reclamation and U.S. Army Corps of Engineers (Reclamation and USACE). 2003. Programmatic biological assessment of Bureau of Reclamation's water and river maintenance operations, Army Corps of Engineers' flood control operation, and non-federal actions on the middle Rio Grande, New Mexico March 1, 2003 – February 28, 2013. Albuquerque, New Mexico.

U.S. Fish and Wildlife Service (USFWS). 1985. Endangered and threatened wildlife and plants: Interior population of the least tern determined to be endangered. Federal Register 50:21784-21792.

U.S. Fish and Wildlife Service (USFWS). 1993. Endangered and threatened wildlife and plants; proposed rule to list the Rio Grande silvery minnow as endangered, with critical habitat. Federal Register 58:11821-11828.

U.S. Fish and Wildlife Service (USFWS). 1994. Endangered and threatened wildlife and plants; final rule to list the Rio Grande silvery minnow as an endangered species. Federal Register 59:36988-37001.

U.S. Fish and Wildlife Service (USFWS). 1995. Endangered and threatened wildlife and plants: final rule to list the southwestern willow flycatcher (*Empidonax traillii extimus*) as endangered with proposed critical habitat. Federal Register 60:10694-10715.

U.S. Fish and Wildlife Service (USFWS). 1996. Draft Biological Opinion and Conference Opinion, Rio Grande and Tributaries Flood Control, San Acacia to Bosque del Apache Unit, Socorro County, New Mexico. U.S. Fish and Wildlife Service, Albuquerque, New Mexico. 54 pp.

U.S. Fish and Wildlife Service (USFWS). 1999. Rio Grande silvery minnow (*Hybognathus amarus*) Recovery plan. U.S. Fish and Wildlife Service, Albuquerque, New Mexico. 138 pp.

U.S. Fish and Wildlife Service (USFWS). 2000. Memo from U.S. Fish and Wildlife Service, New Mexico Fishery Resources Office, to U.S. Army Corps of Engineers, Albuquerque Office, Re: September Rio Grande silvery minnow surveys in Angostura and Isleta reaches of the middle Rio Grande, NM, dated October 20, 2000. 12 pp.

U.S. Fish and Wildlife Service (USFWS). 2001. Programmatic biological opinion on the effects of actions associated with the U.S. Bureau of Reclamation's, U.S. Army Corps of Engineers', and non-federal entities discretionary actions related to water management on the middle Rio Grande, New Mexico. Albuquerque, New Mexico.

U.S. Fish and Wildlife Service (USFWS). 2002a. Final Southwestern Willow Flycatcher recovery plan. U.S. Fish and Wildlife Service, Albuquerque, N. M.

U.S. Fish and Wildlife Service (USFWS). 2002b. Report to the Rio Grande Compact Commission, U.S. Fish and Wildlife Service Activities in the Rio Grande Basin Calendar Year 2001. Prepared for the Rio Grande Compact Commission by the New Mexico Ecological Services Field Office, Albuquerque, New Mexico.

U.S. Fish and Wildlife Service. 2003a. 50 CFR Part 17 Endangered and threatened wildlife and plants; Designation of critical habitat for the Rio Grande silvery minnow; Final rule. U.S. Fish and Wildlife Service, Department of the Interior.

U.S. Fish and Wildlife Service (USFWS). 2003b. 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, Army Corps of Engineers' Flood Control Operation, and related non-federal actions on the middle Rio Grande, New Mexico. U.S. Fish and Wildlife Service, Albuquerque, New Mexico.

U.S. Fish and Wildlife Service (USFWS). 2004a. Biological Opinion on the Effects of Actions Associated with the Programmatic Biological Assessment for the City of Albuquerque Drinking Water Project. New Mexico Ecological Services Field Office, Albuquerque, NM. 73 pp.

U.S. Fish and Wildlife Service (USFWS). 2004b. Hydrologic and Biologic Data for the Water-Quality Assessment in Relation to Rio Grande Silvery Minnow Habitats. Middle Rio Grande, New Mexico. New Mexico Ecological Services Office, Albuquerque, NM.

U.S. Fish and Wildlife Service (USFWS). 2005. Designation of critical habitat for the Southwestern Willow Flycatcher (*Empidonax traillii extimus*). Federal Register 70:60886-61009.

U.S. Fish and Wildlife Service (USFWS). 2005. Pecos Sunflower Recovery Plan. Albuquerque, New Mexico. 39 pp.

U.S. Fish and Wildlife Service (USFWS). 2007a. Rio Grande silvery minnow rescue and salvage-2006. New Mexico Ecological Services Field Office, U.S. Fish and Wildlife Service, Albuquerque, New Mexico.

U.S. Fish and Wildlife Service (USFWS). 2007b. Draft revised Rio Grande silvery minnow (Hybognathus amarus) recovery plan. U.S. Fish and Wildlife Service, Albuquerque, New Mexico.

U.S. Fish and Wildlife Service (USFWS). 2007c. Biological Opinion on the Effects of Actions Associated with the Biological Assessment for the Buckman Water Diversion Project, Santa Fe National Forest, USDA Forest Service, June 25, 2007.

U.S. Fish and Wildlife Service (USFWS). 2008. Designation of Critical Habitat for Helianthus Paradoxus (Pecos Sunflower); Final Rule. Federal Register 73: 17762-17807.

U.S. Fish and Wildlife Service (USFWS). 2011a. Endangered and Threatened Wildlife and Plants: Designation of Revised Critical Habitat for Southwestern Willow Flycatcher. Federal Register 73:50542-50629.

U.S. Fish and Wildlife Service (USFWS). 2011b. Arc GIS Data Files: 2011 Southwestern Willow Flycatcher Critical Habitat Proposal. <http://www.fws.gov/southwest/es/arizona/SWWF_pCH_2011.htm> [Last visited Sep. 20, 2011.]

U.S. Fish and Wildlife Service (USFWS). 2013a. Designation of Critical Habitat for Southwestern Willow Flycatcher; Final Rule. Federal Register 72:344-534 (Jan. 3, 2013).

U.S. Fish and Wildlife Service (USFWS). 2013b. GIS data files obtainable at: Southwestern Willow Flycatcher, Final Revised Critical Habitat 2013. <http://www.fws.gov/southwest/es/arizona/SWWF_revisedCH_2013.htm> [Last accessed, Feb. 5, 2013.]

U.S. Geological Survey (USGS). 2001. Selected findings and current perspectives on urban and agricultural water quality by the National Water-Quality Assessment Program. United States Geological Survey, Reston, Virginia.

U.S. Geologic Survey (USGS). 2002. Ground-water resources of the Middle Rio Grande basin, New Mexico. Circular 1222.

Unitt, P. 1987. Empidonax traillii extimus: An Endangered Subspecies. Western Birds 18:137–162.

Utton Center Staff (Susan Kelley). 2007. Natural Resources Journal. Summer 2007. Vol. 47. No. 3.

Valdez, R.A., and E.J. Wick. 1983. Natural vs. manmade backwaters as native fish habitat. Pages 519–536 *in* V.D. Adams and V.A. Lamarra (eds.). Aquatic resources management of the Colorado River ecosystem. Ann Arbor Science, Ann Arbor, Michigan.

Van Auken, O. W. 2001. Germination requirements of seeds of Helianthus paradoxus (Asteraceae). Texas Journal of Science 53:157-170.

Van Auken, O. W., and J. K. Bush. 1995. Factors affecting the growth and distribution of Helianthus paradoxus. Performance Report for Section 6 Grant No. E-1-7, Project No. 60, Texas Parks and Wildlife Department, Austin.

Van Auken, O. W., and J. K. Bush. 1998. Spatial relationships of *Helianthus paradoxus* (Compositae) and associated salt marsh plants. Southwestern Naturalist 43:313-320.

Van Citters, K. 2000. Historic Engineering Overview of the San Marcial Railroad Bridge. Office of Contract Archeology, University of New Mexico. May 2000.

Van Horn, D. and C. Dahm. 2008. Water Quality in the Middle Rio Grande, September 2005 – February 2008: Final Report. Prepared for: U.S. Army Corps of Engineers, and U.S. Fish and Wildlife Service. 35 pgs.

Waltermeyer, S.D. 1987. Trend in Streamflow and Reservoir Contents in the Rio Grande Basin, NM. Proceedings, 31st Annual New Mexico Water Conference, WRRI Report No. 219.

Whitfield, M. 1990. Willow Flycatcher Reproductive Response to Brown-headed Cowbird Parasitism. Masters Thesis, California State University, Chico, California State University, Chico, California.

Widmer, A. M., J. W. Kehmeier, and J. J. Fluder. 2007. Characterization of Rio Grande silvery minnow egg and larval drift and retention in the Middle Rio Grande. SWCA Environmental Consultants, Broomfield, CO.

Widmer, A. M., J. J. Fluder, J. W. Kehmeier, C. N. Medley and R.A. Valdez. 2010. Drift and Retention of Pelagic Spawning Minnow Eggs in a Regulated River. River Research and Applications. 12 pgs.

Wilcove, D. S. 1988. Changes in the avifauna of the Great Smoky Mountains: 1947-1983. Wilson Bulletin 100:256-271.

Williams, G.P., and M.G. Wolman. 1984. Downstream Effects of Dams on Alluvial Rivers. U.S. Geological Service Professional Paper 1286. U.S. Government Printing Office, Washington, D.C.

Woodhouse, C.A., and J.J. Lukas. 2006. Multi-Century Tree-Ring Reconstructions of Colorado Streamflow for Water Resource Planning.

Wozniak, F.E. 1997. Irrigation in the Rio Grande Valley, New Mexico: A Study and Annotated Bibliography of the Development of Irrigation Systems. RMRSP-2. USDA, Rocky Mountain Research Station. Fort Collins, Colorado.

Yevjevich, V., W.A. Hall, and J.D. Salas (eds.). 1977. Drought research needs *in* Proceedings of the Conference on Drought Research Needs, December 12-15, 1977. Colorado State University, Fort Collins, Colorado. 276 p.

Yong, W. and D. M. Finch. 1997. Migration of the Willow Flycatcher along the middle Rio Grande. Wilson Bulletin 109:253-268.

APPENDIX A

PERTINENT PUBLIC LAWS

Excerpted from: **PUBLIC LAW 86-645** [H. R. 7634]

LAWS OF THE 86th CONGRESS—SECOND SESSION, July 14, 1960

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That: . . .

TITLE II—FLOOD CONTROL

Sec. 203. The following works of improvement ... are hereby adopted and authorized to be prosecuted under the direction of the Secretary of the Army and the supervision of the Chief of Engineers ...

RIO GRANDE BASIN

The project for improvement of the Rio Grande Basin is hereby authorized substantially as recommended by the Chief of Engineers in Senate Document Numbered 94, Eighty-sixth Congress, at an estimated cost of $58,300,000.

The approval granted above shall be subject to the following conditions and limitations:

Cochiti Reservoir, Galisteo Reservoir, and all other reservoirs constructed by the Corps of Engineers as a part of the Middle Rio Grande project will be operated solely for flood control and sediment control, as described below:

(a) The outflow from Cochiti Reservoir during each spring flood and thereafter will be at the maximum rate of flow that can be carried at the time in the channel of [the] Rio Grande through the middle valley without causing flooding of areas protected by levees or unreasonable damage to channel protective works:

Provided, That whenever during the months of July, August, September, and October, there is more than two hundred twelve thousand acre-feet of storage available for regulation of summer floods and the inflow to Cochiti Reservoir (exclusive of that portion of the inflow derived from upstream flood-control storage) is less than one thousand five hundred cubic feet per second, no water will be withdrawn from storage in Cochiti Reservoir and the inflow derived from upstream flood-control storage will be retained in Cochiti Reservoir.

(b) Releases of water from Galisteo Reservoir and Jemez Canyon Reservoir during the months of July, August, September, and October, will be limited to the amounts necessary to provide adequate capacity for control of subsequent summer floods; and such releases when made in these months, or thereafter, will be at the maximum rate practicable under the conditions at the time.

(c) Subject to the foregoing, the storage of water in and the release of water from all reservoirs constructed by the Corps of Engineers as part of the Middle Rio Grande project will be done as the interests of flood and sediment control may dictate:

Provided, That the Corps of Engineers will endeavor to avoid encroachment on the upper two hundred and twelve thousand acre-feet of capacity in Cochiti Reservoir, and all reservoirs will be evacuated completely on or before March 31 of each year:

And provided further, That when estimates of anticipated streamflow made by appropriate agencies of the Federal Government indicate that the operation of reservoirs constructed as a part of the Middle Rio

Grande project may affect the benefits accruing to New Mexico or Colorado, under the provisions of the eighth unnumbered paragraph of article VI of the Rio Grande compact, releases from such reservoirs shall be regulated to produce a flow of ten thousand cubic feet per second at Albuquerque, or such greater or lesser rate as may be determined by the Chief of Engineers at the time to be the maximum safe flow, whenever such operation shall be requested by the Rio Grande compact commissioner for New Mexico or the commissioner for Colorado, or both, in writing prior to commencement of such operation.

(d) All reservoirs of the Middle Rio Grande project will be operated at all times in the manner described above in conformity with the Rio Grande compact, and no departure from the foregoing operation schedule will be made except with the advice and consent of the Rio Grande Compact Commission:

Provided, That whenever the Corps of Engineers determines that an emergency exists affecting the safety of major structures or endangering life and shall so advise the Rio Grande Compact Commission in writing these rules of operation may be suspended during the period of and to the extent required by such emergency.

(e) The foregoing regulations shall not apply to storage capacity which may be allocated to permanent pools for recreation and fish and wildlife propagation:

Provided, That the water required to fill and maintain such pools is obtained from sources entirely outside the drainage basin of the Rio Grande.

Excerpted from: **PUBLIC LAW 88-293**; 88th Congress, S. 614; March 26, 1964

An Act

To authorize the Secretary of the Interior to make water available for a permanent pool for fish and wildlife and recreation purposes at Cochiti Reservoir from the San Juan-Chama unit of the Colorado River storage project.

Be it enacted by the Senate and the House of Representatives of the United States of America assembled. That the proviso to subdivision (e) of the conditions applicable to the project for improvement of the Rio Grande Basin authorized by section 203 of the Flood Control Act of 1960 (Public Law 86-645; 74 Stat. 493), is hereby supplemented to authorize, for conservation and development of fish and wildlife resources and for recreation, approximately fifty thousand acre-feet of water for the initial filling of a permanent pool of one thousand two hundred surface acres in Cochiti Reservoir, and thereafter sufficient water annually to offset the evaporation from such area, to be made available by the Secretary of the Interior from water diverted into the Rio Grande Basin by the works authorized by section 8 of the Act of June 13, 1962 (Public Law 87-483, 76 Stat. 97), subject to the conditions specified in sections 8, 12, 13, 14, and 16 of said Act. An appropriate share of the costs of said works shall be reallocated to recreation and fish and wildlife, and said allocation, which shall not exceed $300,000, shall be nonreimbursable and nonreturnable.

SEC. 2. Nothing contained in the Act shall be construed to increase the amount heretofore authorized to be appropriated for construction of the Colorado River storage project or any of its units.

Approved March 26, 1964.

STORAGE OF SAN JUAN-CHAMA PROJECT WATER IN OTHER RESERVOIRS

Pub. L. 97-140, Sec. 5, Dec. 29, 1981, 95 Stat. 1717

(a) The proviso of section 2 of Public Law 84-485 (this section) shall not be construed to prohibit the storage of San Juan-Chama project water acquired by contract with the Secretary of the Interior pursuant to Public Law 87-483 (section 615ii et seq. of this title) in any reservoir, including the storage of water for recreation and other beneficial purposes by any party contracting with the Secretary for project water.

(b) The Secretary of the Army, acting through the Chief of Engineers, is authorized to enter into agreements with entities which have contracted with the Secretary of the Interior for water from the San Juan-Chama project pursuant to Public Law 87-483 for storage of a total of two hundred thousand acre-feet of such water in Abiquiu Reservoir. The Secretary of the Interior is hereby authorized to release San Juan-Chama project water to contracting entities for such storage. The agreements to thus store San Juan-Chama project water shall not interfere with the authorized purposes of the Abiquiu Dam and Reservoir project and shall include a requirement that each user of storage space shall pay any increase in operation and maintenance costs attributable to the storage of that user's water.

(c) The Secretary of the Interior is authorized to enter into agreements with entities which have contracted with the Secretary of the Interior for water from the San Juan-Chama project pursuant to Public Law 87-483 for storage of such water in Elephant Butte Reservoir. The Secretary of the Interior is hereby authorized to release San Juan-Chama project water to contracting entities for such storage. Any increase in operation and maintenance costs resulting from such storage not offset by increased power revenues resulting from that storage shall be paid proportionately by the entities for which the San Juan-Chama project water is stored.

(d) The amount of evaporation loss and spill chargeable to San Juan-Chama project water stored pursuant to subsections (b) and (c) of this section shall be accounted as required by the Rio Grande compact and the procedures established by the Rio Grande Compact Commission.

STORAGE OF WATER AT ABIQUIU DAM IN NEW MEXICO

Pub. L. 100-522, Oct. 24, 1988, 102 Stat. 2604

SECTION 1. WATER STORAGE.

Notwithstanding any other provision of law, the Secretary of the Army, acting through the Chief of Engineers, is authorized to store 200,000 acre-feet of Rio Grande system water at Abiquiu Dam, New Mexico, in lieu of the water storage authorized by section 5 of Public Law 97-140 *[set out below]*, to the extent that contracting entities under section 5 of Public Law 97-140 no longer require such storage. The Secretary is authorized further to acquire lands adjacent to Abiquiu Dam on which the Secretary holds easements as of the date of enactment of this Act *[Oct. 24, 1988]* if such acquisition is necessary to assure proper recreational access at Abiquiu Dam. The Secretary is further directed to report to Congress as soon as possible with recommendations on additional easements that may be required to assure implementation of this Act.

SEC. 2. LIMITATION.

The authorization to store water and to acquire lands under section 1 is subject to the provisions of the Rio Grande Compact and the resolutions of the Rio Grande Compact Commission.

MIDDLE RIO GRANDE ENDANGERED SPECIES COLLABORATIVE PROGRAM

Excerpted from Pub. L. 111–8, MAR. 11, 2009, STAT. 607:

SEC. 106. Section 121 of the Energy and Water Development Appropriations Act, 2006 (Public Law 109–103; 119 Stat. 2256) is amended by striking subsection (a) and inserting the following:

"(a) Hereafter, the Secretary of the Army may carry out and fund planning studies, watershed surveys and assessments, or technical studies at 100 percent Federal expense to accomplish the purposes of the 2003 Biological Opinion described in section 205(b) of the Energy and Water Development Appropriations Act, 2005 (Public Law 108–447; 118 Stat. 2949) as amended by subsection (b) or any related subsequent biological opinion, and the collaborative program long-term plan. In carrying out a study, survey, or assessment under this subsection, the Secretary of the Army shall consult with Federal, State, tribal and local governmental entities, as well as entities participating in the Middle Rio Grande Endangered Species Collaborative Program referred to in section 205 of this Act: *Provided*, That the Secretary of the Army may also provide planning and administrative assistance to the Middle Rio Grande Endangered Species Collaborative Program, which shall not be subject to cost sharing requirements with non-Federal interests.".

MIDDLE RIO GRANDE HABITAT RESTORATION AUTHORITY

Excerpted from Pub. L. 110–114, NOV. 8, 2007, STAT. 1137

SEC. 3118. MIDDLE RIO GRANDE RESTORATION, NEW MEXICO.

(a) RESTORATION PROJECTS DEFINED.—In this section, the term ''restoration project'' means a project that will produce, consistent with other Federal programs, projects, and activities, immediate and substantial ecosystem restoration and recreation benefits.

(b) PROJECT SELECTION.—The Secretary shall select and shall carry out restoration projects in the Middle Rio Grande from Cochiti Dam to the headwaters of Elephant Butte Reservoir in the State of New Mexico.

(c) LOCAL PARTICIPATION.—In carrying out subsection (b), the Secretary shall consult with, and consider the activities being carried out by—

(1) the Middle Rio Grande Endangered Species Act Collaborative Program; and

(2) the Bosque Improvement Group of the Middle Rio Grande Bosque Initiative.

(d) AUTHORIZATION OF APPROPRIATIONS.—There is authorized to be appropriated $25,000,000 to carry out this section.

APPENDIX B

RECENT AND CONTEMPORARY FEDERAL ACTIONS

The 2003 BO (USFWS 2003b) contained a succinct summary of the environmental baseline up to that its date of issue. This appendix contains a summary of pertinent Section 7 consultations since that date. This information is not intended to be all-inclusive, but rather is provided to assist the Service in their responsibility to determine the baseline and ongoing effects.

U.S. Army Corps of Engineers

Rio Grande Nature Center Habitat Restoration Project

In September 2006, the Corps submitted a BA to the Service for the proposed Rio Grande Nature Center Habitat Restoration Project for the Angostura Reach of the Rio Grande and requested formal Section 7 consultation (Consultation #22420-2006-F-161). This project rehabilitated floodplain areas and reconnected an old channel to the river to create habitat for the silvery minnow, and facilitated the regeneration of native vegetation suitable for the flycatcher while meeting priorities of the Middle Rio Grande ESA Collaborative Program to complete restoration projects in the Angostura Reach. The Service concurred with the Corps' determination that the proposed project "may affect, is not likely to adversely affect" the Bald Eagle, flycatcher, and critical habitat for the minnow. The Service determined that the proposed project is not likely to jeopardize the continued existence of the minnow, and although it may have a minimal adverse affect on individual minnows in the 15-acre project area, is anticipated to have a long-term positive impact on the species through improvements to quality and availability of suitable habitat.

Environmental commitments associated with the proposed Rio Grande Nature Center Habitat Restoration Project included development of protocols to monitor minnows in the ephemeral channel following high flows and to determine whether channel maintenance is warranted, reporting injured or dead minnows to the Service, and providing a final restoration monitoring report outlining results and effectiveness of the side channel restoration and embayments to the Service. Additional commitments were to monitor and report on water quality before, during, and after construction activity and schedule embayment construction during dry or frozen soil conditions if possible.

Bosque Revitalization at Route 66 Project

In March 2008, the Corps submitted a BA to the Service for the proposed Bosque Revitalization @ Route 66 Project for the Angostura Reach of the Rio Grande and requested formal Section 7 consultation (Consultation #22420-2008-F-0125). This project entailed jetty jack removal, non-native shrub removal, native woody plantings, and creation of willow swales throughout a 121-acre area extending approximately from the Central Avenue Bridge to the Bridge Boulevard Bridge in Albuquerque. These riparian features would improve habitat conditions for the flycatcher and minnow. Three high-flow side channels are expected to establish diverse mesohabitats that support the silvery minnow. Such habitat benefits the species through improved egg and larval retention, increased recruitment rates, and increased survival of both juvenile and adult minnows.

The Service concurred with the Corps determination that the proposed project "may affect, is not likely to adversely affect" the flycatcher and designated critical habitat for the silvery minnow. The Service determined that the proposed project is not likely to jeopardize the continued existence of the minnow, and although it may minimally adversely affect individual minnows when constructing channel embayment areas, the project is anticipated to have a long-term positive impact on the species through improvements to quality and availability of suitable habitat.

The attendant Incidental Take Statement included RPMs to minimize take of silvery minnow due to habitat restoration activities; manage for the protection of water quality from activities associated with the restoration project; and to continue to work collaboratively with the Service on the Middle Rio Grande Endangered Species Act Collaborative Program.

Temporary Deviation for Recruitment and Overbanking Flows

In 2009, the Corps, in coordination with the Pueblos of Cochiti and Santa Ana, implemented a temporary, three-year deviation to the flood operation schedules in the water control plans for Cochiti and Jemez Canyon dams (USACE 2009). In 2012, the Corps' South Pacific Division approved an extension of this deviation for an additional two years (through July 2013). The Corps conducted informal consultation on the entire, five-year action in 2008 (Consultation #22420-2008-I-0141). The Service sent a letter of concurrence for the deviation on August 25, 2008, which stated that the action would be beneficial to the minnow, flycatcher, and their designated critical habitats.

When required and flow is available, the Corps would alter its release schedule to temporarily detain up to 20,000 ac-ft of Rio Grande basin runoff at Cochiti Lake and/or Jemez Canyon Reservoir which would facilitate spawning and recruitment flows for the silvery minnow without adversely affecting irrigation demand or Rio Grande Compact deliveries. In a related fashion, the Corps would similarly store up to 45,000 ac-ft to induce overbank inundation—which would occur primarily downstream from Isleta Diversion Dam—and which would benefit the minnow, the flycatcher, and their designated or proposed critical habitat. Implementation of either action is subject to annual approval by the Rio Grande Compact Commission and the Pueblos of Cochiti and Santa Ana, and to the availability of sufficient water to offset depletions due to temporary detention.

(Because this temporary deviation in operations will expire on June 15, 2013, it has not been included in the proposed action for the current consultation.)

Bureau of Reclamation

Middle Rio Grande Riverine Habitat Restoration Project for the Angostura Reach of the Rio Grande in Bernalillo County, New Mexico (NM Interstate Stream Commission)

In September 2005, Reclamation submitted a BA to the Service on behalf of the New Mexico Interstate Stream Commission (NMISC) addressing potential impacts of a proposed habitat restoration project within the Angostura Reach on the endangered silvery minnow, the endangered flycatcher and the threatened Bald Eagle (Consultation #22420-2006-F-02). The Service concurred with Reclamation's determination of "may affect, not likely to adversely affect" for the Willow Flycatcher and Bald Eagle and provided an opinion that the proposed action is not likely to jeopardize the continued existence of the minnow, and that the proposed action "may affect is likely to adversely affect" minnows in the short-term with long-term "positive impact on the species," and that the proposed action is "not likely to destroy or adversely modify designated critical habitat" for the minnow.

Environmental commitments for the Angostura Reach Habitat Restoration Project required the NMISC to monitor minnows at construction sites; use adaptive management as appropriate; develop and submit a

Restoration Monitoring Plan to the Service; and report dead or injured minnows to the Service. Additional commitments were to schedule crossings during dry or frozen soil conditions; measure and report water quality parameters before, during, and after construction; as well as to report any hazardous materials spills (*i.e.,* fuels, hydraulic fluids) to the Service.

Sandia Priority Site Project

In June 2006, Reclamation submitted a BA (Reclamation 2006) to the Service for this action on the endangered silvery minnow, the endangered flycatcher, and the threatened Bald Eagle. The proposed project included the protection of the east levee and canal system from the U.S. Highway 550 bridge downstream into the Pueblo of Sandia by creating secondary channels, realigning the main river channel, and installing bendway wiers and rootwad revetments to reduce bank erosion threatening the levee. The Service concurred (Consultation #22420-2006-F-039) with Reclamation's determination of "may affect, not likely to adversely affect" the flycatcher and eagle, and also determined that the project "may affect, is not likely to adversely affect" minnow critical habitat, and that long-term effects would be beneficial. The Service concluded that the Sandia Priority Site Project was "not likely to jeopardize the continued existence of the silvery minnow," and that impacts on the population would be minimal because of the small area within occupied habitat.

Environmental commitments for the Sandia Priority Site Project required Reclamation to monitor minnows at construction sites; use adaptive management to modify construction activities, partial dewatering, and habitat improvement activities, as appropriate; and to report dead or injured minnows to the Service. Additional commitments were to schedule crossings during dry or frozen soil conditions; measure and report water quality parameters before, during, and after construction; report water quality measurements per conditions of Reclamation's Clean Water Act 401 certification to the Service and the Pueblo of Sandia; as well as to report any exceedance of Pueblo water quality standards or spills (*i.e.,* fuels, hydraulic fluids) to the Service and the Pueblo of Sandia, and immediately remediate those conditions.

Middle Rio Grande Riverine Habitat Restoration Phase II Project for the Angostura Reach (NMISC)

In August 2006, Reclamation submitted a BA to the Service on behalf of the NMISC addressing potential impacts of Phase II of a proposed habitat restoration project within the Angostura Reach on the endangered silvery minnow, the endangered flycatcher and the threatened Bald Eagle. This phase of the proposed project was to create or improve habitat for minnows, including promoting egg retention, larval rearing, and habitat for young-of-year and overwintering silvery minnows within four sub-reaches of the Angostura Reach in support of Element S of the RPA in the March 2003 BO. Habitat restoration techniques included island modifications, bank scouring, and installation of woody debris to improve aquatic habitats. The Service concurred (Consultation #22420-2006-F-160) with Reclamation's determination of "may affect, not likely to adversely affect" for the Bald Eagle and the flycatcher and its critical habitat, and provided an opinion that the proposed action is not likely to jeopardize the continued existence of the minnow, and is not likely to destroy or adversely modify designated critical habitat. The Service also determined that the proposed action may adversely affect individual minnows in the short term, but that the proposed action was likely to have a long-term positive impact on the species.

Environmental commitments for the Angostura Reach Habitat Restoration Project required the NMISC to monitor minnows at construction sites, use adaptive management as appropriate, and develop a protocol to monitor for minnows in ephemeral channels following high flows. In coordination with the Service, NMISC was required to determine whether channel maintenance is warranted. NMISC also was required to report on the effectiveness of all treatments to the Service in a timely manner, and to report dead or injured minnows to the Service. Additional commitments were to schedule crossings during dry or frozen soil conditions; measure and report water quality parameters before, during, and after construction; and report water quality measurements per conditions of Reclamation's Clean Water Act 401 certification to the Service and the Pueblo of Sandia.

Perennial Rio Grande Silvery Minnow Refugia at Drain Outfalls

Reclamation submitted a BA to the Service on October 4, 2006, for the proposed Perennial Rio Grande Silvery Minnow Refugia at Drain Outfalls Project (Perennial Outfalls Project), located in the Isleta Reach of the Middle Rio Grande. The project partners will create habitat structures for minnows using large woody debris in three drain outfalls: Los Chavez Wasteway, Peralta Wasteway, and the Lower Peralta Drain #1 outfall. Reclamation determined that the proposed action "may affect, is not likely to adversely affect" the flycatcher, or its designated critical habitat, or the Bald Eagle. The Service (Consultation #22420-2007-F-0021) concurred with Reclamation's determinations, and also found that although the project would have temporary adverse effects to the minnow and its designated critical habitat, it would benefit the minnow during dry conditions by creating refugial habitat.

Environmental commitments for the Perennial Outfalls Project required Reclamation to minimize take of silvery minnow during construction; manage for water quality protection from activities associated with construction by avoiding the wetted river channel with heavy equipment during high flows; and by monitoring water quality before, during, and after construction activities. Additional commitments included monitoring of piscivores in newly created habitats and reporting monitoring results to the Service; coordinating with the Service if poor water quality, potential for stranding, high predation levels, or occurrence of disease were observed in the pools created by the project; and determining if a decrease in habitat suitability or value occurred due to the project, and if observed, removing the structures.

Santo Domingo Pueblo Restoration Project Phase II

Reclamation submitted a BA to the Service in April 2007, requesting concurrence for proposed activities associated with the Santo Domingo Pueblo Restoration Project Phase II. This project entailed the winter-time excavation of three sites on the east side of the Rio Grande beginning 1.5 miles south of SP88 and Bridge No. M102, and the placement of large woody debris in the Rio Grande to reduce water velocity and enhance sediment deposition as a means for improving habitat for the minnow in the Cochiti Reach. Reclamation determined that the proposed action "may affect, is not likely to adversely affect" the endangered silvery minnow and the threatened Bald Eagle. The Service concurred with Reclamation's determinations by letter dated April 19, 2007, provided that general environmental commitments for the Bald Eagle were followed; excavation would take place during winter low flows or dry periods; no equipment would enter the river; silt fences and sand bags would be used to isolate the excavation area from the river and minimize transport of sediment from the work area into the river; and standard best management practices would be utilized. The Service also agreed that the Pueblo of Santo Domingo would be responsible for monitoring and notifying the Service if silvery minnows were to use ephemeral channels or other isolated habitats forming in the channel.

Proposed Installation of Crump Weir and Passive Integrated Transponder Tag Readers in the Albuquerque Drinking Water Project Fishway

Reclamation submitted a BA to the Service on May 1, 2007, for the proposed installation of crump weir and passive integrated transponder tag readers in the Albuquerque Drinking Water Project Fishway. Reclamation determined that the proposed action "may affect, is not likely to adversely affect" the minnow or its designated critical habitat. The Service concurred with Reclamation's determinations by letter dated June 21, 2007, provided that the following conditions were followed: block nets would be used to exclude minnows from the work area and installation would occur by hand.

Corrales Siphon River Maintenance Project

In September 2007, Reclamation submitted a BA to the Service for this action on the endangered silvery minnow and the endangered flycatcher and their respective designated critical habitats. The proposed project would protect the inverted siphon and associated infrastructure from damage caused by potential westward migration of the Rio Grande by moving the river eastward using a bioengineering technique designed to create and improve habitat for the minnow. Reclamation determined that the proposed project "may affect, but is not likely to adversely affect" the flycatcher or its designated habitat. The Service concurred with this determination (Consultation #22420-2007-F-0056) and also determined that the proposed project was not likely to jeopardize the continued existence of the minnow or result in adverse modification of its designated critical habitat. The project was also anticipated to be of long-term benefit to silvery minnow habitat quality.

Environmental commitments for the Corrales Siphon Project included monitoring for minnows prior to, and at least four times during and after, construction; reporting findings and results to the Service; transporting fill materials with heavy equipment across the Rio Grande as few times as possible to minimize destabilization of sediments; avoidance (to the extent possible) of crossing the wetted channel of the river at flows exceeding 900 cfs; and monitoring water quality during and after equipment operating in the river.

Proposed Pueblo of San Felipe Bosque Restoration Project

In September 2007, Reclamation submitted a BA to the Service, on behalf of the Pueblo of San Felipe, addressing potential impacts of a Bosque restoration project under Section 7 of the Endangered Species Act of 1973, as amended. The proposed project would remove about 10 acres of non-native vegetation in the abandoned riparian floodplain of the Bosque and subsequent replanting of Goodding's willow (*Salix gooddingii*) and Rio Grande cottonwood (*Populus deltoides* var. *wislizeni*) poles. Reclamation determined that the proposed action "may affect, is not likely to adversely affect" the minnow or its designated critical habitat or the flycatcher and its designated critical habitat. The Service concurred with these determinations (Consultation # 22420-2008-IC-0010) provided that no vegetation would be removed within 20 feet of the Rio Grande, the bankline would not be disturbed, and the construction would take place outside normal breeding and nesting seasons for the flycatcher.

Elephant Butte Reservoir Temporary Channel Maintenance Project

In October 2007, Reclamation submitted a BA (Reclamation 2007) addressing the effects of the proposed project on the endangered flycatcher and the minnow, and on the designated critical habitat for each. The proposed action includes maintenance of the temporary channel, which facilitates delivery of water and sediment from River Mile (RM) 57.8 to Elephant Butte Reservoir, for a period of five and one half years. Activities included ongoing non-channel enhancement features, maintenance operations, future temporary channel construction, and widening and realignment of the existing temporary channel. The Service determined (Consultation # 22420-2008-F-0017) that the project was not likely to jeopardize the continued existence of the minnow or flycatcher or result in adverse modification of designated critical habitat. In April 2008, the Service transmitted a letter amending the January 2008 BO, pursuant to communication among the Service and Reclamation in February and March.

In order to fulfill environmental commitments for this project, Reclamation will: 1) to the extent possible, operate airboats in the middle of the channel; 2) avoid pumping directly from the channel to minimize minnow egg and larvae entrainment, and use sumps adjacent to the channel whenever feasible; 3) in coordination with the Service, fund a program to monitor minnows in the temporary channel; 4) support

Collaborative Program efforts to prioritize and implement habitat restoration projects in the San Acacia Reach pursuant to the Program's 2006 Long-Term Plan; 5) excavate an area as few times as possible and when excavating within the wetted channel, minimize movement of excavator tracks and bucket contact with the bed of the channel to minimize sediment disturbance; 6) monitor water quality before, during, and after the project, which may include visual observations or direct sampling; 7) use current flycatcher monitoring data and avoid working within 0.25 miles of an active nest; 8) monitor vegetation health, incorporating vegetation mapping; 9) monitor groundwater levels from the north boundary of the refuge, along the temporary channel, and the west side of the Reservoir, as needed; 10) monitor the riverbed and movement of the headcut; and 11) work with the Service to plan and implement a specific restoration project to establish flycatcher habitat on the Rio Grande, outside the San Marcial reach, by January 2009, and implemented by July 2013.

Rio Grande Restoration Project at Santa Ana Pueblo

In June 2007, Reclamation submitted a BA to the Service, on behalf of the Pueblo of Santa Ana, to perform a project to protect existing levees and associated infrastructure using bioengineering and other techniques, including installation of 13 bendway weirs to protect a threatened bankline by moving the river eastward and relocating sediment to the west bank of the river and to provide habitat for listed species, the endangered silvery minnow and Southwestern Willow Flycatcher. No critical habitat exists for either species and, therefore, will not be affected. Reclamation determined that the project "may affect, is not likely to adversely affect" the flycatcher. The Service concurred (Consultation # 22420-1998-F-0168-R002) and also determined that the Santa Ana Restoration Project is not likely to jeopardize the continued existence of the silvery minnow or result in adverse modification of designated critical habitat. However, the minnow and its food base will be adversely affected by the use of heavy equipment and placement of fill in the wetted channel of the river.

Environmental commitments for the Santa Ana Restoration Project include limiting equipment crossing speeds to 5 miles per hour (mph) for the first three crossings per day, and to the extent feasible, limit all crossing speeds to 5 mph; reporting of dead or injured minnows to the Service; and immediately cease construction activity until the Service determines it is safe to resume. Additionally, Reclamation would transport fill materials across the Rio Grande as few times as possible; avoid crossing the wetted channel of the river at >900 cfs flows; and monitor water quality before, during, and after construction activities.

River Mile 111 Priority Site Project

In March 2008, Reclamation submitted a BA to the Service evaluating the effects of relocation of the Low Flow Conveyance Channel and the associated levee, on the endangered flycatcher and minnow and designated critical habitat. The project would allow the Rio Grande more freedom to move within its historic floodplain. Reclamation determined that the project "may affect, is not likely to adversely affect" the minnow and its designated habitat. The Service concurred with this determination (Consultation #22420-2008-I-0067), provided the following conditions were met: 1) all construction of woody debris piles would occur under dry working conditions or during low flow conditions; 2) recent surveys of the Low-Flow Conveyance Channel (LFCC) downstream of the proposed construction area did not find any minnows; 3) the Lemitar radial gate structure would be closed during the construction operations; 4) cottonwood root wads would be placed on the bank near RM 111 and would cascade into the river as it migrates west; and 5) the Mitigation Plan described in the BA would be fully implemented and the Conservation Measures described in the BA would also be fully implemented by Reclamation.

Rio Grande Sediment Plug Removal Project at Bosque del Apache National Wildlife Refuge

In August 2008, Reclamation submitted a BA to the Service addressing potential impacts of removal of a sediment plug, which had formed within the Rio Grande at the Bosque del Apache National Wildlife Refuge (Refuge) during spring runoff 2008, on the endangered minnow and its designated critical habitat and on the endangered flycatcher. Reclamation's environmental commitments for the Sediment Plug Removal Project include: 1) construction of at least four embayments (each approximately 30 to 50 feet in width and 50 to 70 feet in length) on the west side of the pilot channel to promote channel widening to be completed during Phase I(b); 2) collection of data for four years following excavation of the pilot channel to monitor channel degradation/aggradation and overbanking patterns, including *i.* cross-section data of the river channel from the north boundary of the Refuge to the San Marcial Railroad Bridge, *ii.* at least two inspections of the river channel by boat when overbanking begins during runoff, and *iii.* at least once during the four years, cross-section data of the river channel and floodplains that extend between endpoints for these rangelines; 3) data collected as above will be analyzed and compared to 2002 and 2005 cross-section data to assess changes to the riverbed thalweg and channel geometry, including width/depth ratio, and data and analysis will be provided to the Service (New Mexico Ecological Services Fishery Office and the Refuge); and 4) in-depth analysis of alternatives to pilot channel construction within the aforementioned reach of river will be initiated within six months of completion of Phase I(b) of the project. Environmental commitment number 4 will include at least three strategies to address sediment transport through the reach; maintenance of connected un-vegetated river bars; opportunities for river realignment following sand plug formation; river connectivity during low flows; river/floodplain surface connectivity; surface water supplies to adjacent wetlands; and effects on threatened, endangered, or candidate species. This analysis must be conducted in coordination with the Service, and the final report must be completed within three years and will be used in all future sediment plug removal or maintenance activities within the Refuge.

Drain Unit 7 Extension River Maintenance Priority Site Project

On June 13, 2008, Reclamation submitted a BA, along with a letter formally requesting consultation reinitiation, to the Service for the proposed Drain Unit 7 (DU7) Extension River Maintenance Priority Site Project. The project will reinforce the bankline and protect the adjacent access road and drain by placing riprap along the bank within the active river channel. Reclamation determined that this action may affect, and is likely to adversely affect, the endangered minnow during construction; and may affect, and is not likely to adversely affect, designated minnow critical habitat. The Service concluded that the proposed action is not likely to jeopardize the continued existence of the minnow and that there is likely to be short-term adverse effects on a very small portion of designated critical habitat at the construction site.

Environmental commitments associated with the proposed DU7 Project include implementing construction Best Management Practices (BMPs) and dust abatement during construction and re-vegetating the site, along with performing construction outside minnow spawning periods (construction exclusion period of April 15 through July 1).

APPENDIX C

TWO-DIMENSIONAL HYDRAULIC MODELING OF INUNDATED AREA WITHIN THE RIO GRANDE FLOODWAY

The pattern of inundation within the Rio Grande floodway between Cochiti Dam and Elephant Butte Reservoir during spring runoff was determined by a hydraulic study using the unsteady state, two-dimensional model FLO-2D (version 2007.06). The model uses a one-dimensional channel and a two-dimensional grid system (250 ft by 250 ft) throughout the floodplain to compute flood depths resulting from input hydrographs (Riada Engineering, Inc. 2007). The grid's topography was based on a 2005 topographic data set. The model was calibrated to the actual discharge and extent of inundation that was mapped by the Corps during the 2005 spring runoff event.

Individual model runs were performed for the following discharges at the Albuquerque gage: 500, 1,000, 2,000, 2,500, 3,000, 3,500, 4,000, 4,500, 5,000, 6,000, and 7,000 cfs. For each model run, the input hydrograph was a constant flow rate, and the event duration was sufficient to reach the maximum extent of inundation (typically, equivalent to 5 days or more). This duration is generally needed for simulated, and actual, flows to reach the downstream end of the study reach without attenuation due to channel and floodplain storage. Results from all runs were compiled into inundated area *versus* discharge curves. Individual curves were generated for the Cochiti, Angostura, Isleta, and San Acacia reaches. The total inundated area was estimated for each reach, as well as separately for the channel and overbank areas.

The area of inundated river channel (including vegetated pointbars) increases rapidly up to approximately 6,040 acres at an Albuquerque discharge of 3,000 (Table B-1 and Figure B-1). Additional discharge results in only minor increases in the inundated channel area. At flows of 7,000 cfs, approximately 7,030 acres of channel area are inundated.

Table B-1. Inundated area of river channel and overbank (riparian zone) for various discharges at the Albuquerque streamflow gage.

Discharge (cfs) at Albuq. gage	Inundated area (acres): River channel	Overbank area	Total
0	0	0	0
500	3,451	0	3,451
1,000	4,136	0	4,136
2,000	5,355	0	5,355
2,500	5,756	402	6,157
3,000	6,046	1,348	7,394
3,500	6,280	2,666	8,946
4,000	6,468	3,611	10,079
4,500	6,628	5,206	11,835
5,000	6,743	7,516	14,259
6,000	6,916	10,983	17,899
7,000	7,030	14,013	21,043

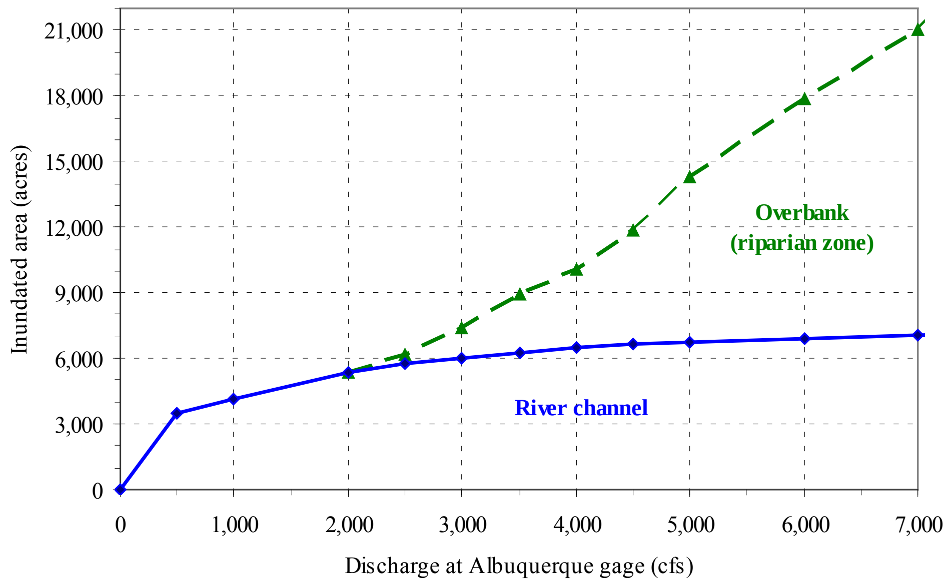


Figure B-1. Inundated area within the Rio Grande channel and overbank zones between Cochiti Dam and Elephant Butte Reservoir.

Riparian zone flooding begins when flows exceed 2,000 cfs at Albuquerque, and inundation increases nearly linearly with higher flows (Table B-1 and Figures B-1). The San Acacia Reach experiences the earliest onset and the most widespread distribution of overbank inundation (Table B-2 and Figure B-2). In the Isleta Reach, low-lying areas near Isleta Marsh begin flooding when flows reach 4,000 cfs at Albuquerque. Field observations indicate that portions of the Los Lunas-to-Belen section experience incipient flooding at 4,900 cfs—slightly higher than the model indicates—and inundation is widespread throughout the Isleta Reach when Albuquerque discharge is 5,800 to 6,000 cfs. The Cochiti and Angostura reaches experience only minor overbank inundation when flows are less than 6,000 cfs at Albuquerque.

Table B-2. FLO2-D modeling results: estimated inundated overbank area (acres) within the floodway between Cochiti Dam and River-mile 62 by primary river reaches and for various discharges.

Discharge at Albuquerque (cfs)	Cochiti Reach	Angostura Reach	Isleta Reach	San Acacia Reach	All
2,000	0	0	0	0	0
2,500	3	0	0	399	402
3,000	3	0	2	1,343	1,348
3,500	11	0	28	2,628	2,667
4,000	38	0	244	3,328	3,610
4,500	59	0	1,114	4,033	5,206
5,000	87	48	2,364	5,017	7,516
6,000	297	552	3,464	6,670	10,983
7,000	959	1,090	4,617	7,347	14,013

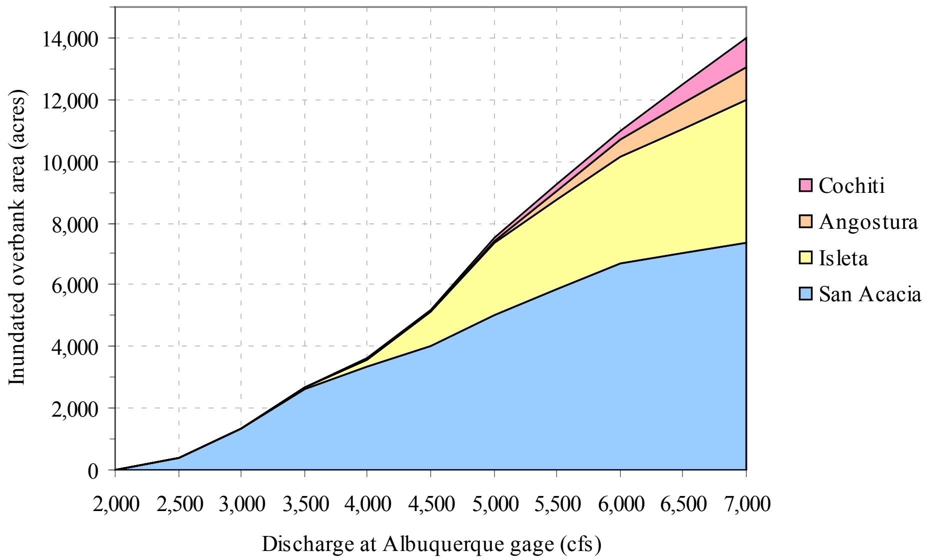


Figure B-2. Inundated area within the overbank (riparian) zone of the Rio Grande by major river reaches.

APPENDIX D

DRAFT SOUTHWESTERN WILLOW FLYCATCHER SURVEY FORM, FRIJOLES REACH, 2011

Willow Flycatcher (WIFL) Survey and Detection Form (revised April, 2010)

Site Name: **Frijoles Reach** State: **New Mexico** County: **Sandoval**

USGS Quad Name: **Cochiti Dam** Elevation: **1,615** (meters)

Creek, River, or Lake Name: **Rio Grande**

Is copy of USGS map marked with survey area and WIFL sightings attached (as required)? ***Yes*** **X** ***No*** ____

Survey Coordinates: Start: E **385,900** N **3,955,300** UTM Datum: **NAD83** (See instructions)

Stop: E **381,000** N **3,949,000** UTM Zone: **13**

If survey coordinates changed between visits, enter coordinates for each survey in comments section on back of this page.

*****Fill in additional site information on back of this page*****

Survey # Observer(s) (Full Name)	Date (m/d/y) Survey Time	Number of Adult WIFLs	Estimated Number of Pairs	Estimated Number of Territories	Nest(s) Found? Y or N If Yes, number of nests	Comments (e.g., bird behavior; evidence of pairs or breeding;-potential threats [livestock, cowbirds, *Diorhabda* spp.]). If *Diorhabda* found, contact USFWS and State WIFL coordinator.
Survey # 1 Observer(s): Carstensen, D Ryan, V	Date: 5/25/2011 Start: 6:00am Stop: 11:00am Total hrs: 10.0	6	0	2	N	Lots of Beaver activity. Nice flycatcher habitat at the southern end of the site. River flowing at about 1140 cfs with Cochiti Lake water surface elevation at about 5341.43 feet (50739 ac-ft storage).
Survey # 2 Observer(s): Carstensen, D Ryan, V	Date: 6/13/2011 Start: 6:00am Stop: 11:00am Total hrs: 10.0	3	1	2	N	Pair detected was pretty aggressive. No nest found, but likely to stick around all summer. Lone male territory found on island just south of pair.
Survey # 3 Observer(s):	Date: Start: Stop: Total hrs:	Not surveyed due to potentially hazardous conditions (ie. Smoke, fire, sediment runoff)				
Survey # 4 Observer(s):	Date: Start: Stop: Total hrs:					
Survey # 5 Observer(s):	Date: Start: Stop: Total hrs:					

GPS Coordinates for WIFL Detections (this is an optional column for documenting individuals, pairs, or groups of birds found on each survey). Include additional sheets if necessary.

Survey	# Birds	Sex	UTM E	UTM N
Survey # 1	1	M	381,227	3,949,893
Survey # 1	1	M	380,977	3,949,708
Survey # 1	1	M	381,089	3,949,883
Survey # 1	1	M	383,235	3,952,169
Survey # 1	1	M	382,834	3,950,906
Survey # 1	1	M	382,022	3,950,127
Survey # 2	2	M/F	381,089	3,949,883
Survey # 2	1	M	380,977	3,949,708
Survey # 3				
Survey # 4				
Survey # 5				

Overall Site Summary

Totals do not equal the sum of each column. Include only resident adults. Do not include migrants, nestlings, and fledglings.
Be careful not to double count individuals.

Total Adult Residents	Total Pairs	Total Territories	Total Nests
3	1	2	0

Total survey hrs: 20.0

Were any WIFLs color-banded? Yes ____ No **X**

If yes, report color combination(s) in the comments section on back of form and report to USFWS.

Reporting Individual: **Darrell Ahlers** Date Report Completed: **7/25/2011**

US Fish & Wildlife Service Permit #: **TE819475-0** State Wildlife Agency Permit #: **N/A**

<u>Submit</u> form to USFWS and State Wildlife Agency by September 1st. Retain a copy for your records.

Fill in the following information completely. Submit form by September 1 st . Retain a copy for your records.

Reporting Individual **Darrell Ahlers** Phone # **(303) 445-2233**

Affiliation **Bureau of Reclamation** E-mail dahlers@usbr.gov

Site Name **Frijoles Reach** Date report Completed **7/25/2011**

Was this site surveyed in a previous year? Yes__X__ No____ Unknown____

Did you verify that this site name is consistent with that used in previous yrs? Yes ____ No **X** Not Applicable ____

If name is different, what name(s) was used in the past? **Called Rio Grande Study Area or Frijoles Canyon in previous years**

If site was surveyed last year, did you survey the same general area this year? Yes **X** No ____ If no, summarize below.

Did you survey the same general area during each visit to this site this year? Yes **X** No ____ If no, summarize below.

Management Authority for Survey Area: Federal **X** Municipal/County ____ State ____ Tribal ____ Private ____

Name of Management Entity or Owner (e.g., Tonto National Forest) **Forest Service/Park Service**

Length of area surveyed: **9.0** (km)

Vegetation Characteristics: Check (only one) category that best describes the predominant tree/shrub foliar layer at this site:

X Native broadleaf plants (entirely or almost entirely, > 90% native)

____ Mixed native and exotic plants (mostly native, 50 - 90% native)

____ Mixed native and exotic plants (mostly exotic, 50 - 90% exotic)

____ Exotic/introduced plants (entirely or almost entirely, > 90% exotic)

Identify the 2-3 predominant tree/shrub species in order of dominance. Use scientific name.

Salix gooddingii, Salix exigua

Average height of canopy (Do not include a range): **5** (meters)

Attach the following: 1) copy of USGS quad/topographical map (REQUIRED) of survey area, outlining survey site and location of WIFL detections;
2) sketch or aerial photo showing site location, patch shape, survey route, location of any detected WIFLs or their nests;
3) photos of the interior of the patch, exterior of the patch, and overall site. Describe any unique habitat features in Comments.

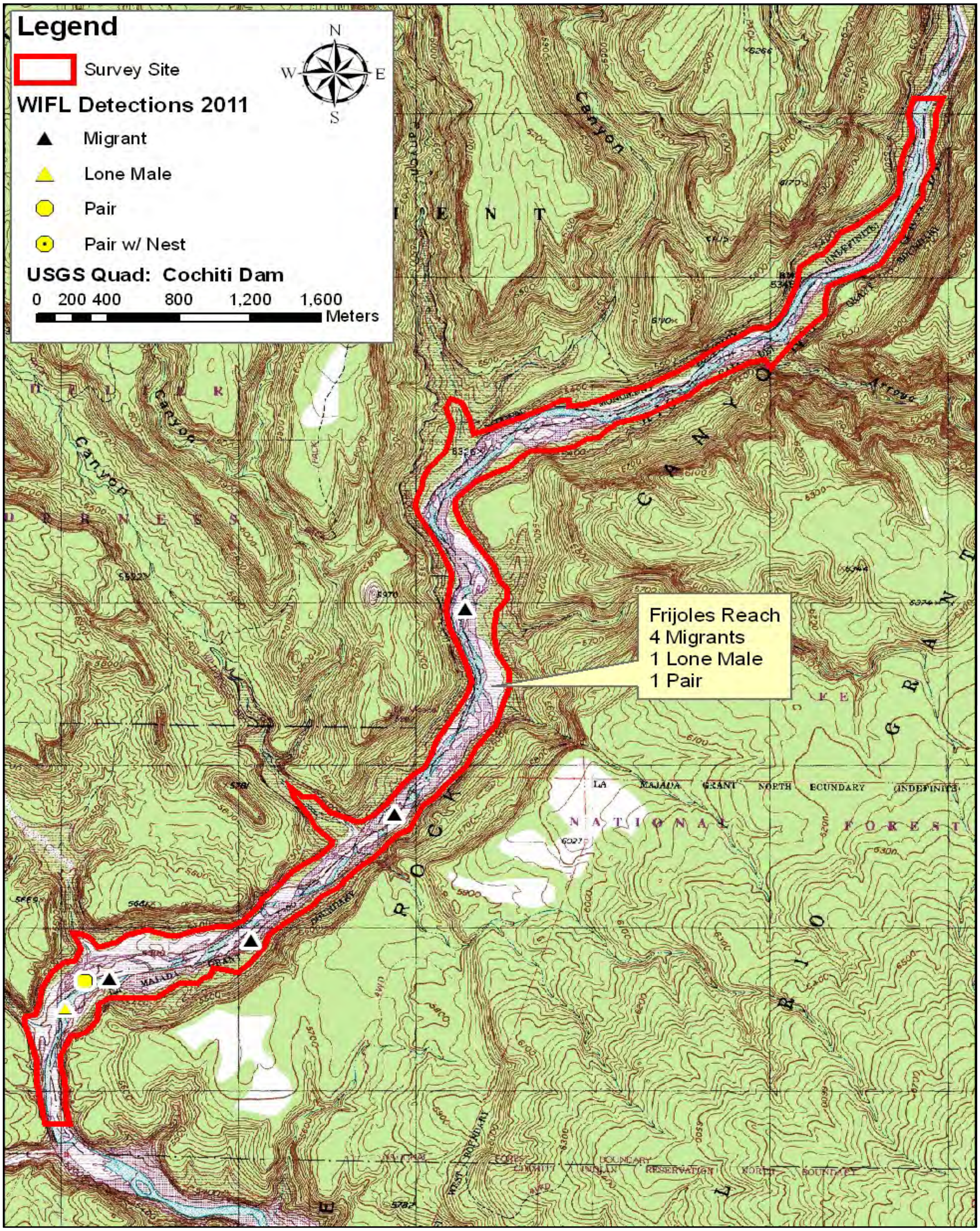
Comments (such as start and end coordinates of survey area if changed among surveys, supplemental visits to sites, unique habitat features.
Attach additional sheets if necessary.

There was a lot of suitable habitat within this site, particularly at the southern end.

Territory Summary Table. Provide the following information for each verified territory at your site.

Territory Number	All Dates Detected	UTM E	UTM N	Pair Confirmed? Y or N	Nest Found? Y or N	Description of How You Confirmed Territory and Breeding Status (e.g., vocalization type, pair interactions, nesting attempts, behavior)
FCP1	5/25/11, 6/13/2011	381,089	3,949,883	Y	N	Pair interaction, aggressive, no nest found.
FCT1	5/25/11, 6/13/2011	380,977	3,949,708	N	N	Fitz-bews, brits - no pairing suspected, occupied a large territory

Attach additional sheets if necessary



Legend
Survey Site
WIFL Detections 2011
Migrant
Lone Male
Pair
Pair w/ Nest
USGS Quad: Cochiti Dam
0 200 400 800 1,200 1,600
Meters
N
S
E
W
Frijoles Reach
4 Migrants
1 Lone Male
1 Pair

APPENDIX E

2007 Geomorphic Summary of the Middle Rio Grande.
(Massong *et al*. 2008). U.S. Bureau of Reclamation, Albuquerque Area Office.

RECLAMATION

Managing Water in the West

2007 Rio Grande Geomorphic Summary Final

PREPARED BY:
Tamara M. Massong, Environment Division, Albuquerque Area Office
Paula W. Makar, Sedimentation and River Hydraulics Group, Technical Service Center
Travis R. Bauer, Sedimentation and River Hydraulics Group, Technical Service Center

U.S. Department of the Interior
Bureau of Reclamation

June 2008

Mission Statements

The mission of the Department of the Interior is to protect and provide access to our Nation's natural and cultural heritage and honor our trust responsibilities to Indian Tribes and our commitments to island communities.

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.

Acknowledgements

This report is, in part, the result of discussion with several Reclamation employees. In particular we would like to thank Mark Nemeth, Jonathan AuBuchon, Kristi-Irene Smith, Andrea Glover, Chris Holmquist-Johnson, and Blair Greimann for their input in discussions of field observations and geomorphic processes which aided in formulation of some of the ideas and conclusions presented in this report.

TABLE OF CONTENTS

TABLE OF FIGURES

INTRODUCTION

The high flows of the 1800s and early 1900s coupled with high sediment yields from expanding arroyos, perhaps due to poor land-management practices, resulted in significant aggradation, large-scale flooding, and waterlogging of agricultural lands within the Rio Grande valley (Scurlock 1998). After back-to-back floods in 1941 and 1942, the Middle Rio Grande Project was authorized by Congress, which created a series of large dams on the Rio Grande and its major tributaries (1950s-1970s) and rectified (channelized) the river to control flooding and sedimentation (Lagasse 1980). Coupled with natural changes in climate and sedimentation, much of the Middle Rio Grande (MRG) today is no longer flooding and aggrading, but rather is evolving at a rapid rate in the opposite direction. The historical floodplain is in many places abandoned due to bed degradation/incision (Massong et al., 2006), with vegetated bars making up the majority of the regularly flooded surfaces (Tashjian and Massong, 2006). The river's width was widest in the earliest available data (1918 topography drawings) and has generally decreased since then (Makar,et al., 2006).

The purpose of this summary is to provide current geomorphic information for Reclamation's River Maintenance Plan while incorporating some of the historical trends; the Maintenance Plan describes authorized river maintenance goals and strategies, historical and current maintenance practices, and existing river conditions and needs. Another intended use of this document is to support and help other river projects in the watershed to understand the complex and current evolution of the Rio Grande. This document is also intended to initiate the discussion of a common viewpoint of the current processes of the Rio Grande by synthesizing as much of the available information as possible on a reach by reach basis. After synthesis, these trends are then extrapolated to discuss future riverine conditions and possible changes to aquatic and riparian habitats.

Findings from many reports prepared within Reclamation are presented in this report, and rather than citing each fact or finding individually, a list of reports are presented in the Reference Section. Some of the data were either not prepared by Reclamation Staff or the results have been more officially published, in these cases, an attempt is made to individually reference this information. Also, discussions with personnel from other agencies such as the U.S. Fish and Wildlife Service, U.S. Army Corps of Engineers (USACE), the NM Interstate Stream Commission and several Government contractors have aided in idea formulation and development of some conclusions discussed in this document.

BACKGROUND

In recent times (late 1990s to 2004), the Rio Grande watershed has experienced a regional drought cycle. This has resulted in a major reduction in water supply and peak flows which has caused the river to narrow, mostly through vegetation encroachment on formerly active bars. In 2005 a 50%- to 20%-chance event (2-5 year return) spring runoff event was largely unable to mobilize bars and banklines covered by the new vegetation. The Rio Grande has reacted in a variety of ways in those sections that had extensive bar and island growth during the drought. The most common change was that the river narrowed, deepened and abandoned all but a single dominant channel. In areas where a single channel already existed, but bank-attached bars had stabilized with vegetation, the channel has begun to migrate. These changes and others display the speed at which change can occur on the MRG and at least partially explains the rapid increase in the number of river maintenance sites of concern throughout the management area. For example, the rapidly migrating bend in Figure 1 is the middle bend in a series of three migrating bends. The yellow arrow points to the same cluster of trees in 2000, 2002, and 2005 which are gone by 2006. The pink arrow points to the approximate location of the 2006 bend apex in all years. This bend is only one example of a series of fast changing bends in the recently incised reach downstream of San Acacia Diversion Dam that threaten the Low Flow Conveyance Channel (LFCC) levee to the west.

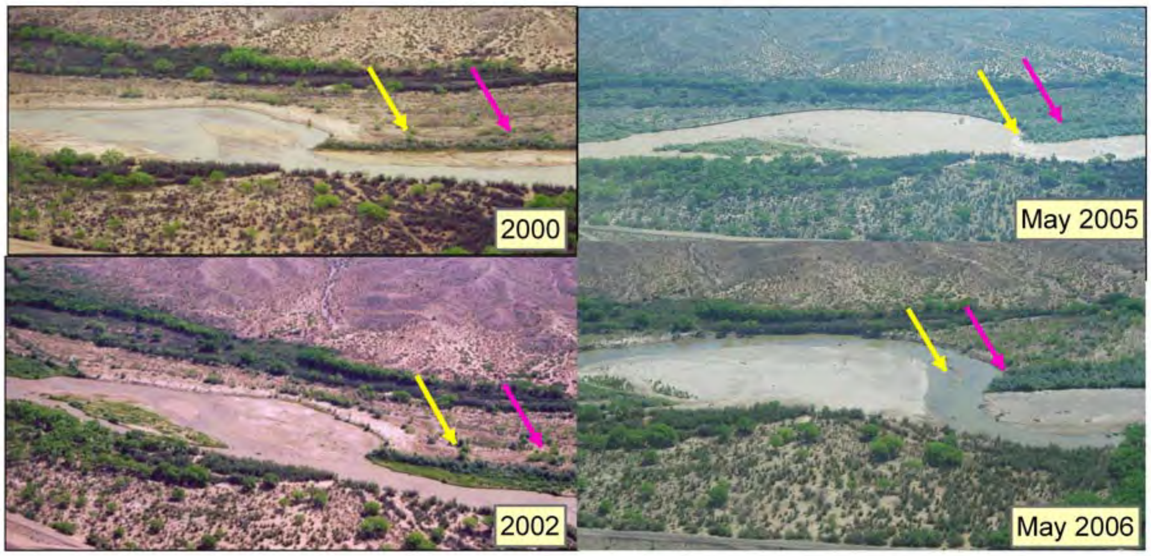


Figure 1 Rapidly migrating bend at River Mile 110. Flow is left to right.

Much of the 270 river miles of Reclamation-managed Rio Grande channel (Velarde-Caballo) is abandoning its historical floodplain through bed incision, or narrowing with rapid planform pattern changes. Also of importance is the rapid and relatively consistent decrease in channel width; documented system-wide width decreases date back to the early 1900s. Some of this decrease can be attributed to the rectification activities of the MRG Project in the 1950s and 1960s but changes in runoff patterns are also a cause. Narrowing has continued to the present day without additional channelization (Makar et al., 2006). One commonly accepted theory for the general narrowing trend is the ongoing reduction of peak flows after 1942, the last large flood in the MRG. A simple planform evolution model is presented in Massong et al. (in prep.) which generally describes how channel narrowing influences other in-channel processes.

Along with the highly visible planform changes, gravel is becoming more abundant in parts of the riverbed and is changing channel processes. The combination of incision, migration, planform conversion and gravel emergence is rapidly changing the Rio Grande channel and forcing a re-evaluation of the trends in geomorphology of the Rio Grande and appropriate management strategies.

GENERAL RIVERINE DESCRIPTION

Although many processes control changes on the Rio Grande, four major features have been changing throughout the MRG: floodplain conversion to terraces, active channel narrowing, loss of sand on the channel bed resulting in a gravel-dominated bed, and lateral channel migration. Channel incision is widespread throughout the MRG creating tall banks that confine the Rio Grande which prevents overbank flooding (Massong et al., 2006). Although recently developed islands and bars flood during high flows, the loss of the large historical floodplain indicates a major change in how flood flows are conveyed throughout the watershed and their potential to shape and re-shape the current channel.

Adapted from Tashjian and Massong, 2006
The majority of the historical floodplain within the MRG is disconnected from the MRG at flows below 5,000 cfs. Though often referred to as the "floodplain", this surface functions as a terrace and has been abandoned by river incision through flood and sediment control measures. Even when overbanking occurs, the flows generally do not contain the energy to disrupt the flooded surface. From Bernalillo, NM to Bernardo, NM (~75 river mile), jetty jack lines were placed in the mid 20th century to stabilize bank locations. These structures, coupled with ensuing non-native vegetation, have 'frozen' the banklines creating a ~600 foot wide active channel corridor within the ~1800 foot wide "floodway". Within this corridor, active river processes are limited by upstream sediment supply and the hydrograph. The most vital modern habitat occurs in two parts of this Section; 1) south of Bernalillo in the transition from a multi to a single threaded channel, 2) from Isleta Diversion south where a floodplain-like surface has recently developed within the 600 foot wide river corridor.

Vegetation encroachment has been rampant during this latest drought cycle; dry sand dunes and bars quickly became colonized by a variety of plant species and are now resistant to being re-worked by the river. Although encroachment is widespread through the watershed, it has been most obvious in the Los Lunas and Belen, NM areas where the stabilization of the mid-channel bars has resulted in massive planform change. Once established, vegetation anchors deposited sediments, restricting lateral movement by the river. During this planform transformation, the thalweg deepens, creating a core of water that is more effective at eroding bed sediments. In locations where the banks are tall due to incision and the root mass of the riparian vegetation is above the high water level, this focused thalweg is able to undermine bank material, allowing the river to migrate. Migration is of particular concern in the San Acacia, NM area, as several bends have begun rapidly migrating in the last few years.

Bed material at several locations have coarsened recently, within the Cochiti Reach and near San Acacia Diversion Dam as the two most notable. Although the Rio Grande upstream from White Rock Canyon was traditionally gravel-bedded, downstream from the canyon, the Rio Grande historically transported significant quantities of sand, such that the channel bed was bi-modal. Conversion of the Cochiti Reach from bi-modal to only a gravel bed occurred shortly after Cochiti Dam began operations in 1973, when nearly all sand was eliminated from the reach. Today, the Cochiti Reach has coarsened up to a cobble sized bed material in many areas. This coarsening of bed material associated with dam operations has slowly progressed downstream into the Albuquerque Area. In 2006, the area transitioning to gravel extended throughout the Albuquerque Metro area (Massong et al. 2007).

About 100 miles downstream, gravel was found in measurable amounts by the USGS at the Rio Grande Floodway stream gage at San Acacia, NM beginning in the 1990s. By 2000, large portions of the river bed downstream from the San Acacia diversion dam were covered in gravel; the Rio Salado was acknowledged as a primary source for this coarse sediment (Reclamation 2003). Since that discovery, many arroyo confluences in the San Acacia area have been inspected and acknowledged as sources of coarse sediment material. These supplies of coarser material have altered the predominant sand channel to a channel with a bi-modal sediment size: gravel and sand.

At present, fluvially deposited gravel patches have been mapped at a variety of locations in the Belen reach. Unlike the other two gravel-bed examples, neither Dam operations nor tributary sediment sources appear to be causing the gravel patches to systematically form in this reach. Although the Belen Reach does not have many tributary sources of coarse sediment, it is believed that it will also convert in the future as gravel is transported into the reach from upstream.

There are active bends and lateral migration occurring in many locations along the MRG. Those near Pueblos of Ohkay Owingeh, San Ildefonso, Santo Domingo, and San Felipe have generally shown smaller and slower movement. Downstream near San Acacia and around San Marcial, significant, recent incision set the stage for the large, rapidly migrating bends seen in 2005 and 2006. This pattern is anticipated in other areas, particularly between Isleta and San Acacia, assuming continued incision.

Eleven reaches containing a similar geomorphology have been defined. The primary characteristics used in this definition are hydrology, channel slope, planform, bed material size, channel width, bank heights, and underlying geology. Figure 2 illustrates these reaches. There are no river maintenance activities in White Rock Canyon nor in the Elephant Butte pool, so those reaches are not discussed.

VELARDE TO OTOWI BRIDGE

This Reach of the Rio Grande lies within the Española Basin, which is the northern-most basin in the Rio Grande Rift valley. It runs from Velarde, NM to the Otowi Bridge as shown in Figure 3. This area has been managed for thousands of years, as it was used by the Native Americans long before the Spanish settlements of the 1500s (Scurlock 1998). Unlike downstream of Cochiti Dam, this section of the Rio Grande was probably never a true sand bedded river, as the gravel supply is high and the historical records on the Rio Chama do not indicate an overwhelming supply of sand. Numerous east-side tributaries deliver cobble, gravel and sand-sized sediment to the Rio Grande and have built large, coarse-grained, alluvial fan complexes. The banks are usually composed of sandy material with layers of gravel while the water is relatively clear. Although the floodplain was active into the 1950s, it is essentially abandoned now by a modest amount of bed incision (3-5 feet).

Large channelization projects occurred throughout this reach during the 1930s-1960s which straightened and narrowed the channel. Specifically, the channelization by the USACE and Reclamation in the 1950s attempted to confine the river to a narrow right-of-way. This channel rectification was to provide a stabilized channel having a nominal capacity of 5,000 cubic-feet-per-second (cfs) upstream from the Rio Chama and 7,860 cfs downstream from the confluence. That constructed alignment remaines relatively stable, however the river has recently begun to meander and erode adjacent land. This is a concern as irrigation canals and ditches, orchards, farm land, homes, and other buildings are quite close to the river. Several riprap revetments were constructed in the 1990s to provide bank protection. In addition, more recent bank protection projects have utilized bio-engineering techniques.

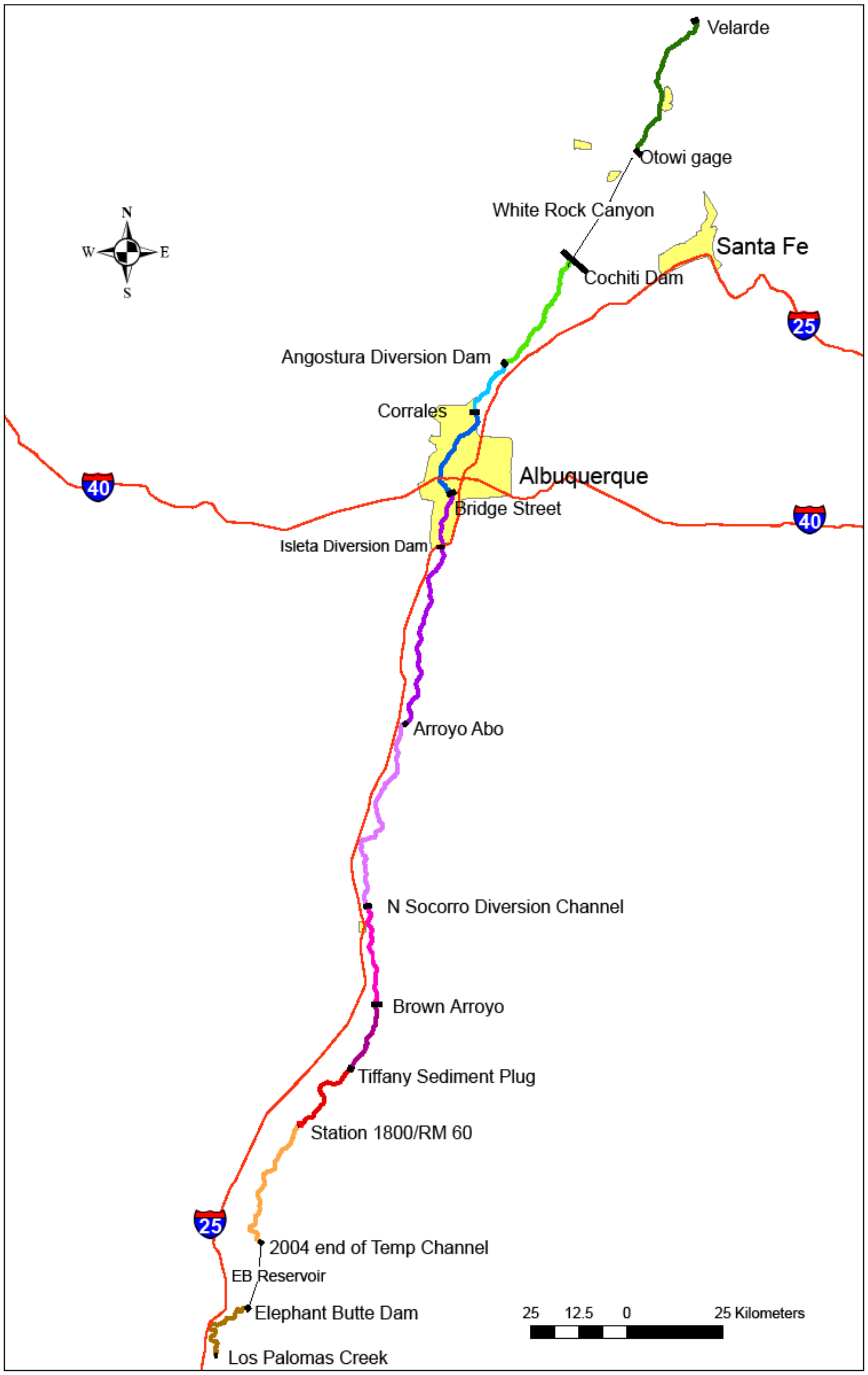


Figure 2 Geomorphic reaches on the Rio Grande from Velarde to Caballo

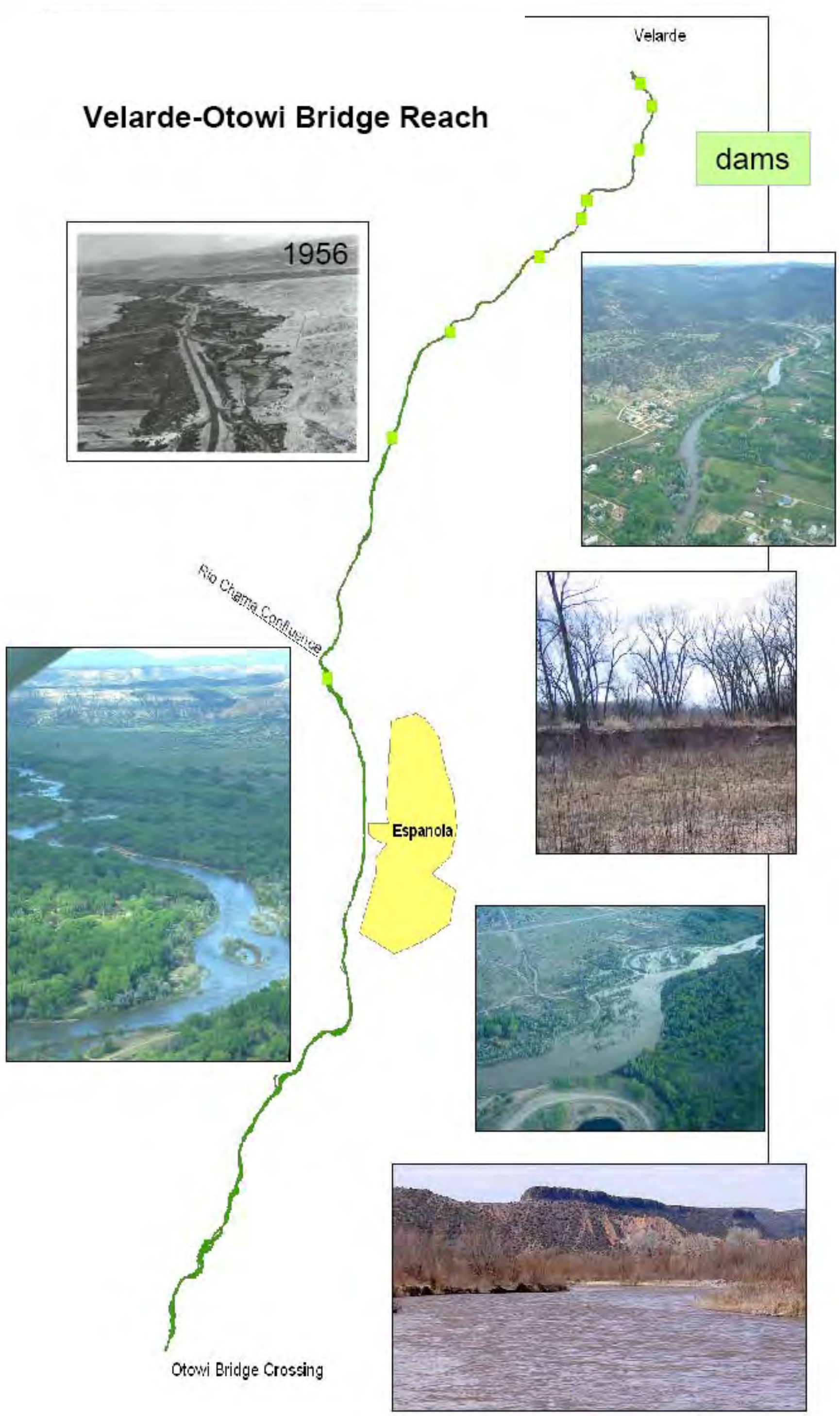


Figure 3 Velarde to Otowi Bridge Reach

Velarde Reach (Velarde to Rio Chama Confluence)

The Velarde Reach extends upstream from the Rio Chama confluence, approximately 13 river miles to Velarde, NM. A major feature of this reach is the lack of a well-formed or extensive Rio Grande floodplain and riparian zone. The numerous east-side tributaries 'push' the Rio Grande towards the west valley wall in this reach, which is composed of large landslide deposits. Prior to sliding, the west valley wall contained thick deposits of ancient Rio Grande sediments (cobble, gravel and sand layers) capped by a lava flow of basalt. The large mass-wasting events created a mixture of the ancient fluvial deposits and basalt boulders, which effectively prevents river migration. As a consequence, the formation of a significant Rio Grande floodplain is absent in this reach. The channel has a slightly sinuous, single channel pattern. The bed is composed of gravel and small cobbles with a pool-riffle morphology, however, the pools tend to be small in size compared to the riffles (glides). This channel morphology has not changed significantly in the recent past and appears relatively stable.

Changes to in-channel habitats are rare, however when changes do occur they are usually the abandonment of wetted channel to vegetated bars. As the channel pattern is stable, in-channel changes are expected to be limited. Also the lack of a floodplain limits the amount of off-channel habitat. Side channels are rare. The riparian zone in this reach is often very small or absent; small patches have recently formed in isolated locations which provide sections of young vegetation.

Rio Chama to Otowi Bridge Reach

Management of peak flows on the Rio Chama (Abiquiu Dam) has reduced the peak flow hydrology of this reach for flood control at Española, NM. Although the dams on the Rio Chama have also reduced the supply of sand-sized sediment, the reduction does not appear significant as the channel bed material appears to have always been coarse (gravel). In-channel gravel mining occurred historically at several locations within this reach; several 'headcuts' and bed lowering events have been verbally linked with the gravel mining activities in this area. The large historical floodplain is abandoned as there exists a moderate amount of incision (4-5 feet). A smaller inset floodplain exists in locations throughout the reach. Unlike the Velarde Reach, the western valley wall is composed of Jemez Caldera deposits high up in the mountains, with ancient Rio Grande sediments exposed near the river. The channel planform is a combination of a slightly sinuous single channel with sections of migrating bends and double (split) channels. Other than the isolated sections with active bends, the banklines throughout this reach appears stable and well armored with dense riparian vegetation. The active bends will likely evolve into split channels and reduce lateral migration.

The channel dimensions are relatively stable with only a slight amount of narrowing in recent times. As the active bends migrate, sediment deposits on the inside of the bend, creating a point bar; these point bars provide new habitat areas for both riparian and aquatic species. Older sections of the point bars are becoming vegetated, creating a mosaic of different vegetation age classes. The active areas of the point bars are providing areas of shallow flow at nearly all discharges. During high flows, these point bars as well as the islands associated with split channels become inundated creating small, isolated patches of floodplain habitat.

COCHITI DAM TO ANGOSTURA DIVERSION DAM

After operations began at Cochiti Dam in 1973, the channel bed immediately began to erode and coarsen (Lagasse 1980), as the Dam releases relatively clear water. This set of processes has continued to the present (Massong 2004). The large grain size that emerged quickly after 1973 is suspected in retarding incision, such that the floodplain although quickly abandoned, is not more than 6 feet higher than the current channel elevation. Several large tributaries continue to deliver the coarse grain sizes to the Rio Grande and so additional incision is not likely. Historical anecdotal information from Cochiti Pueblo indicates that the channel, at least in some locations which were used as "crossing fords" in the first half of this century, was a gravel/cobble bed prior to Cochiti Dam operations.

Similar to the upstream reaches, the Rio Grande is slightly confined on the west by geologic features (volcanic vents and bedrock) and by the pro-grading sedimentary fans/deposits on the east side that 'push' the river towards the west valley wall. As a consequence, the Rio Grande valley is relatively narrow in this section of the MRG. The current channel planform is varied as in the Rio Chama to Otowi Reach; planforms range from mostly straight to slightly sinuous, interspersed with meanders, double channels and abandoned channels, see Figure 4. The point bars that formed in association with the meander bends vegetated quickly but still flood during high flows. Most of these planforms are surprisingly stable, even the migrating bends which are only moving very slowly. This stable channel trend is expected to continue.

The banklines are densely vegetated and mostly stable (not eroding). Historically the channel was wide (~1500 feet), but has narrowed to an apparently stable size of 250-300 feet (Richard et al., 1999). As found upstream, the in-channel morphology is that of a pool-riffle, however the pools are infrequent and poorly formed while the riffles are wide-spread and well-formed.

This reach, 23 river miles, is almost entirely owned by four Native American Tribes; as in the Velarde Reach, the infrastructure is sometimes close to the river, including drains, irrigation canals and roads. Peak flows have been greatly reduced in this reach from flood control operations at Cochiti Dam, with current flows rarely exceeding 6,000 cfs. Historical photography indicates at least two episodes of large channelization projects (1930s-40s and 1950s-60s). Evolution of habitat is similar to that in the Rio Chama to Otowi Reach, however, this reach appears slightly more stable, such that patches of evolving habitats are smaller and more isolated than upstream.

ANGOSTURA DIVERSION DAM TO ISLETA DIVERSION DAM

The gravel/planform transition that started after Cochiti Dam began operations in 1973 is now located within this Reach. In the early 1990s, the transition zone appeared to be located near the City of Bernalillo, NM (R. Ortiz, 2004 MS Thesis). Since that time, the transition has moved downstream and in early 2007 was located within the City of Albuquerque limits. As a consequence of this transition zone, this reach is sub-divided into three smaller reaches based on the location of the gravel conversion: Post-Transition Reach (Angostura to Corrales), Transition Reach (Corrales to Bridge Street Bridge), and Pre-Transition (Bridge Street Bridge to Isleta Diversion Dam).

Figure 4 Cochiti Dam to Angostura Diversion Dam Reach

Post-Transition Reach (Angostura Diversion Dam to Corrales)

Historically, these 10 miles of river were a sand-bedded section of the Rio Grande that was aggrading before Cochiti Dam began operations. As a result of the aggradation, the channel and floodplain within the levees became higher than the floodplain outside the levee system. This perched channel and floodplain is most noticeable near the HWY 550 bridge crossing in Bernalillo, NM. The Rio Grande aggradation is thought to have been a product of high sediment loads from the Jemez River (Rittenhouse, 1944). Jemez River is the largest tributary in this reach and is located just downstream from Angostura diversion dam. This tributary was once a large supplier of fine grained sediments, delivering an estimated 21-39% of the Rio Grande's (at Albuquerque) sediment load (Rittenhouse, 1944). Jemez Canyon Dam built in the 1960s originally withheld peak flows, but was modified for water storage and sediment retention in 1979. This change in management on the Jemez River further reduced the sediment supply to the Rio Grande, and in particular to this reach. In 2001, the permanent pool was drained, the gates opened, with dam operations reverting back to only peak flow retention. A major goal in this reservoir is to reactivate the stored sediment and deliver them to the Rio Grande.

A major feature of this reach is a much larger/broader valley, shown in Figure 5 than that found upstream. Channel bed incision however, has abandoned much of the historical floodplain. Bank heights through most of this reach are higher than those found upstream, as degradation occurred prior to the channel bed coarsening, thus allowing more degradation to occur. Recently, an extensive series of mid-channel bars emerged in the 1990s which are now partly abandoned and creating high-flow floodplain surfaces.

Between the Angostura diversion dam and Arroyo de las Montoyas/Harvey Jones Channel in Corrales, NM, the channel bed has already degraded and coarsened, but the transitions occurred at different times. Near Angostura diversion dam, the incision and conversion occurred first, probably back in the late 1980s-early 1990s, while changes just recently occurred near Corrales (2000-2005). Transition features include:

- Although channel bed incision began in the 1980s, the bed continued to degrade through the 1990s as part of the transition. Channel incision has completely abandoned the historical floodplain.
- A coarsening of the bed material from sand bed to gravel bed began in the 1990s. Currently the grain size is coarse gravel to cobble in the upstream half of the reach, then grades down to medium gravel near Corrales.
- Planform conversion appears to be a late feature to change in the transition as it converted in the late 1990s. The current planform is that of a single, deep thalweg, especially during low flows, with high flow channels inundating the new floodplain surfaces only when the river flows near the 2-year return event or greater.
- Medial bars (islands) were transitory prior to the late 1990s/transition period; post-transition, the bars are relatively stable and now partially vegetated. Some of these surfaces inundate during high flows.

Throughout this reach, the river's planform is mostly straight. In several locations, the thalweg alternates between the banklines which is developing some individual bends. At present, the bank height is tall enough for the river's thalweg to intersect the bankline beneath the root zone of the riparian vegetation; at these individual location, bank erosion has occurred, however migration of the bends has not yet started.

During the 1990s, numerous bars began vegetating; these surfaces are both islands and bank attached bars. These features provide small patches of young vegetation and small patches of floodplain, which adds to both riparian habitat and in-channel habitat. The bends are also creating small point bars, which will evolve in the same manner as the islands, vegetating and acting as small floodplains. Although these small habitat features exist in this section, in general, the channel is coarsening, narrowing and becoming deeper. As these processes continue, the historical floodplain and aging cottonwood riparian forest are becoming more disconnected from the active channel. Neither the main channel nor the historical floodplain are providing quality habitat. If channel migration begins, both the riparian and channel habitat could improve. A migrating planform exchanges the tall, relatively undesirable terrace habitat for new point bar habitat that is better connected to the river channel.

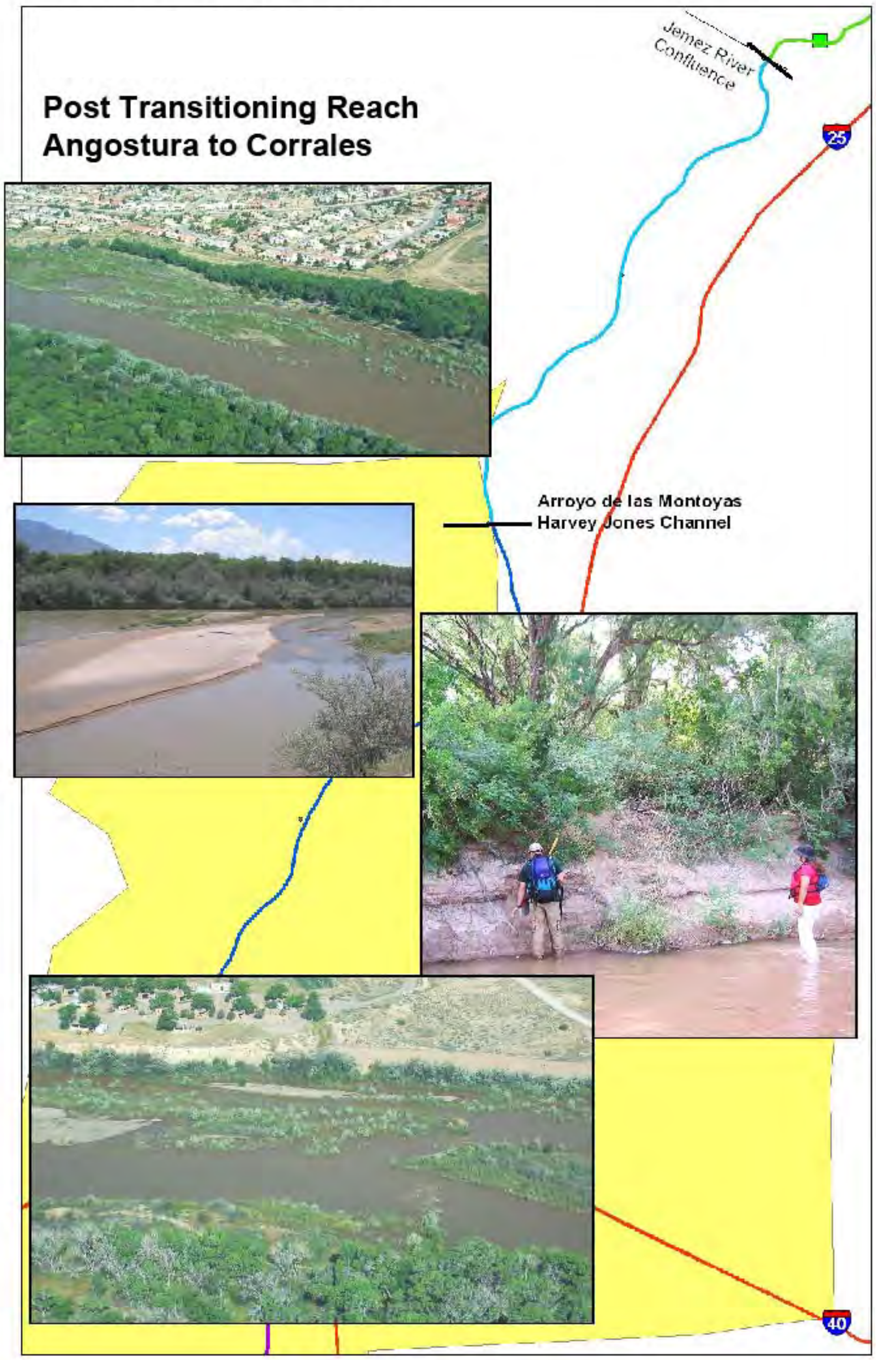


Figure 5 Angostura to Corrales Reach

Transition Reach (Corrales to Bridge Street Bridge)

This portion of the Angostura-Isleta reach is transitioning from the early 20th century sand-bedded channel with a braided planform to gravel bed with a single dominant channel (Figure 6). The amount of transition gradually lessens downstream toward Bridge Street. Common features throughout this sub-reach include: channel bed incision, such that the historical floodplain is abandoned (began 1980s-1990s); gravel sorting and redeposition within the active channel; and some level of planform shift which initially includes the growth of islands, abandonment of side channels, and then the formation of a single, relatively deep channel. At present the channel bed has incised 3-5 feet and has caused the historical floodplain to become disconnected from the normal flood event. Gravel deposition decreases in the downstream direction, but its initial presence is systematic, such that it begins by lining the islands and bar edges then expands into the main channel and eventually forms riffles.

The planform is most commonly an island braided system, but sections have begun to convert to a single, slightly sinuous channel. This change in planform causes a rapid decrease in wetted width and a deep thalweg. Bend formation processes have not yet begun in this reach. Islands and bank-attached bars are now vegetating and still mostly connected to the river channel but due to surface deposits during the high flows in spring 2005, are requiring higher runoff events to inundate. Due to the dense vegetation anchoring the islands, they are highly resistant to river erosion, often forcing the river to flow around them even when they are inundated during high flows. It is anticipated that all of this reach will eventually fully transition into a channel similar to that upstream in the Angostura Diversion Dam to Corrales reach.

The major feature of the fully-transitioned channel is that the channel bed becomes more stable with an increasing gravel bed and coarse-grained riffles. Sand dunes may temporarily cover the gravel but are transient in nature. At present, this reach is still dominantly a sand-bedded river, however, the sand is becoming coarser and gravel is systematically depositing within the active channel, indicating the transition is in progress. Gravel deposits were first sampled near I-40 in 2004, and observed at Bridge Street in 2004:

- The first location where gravel is often found during transition is at the head and along the sides of the islands.
- Next, gravel deposits are often seen in the crossing between two islands or bars and begin to form a channel spanning riffle.
- After the riffles have formed, then the channel between the riffles coarsens until the channel bed is dominated by gravel.
- In this section and throughout the Rio Grande, sand dunes are often present and are transported over the more competent gravel layer. The character of the sand dunes in this reach is changing. During the 2006 bed material sampling the dunes appeared poorly formed and even “chopped off”. The sand size was also coarser than previously seen. This should be expected as the majority of the upstream sand supply has already been transported downstream.

Full conversion of this reach could happen quickly given the right sediment transport conditions into and out of the reach. Conversion to gravel bed appears to require that the planform transition/shift to a narrow single thread channel is near completion or already complete. This shift can happen through island and bar attachment with vertical accretion and/or channel incision. It is more likely that the upstream half of the reach, which is closer to full conversion, would switch sooner than the downstream half. An unknown for this reach is the influence of the additional sediment now delivered to the Rio Grande via the Jemez River. Although this increase in fine sediment (silt and sand) is not expected to reverse this transitional process in the upstream reach, it may partially mitigate the transition in this reach by slowing the process; future analysis is required to better understand this interaction.

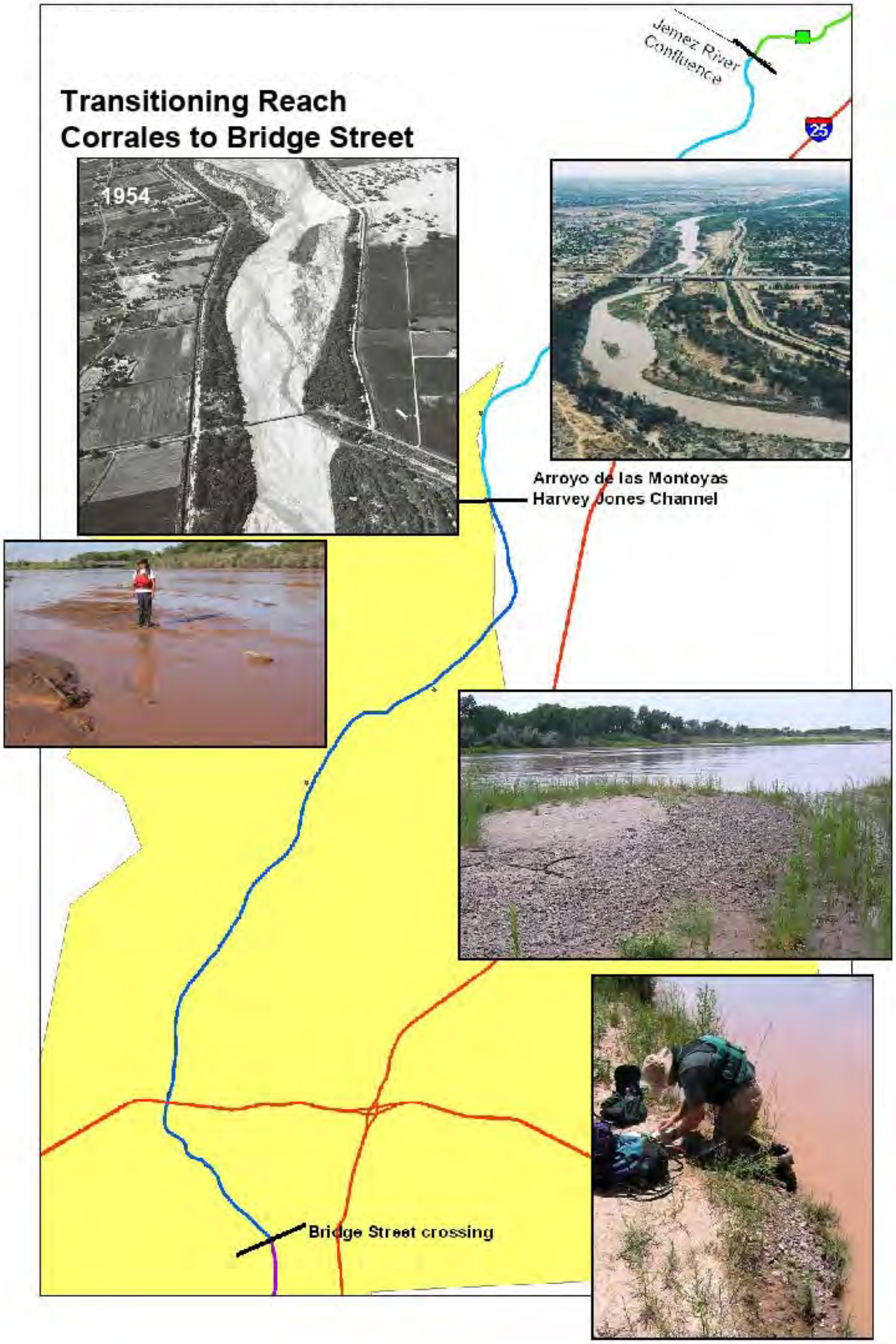


Figure 6 Corrales to Bridge Street Reach

At present, the in-channel features are widely variable and have been considered good habitat. The continued evolution would likely decrease this habitat value. The riparian habitat is similar to the upstream section that is already past this transition; the historical floodplain is already abandoned with a mature vegetation complex. The only locations with new or young vegetation growth are on the islands and bank attached bars. These areas are relatively small, but have the potential for high quality riparian habitat.

Pre-Transition Reach (Bridge Street Bridge to Isleta Diversion Dam)

The Rio Grande downstream from Bridge Street is similar to the historical Rio Grande descriptions, it still has a sand bed with migrating macro-dunes and dune fields plus the historical floodplain still active. During low flows, the dunes become inactive, but do not vegetate as they re-activate when flows increase. The shape of the dunes appear to be changing, smaller fields and dunes with coarsening sediment sizes; these physical changes are not as advanced as those found in the upstream Transition reach. Gravel deposition is not present in measurable amounts although patches have been found as far downstream as the I-25 crossing near the Pueblo of Isleta property boundary. The floodplain is active during high flows and the channel planform and width are relatively stable. The planform is low-flow braided with a relatively shallow thalweg that changes to a single, fairly uniform channel during high flows. Islands and bank-attached bars are mostly absent. The bed elevation is mostly stable to slightly decreasing (slightly incising).

As the channel still exhibits early 20th century river conditions, the in-channel habitat has good complexity within the braided planform and an active floodplain. The transition is anticipated to move into this reach as the dune morphology is evolving and the incoming sediment supply is still less than historical loads, even with the new supply from the Jemez River watershed. However, the rate of transition may be slower than that found upstream due to the increased sediment supply. The riparian habitat may not be considered as good since the floodplain contains mostly mature habitat. Areas with new riparian growth are rare and isolated. As the transition begins in this reach, it will evolve in a similar manner to the subreaches discussed above.

ISLETA DIVERSION DAM TO ARROYO ABO CONFLUENCE

This reach is also known as the Belen Reach and has been described as one of the most stable reaches on the Rio Grande, but the stability appears to have been lost, as the channel is rapidly changing. The channel remains sand bedded with a connected floodplain and a mostly braided morphology. Channel width varies little throughout the reach; channelization and bank stabilization efforts in the 1930s and 1950s resulted in large-scale reductions in width between 1935 and 1962, reinforced by numerous fields of jetty jacks. The width remained stable until around 2000 (during the latest drought cycle) when the lack of water reduced sediment transport of the in-channel sand deposits, allowing vegetation to encroach into the channel. Figure 7 illustrates the significant amount of narrowing that occurred between 2001 and 2002; comparisons with field data confirmed that numerous islands and vegetated sand bars were the narrowing mechanism. Since 2002, the channel has begun shifting towards a single-thread planform, with the islands becoming bank attached. The unvegetated portion of the channel has generally continued to decrease and a more sinuous low flow channel is forming. The reach has seen significant amounts of vegetation growth on the bars and islands in the past few years which have stabilized these features.

Several changes indicate that this reach is rapidly becoming unstable.

- Planform
  - Starting in 2002 with an abnormally low water year, macro-dunes in the Belen reach became inactive and woody riparian vegetation became established. This bar stabilization process created numerous islands that effectively reduced the channel width and concentrated the low and moderate flows into a small channel area.
  - In 2004, during a moderate spring runoff year, many of the smaller channels were filled with sediment, which began the process of changing their function from low-flow channels to moderate or even high flow channels.
  - Through the 2005 runoff cycle, the islands continued to be stable and resisted overbank erosion.
  - A dominant thalweg developed during the 2005 spring runoff. In addition, the continuation of side channel filling produced numerous high flow channels.
  - After 2005, field observations indicate that many of the side channels are starting to vegetate.
  - The current planform is best described as a single-threaded channel at low flows, but can become an island-braided planform at higher flows (if the side channels become active).
- Floodplain
  - In 2005, much of the historical floodplain was significantly inundated during the spring runoff event. Also inundated were the islands and bars.
  - After runoff ended, field observations indicate significant aggradation on the bars, islands and floodplains (natural sand levees) which has increased bank heights, such that higher flows are now required to inundate these surfaces.
- Sediment Composition
  - Prior to 2005, only minor amounts of gravel were observed in this reach, and the locations appeared random.
  - After the 2005 runoff, gravel deposits have been found systematically at the head of islands/side channels and in long patches within the high-flow side channels, and at the side channel outlets between islands.
  - The size of sand found in the channel is also coarser than it has ever been. Sediment samples collected in 2006 from active dunes in the main channel were generally coarser than previous samples from this reach.

At present, the banklines in this reach are stable as they are densely vegetated and near a similar elevation as a typical spring runoff discharge. Jetty jacks line both banks in this reach, increasing bank stability. The planform will likely continue to evolve into a slightly sinuous, single channel. For in-channel habitat, this reach is expected to continue to narrow through the abandonment of side channels, and the main channel is expected to incise, eventually containing the larger flows and abandoning the current historical floodplain (behind the jetty jacks). All of these changes reduce space for aquatic habitat. However, as these riverine features evolve, new vegetation will emerge, thus providing new riparian and new floodplain features.

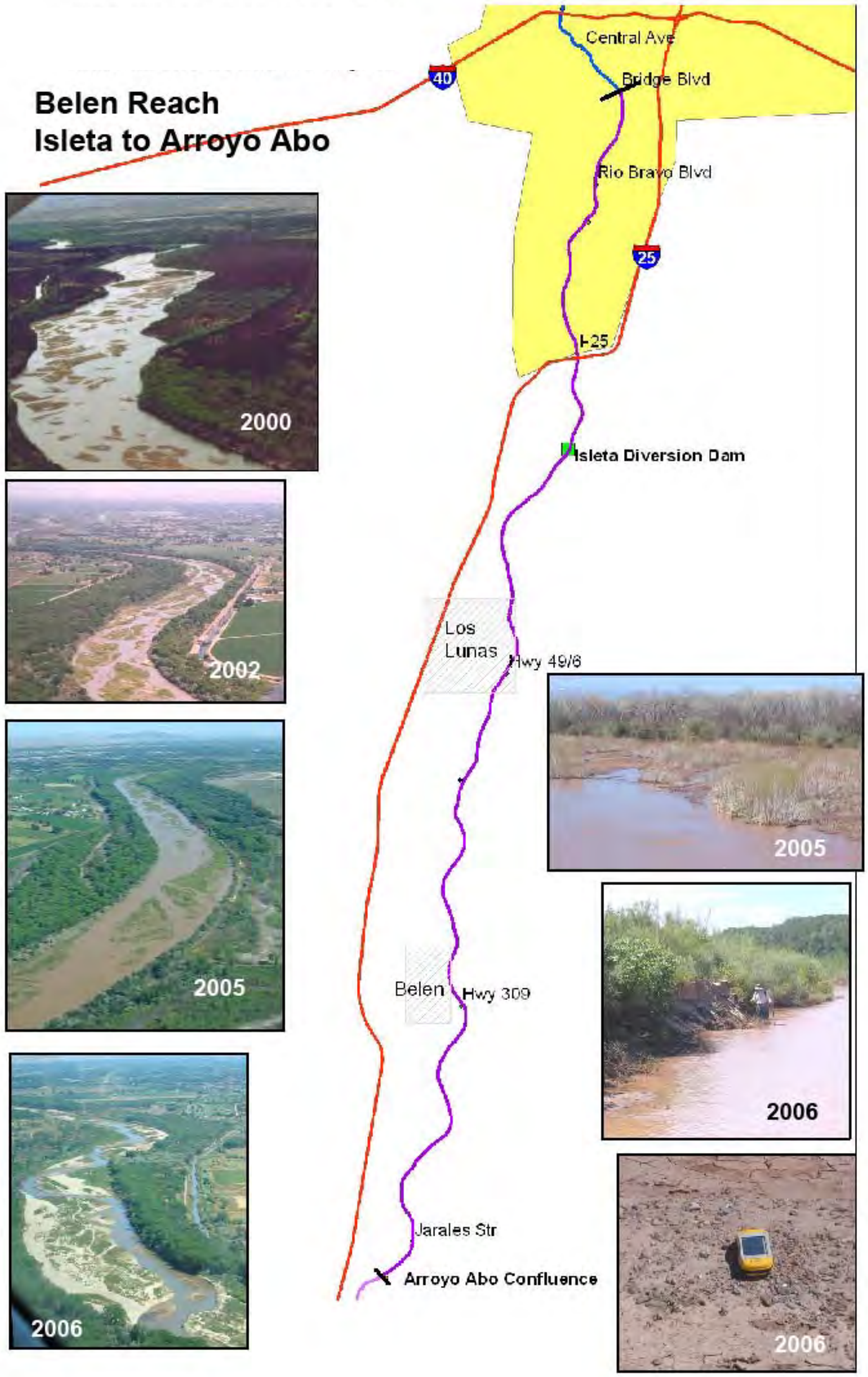


Figure 7. Isleta to Abo Arroyo Reach

ARROYO ABO TO NORTH SOCORRO DIVERSION CHANNEL

Two major features of this geomorphic reach are that it is affected by the uplift of the Socorro Magma Body and that there are two large uncontrolled tributaries, the Rio Puerco and the Rio Salado. As a result of the uplift, sediment inflows from a large number of connected tributaries and ongoing changes in the river channel, a series of terraces and abandoned floodplains line the Rio Grande from about Arroyo Abo confluence to the North Socorro diversion channel outfall (Figure 8). Smaller, inset floodplains appear to be continuously developed as the river abandons older surfaces creating a more classically entrenched river system. Presumably due to a basin-wide reduction in sand supply, gravel has become a large component of the bed material in this reach, especially downstream from the Rio Salado confluence. From the Rio Salado to almost the Escondida Bridge crossing, the channel bed is dominated by gravel, even though sand dunes often cover the gravel layer. At nearly all of the tributary junctions, gravel fans have developed and partially cover the Rio Grande's bed with gravel sized sediment and sometimes create temporary breaks in the channel's slope. This reach can be subdivided into two smaller reaches: upstream from the center of uplift; and downstream from the center of uplift.

Upstream from Uplift Center (Arroyo Abo to Rio Salado Confluences)

Upstream from the Rio Salado, the channel is single threaded with what appears to be continually encroaching vegetation onto the sediment deposits. Although islands are present, most of the new sediment deposits are bank-attached or are islands that are in the process of attaching to the banks. This process results into an ever decreasing channel width, but with very stable banklines. Much of the wider historical banklines are from the channelization in the middle of the 20th century. This channelization is very obvious on the 1962 and 1972 aerial photos where large bends were abandoned. Much of the channelization work appears to have been constructed in the dry; this was possible because the river was diverted into the Bernardo Conveyance Channel from at least 1954 - 1967 (Reclamation 1967). The Bernardo Conveyance Channel began at Abeyta's Heading (~RM 134.4) and followed the current San Francisco Riverside Drain alignment to near the Rio Puerco at about RM 127.4.

The channel slope is slightly lower than that measured downstream from the Rio Salado. Recent survey data and the 2007 profile data show that the elevation of the Salado fan has increased in recent years thereby decreasing the upstream channel slope. A similar pattern, though reduced in scale, is found at many of the arroyo confluences. Channel incision is also less here than that measured downstream. Deposits of gravel are mostly isolated around the arroyo confluences and appear to be scoured and scattered by high flows

The channel in this reach is a slightly sinuous, single channel planform, which generally appears stable. However, as the banks are tall, the slightly sinuous pattern that currently exists could cause some bank erosion in isolated areas. Large migrating bends are unlikely as the channel slope is relatively low. As this is within the uplifted area, the floodplains are continually, and naturally becoming abandoned, however, new floodplains are forming and quickly becoming vegetated. Riverine habitat is naturally shrinking as the channel incises, narrows, and the bars become vegetated and stable. However, the new active floodplains provide small isolated pockets of good habitat for both riparian and in-channel species.

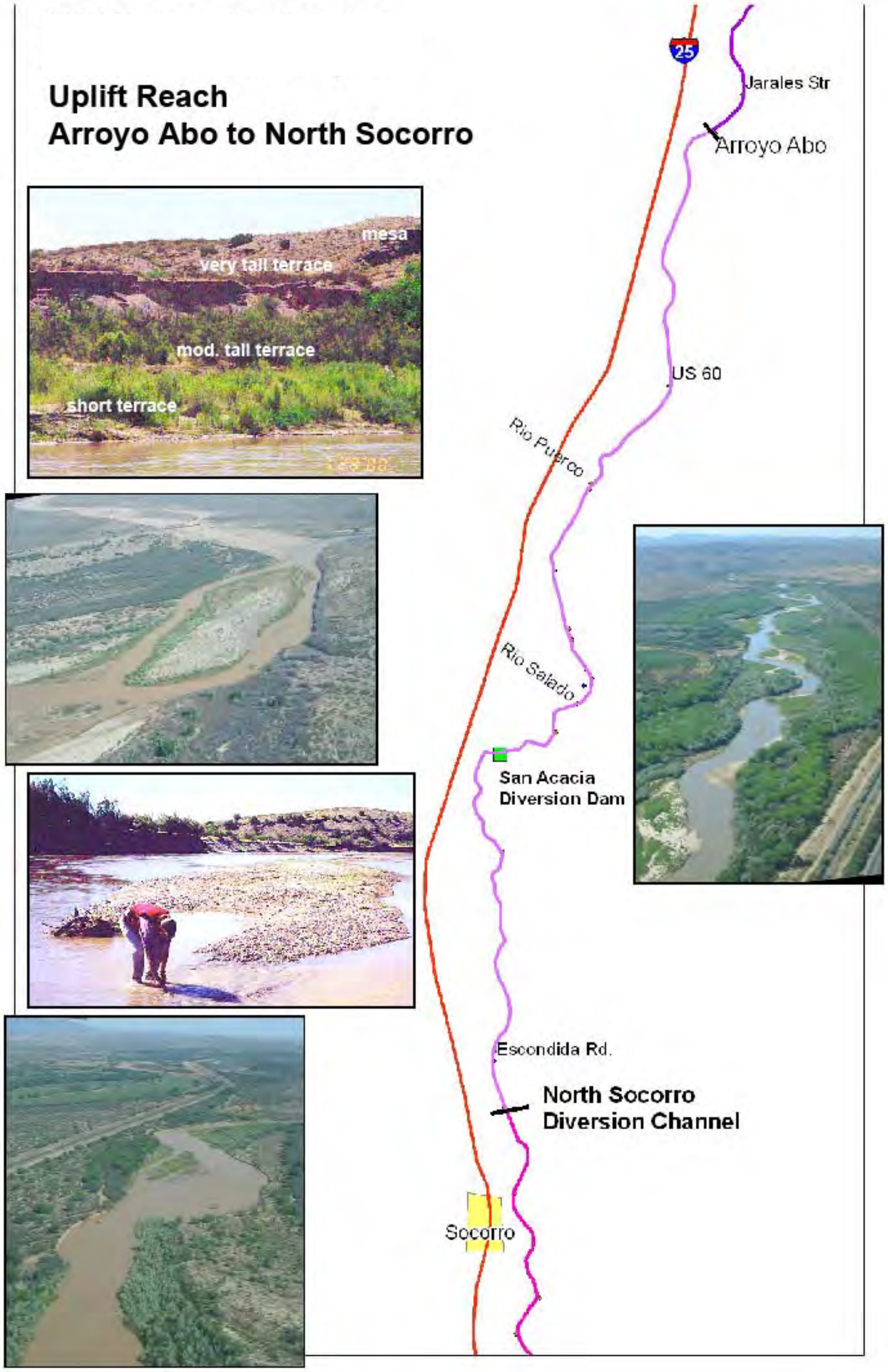


Figure 8 Abo Arroyo to North Socorro Diversion Reach

Downstream from Uplift Center (Rio Salado Confluence to North Socorro Diversion Channel)

Downstream from the Rio Salado, the channel planform is also single threaded, but the channel is more incised (especially downstream from the San Acacia diversion dam) and several bends have started migrating. The alternating thalweg that began forming in the late 1990s has become the dominant morphology, creating numerous migrating bends. Several “mega-bends” have formed throughout this reach with some migrating towards riverside facilities (i.e., levees, canals). Channel incision has been significant with up to 12 feet in the past 60 years. Terraces in this reach are quite tall so the spring runoff water surface elevation is often well below the root zone of the riparian vegetation. When coupled with the dominantly sandy bank composition, the banks are particularly susceptible to riverine erosion.

Most of this reach is gravel-bedded, with the coarsest bed material located at the Rio Salado confluence and grading downstream towards Escondida Bridge area where it is still dominantly sand-sized bed material. Planforms range from the single, slightly sinuous channel to advanced bends with well-developed cutoff channels that have captured the main flow.

This reach is on the downstream side of the uplift and will naturally have a long-term higher slope than the reach upstream from the uplift. When combined with deposition at the Rio Salado fan and the amount of coarse grained bed material, and weak bank material, this reach is prone to lateral migration. There is a natural tendency for abandonment of floodplain surfaces because of the uplift, but this process has been accelerated because of bed incision. The rate of new bar growth has been quite high due to the rapid movement of several bends in this reach. The new point bars act as floodplain surfaces and create shallow, wetted surfaces at nearly all flows. The older sections of the point bars are being colonized creating new riparian areas. Old riparian zones that are located on top of the abandoned floodplains (terraces) are being eroded by the migrating bends. General riverine habitat features appear stable, as the channel width and planform are relatively stable, however, the exact location of the channel is systematically changing as the channel migrates. New bar surfaces are created during each large flow event that later become vegetated and active floodplains. These new floodplains provide small isolated pockets of good habitat for both riparian and in-channel species during high flows.

STABLE TRANSITION ZONE (NORTH SOCORRO DIVERSION CHANNEL TO BROWN ARROYO)

Unlike the transition zone in Albuquerque, which is transitory in space, this transition zone (8 river miles) represents a relatively stable stretch of river in time; this section separates the upstream degradation from the downstream aggradation. Figure 9 has photographs of this short reach’s characteristics. In the last 10 years, channel width has decreased slightly, which can be attributed to island and bar growth/vegetation during the recent drought cycle. Planform characteristics within this reach are relatively stable, however with the development/stabilization of the bars and islands, the remaining active channel area is concentrating the river flows, a similar process of that found in the Belen Reach but at a smaller scale. The channel’s grain size and bed elevation remain stable. The location of greatest bed elevation stability appears to be near river mile 100, just upstream from Arroyo de la Presilla. The floodplain throughout this reach is active and begins to inundate at moderate sized flows (2,000-3,000 cfs).

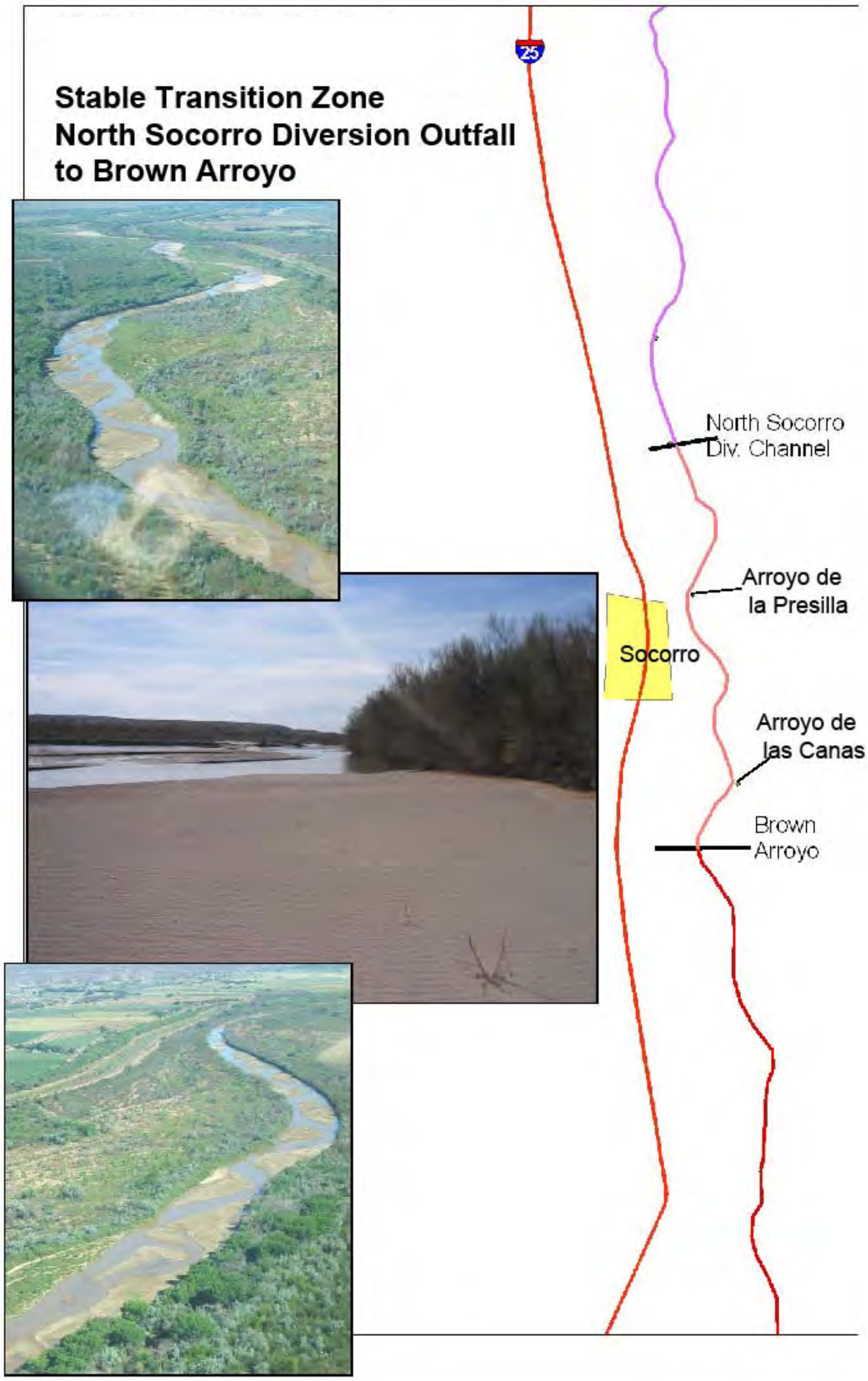


Figure 9 North Socorro Diversion to Brown Arroyo Reach

The bed and banklines, while narrowing, in this reach are mostly stable, however, a slightly meandering thalweg pattern is beginning to form. Although individual bends may form in this reach, numerous migrating bends are unlikely since bank height is low, the channel slope is relatively low and the bed material is finer than upstream. For in-channel habitat, this reach may continue to narrow and possibly incise as the thalweg becomes more concentrated into an ever smaller active channel, reducing space for aquatic habitat. However, the channel's planform and character still appear stable. As new riparian areas develop with the existing active historical floodplain, overbank habitat/riparian habitats may improve.

BROWN ARROYO TO THE TIFFANY PLUG AREA

The reach from Brown Arroyo to the Tiffany Plug area (~22 river miles) is and has been gradually aggrading since the 1930s; bank heights are low and the floodplain along with newly formed islands are inundated at relatively low flows (around 3,000 cfs) as seen in Figure 10. Historically, the amount of aggradation increased in the downstream direction for many miles downstream of the Tiffany area, however at present, Tiffany is a boundary between this slightly aggrading reach and the temporary degradation occurring downstream from Tiffany. Of the Rio Grande discussed in this report, this section of river has always been the widest and currently is still the widest. Although planform changes are just beginning, much of this channel is still wide, braided, and shallow. Several possibilities give insight into this reach's resistance to significant change:

- Northern portion of the reach has not been extensively channelized.
- This reach has been slightly aggradational since first surveyed in the 1930s through 2002.
- Channel slope is slightly less than the upstream channel slopes.
- The total valley width in this reach is very wide.
- This reach receives water and sediment from numerous tributaries that are not controlled for flood or sediment production, allowing for a more natural hydrograph and sediment supply than found in the upstream reaches.
- Sediment transport out of this reach is limited by a severe constriction at RM 78 where the channel enters the constructed channel from the LFCC construction during the 1950s.

During the recent drought cycle, mid-channel bars have formed and become vegetated. In 2005, some of the side channels filled-in, became vegetated, and are now attaching the islands to the banks. Neither the high spring runoff of 2005 nor the several high peak flows during the summer of 2006 generally eroded these features. Initial descriptive information indicated some deposition in the channel after the 2006 summer thunderstorms. The main channel has narrowed and become more uniform in width.

In the lower section of the reach, the channel was straightened by cutting pilot channels through the floodplains at various times and locations between the early part of the century and the early 1970s. At these sites, the channel width is significantly narrower than elsewhere in the reach. The bank and bed material in these locations are also more resistant to erosion due to a higher silt/clay content more consistent with the floodplain depositional environments.

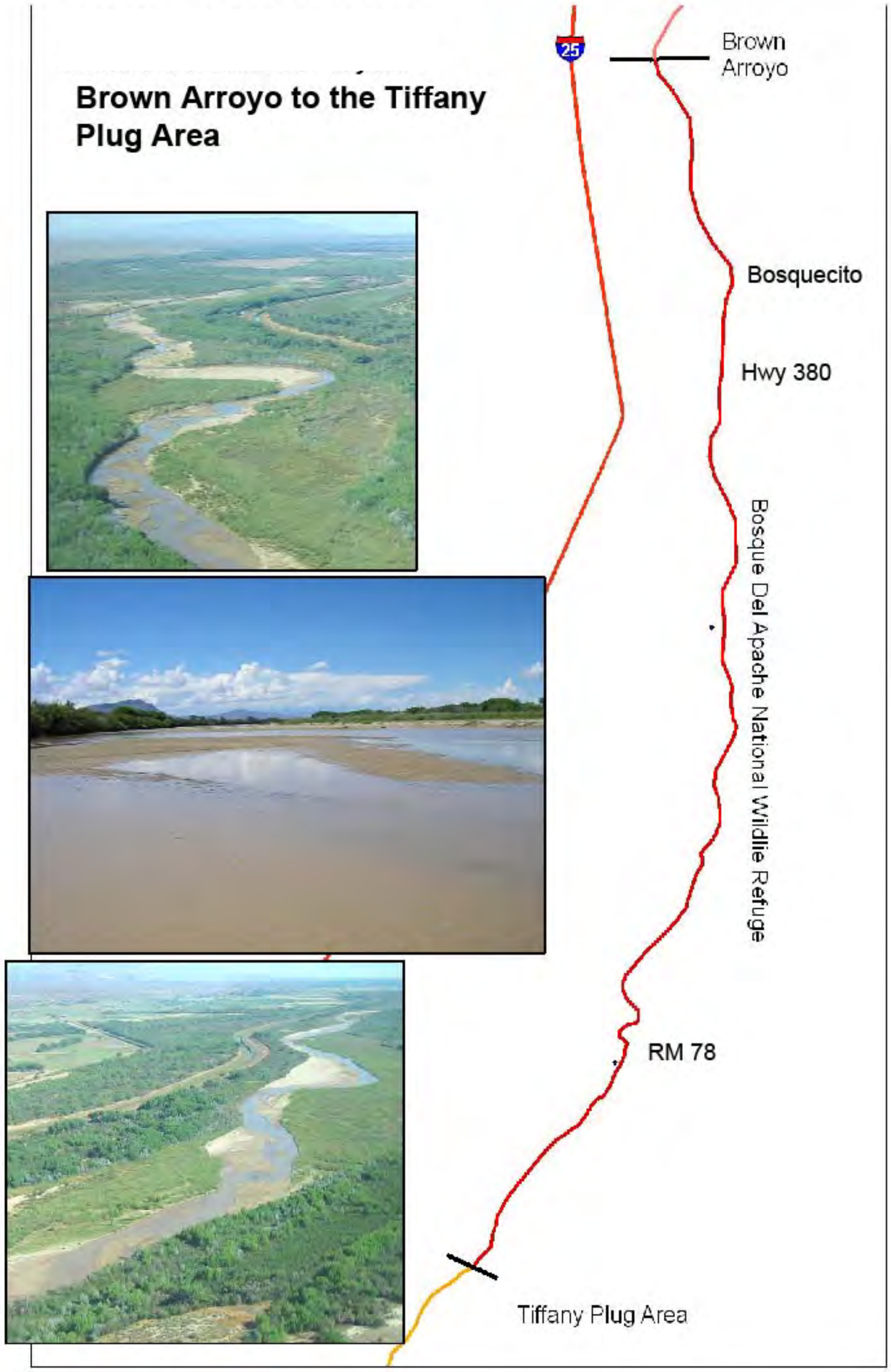


Figure 10 Brown Arroyo to Tiffany Plug Reach

With the channel narrowing, less wetted channel area is available for aquatic species. The growth of vegetated bars is expected to continue in this reach. These islands/bars are very stable and force the main channel to flow around them forming a deeper more concentrated main channel to convey the in-channel flows. The likely evolution of this reach is that a single dominant channel will emerge, with the rest of the current active channel becoming vegetated floodplain. Although these newly formed surfaces easily flood, so does the historical floodplain, therefore, these features only add to the abundant floodplain habitat already available in this reach. These new riparian areas provide young vegetation that is close to the river's edge and may improve avian habitats.

One additional concern for this reach is the upstream migration of the Elephant Butte Reservoir headcut. At present, the 2003 headcut appears to taper out in the Tiffany area, the downstream boundary of this reach. Although the zone of temporary degradation appears to be stalled, it could migrate into this reach. The effects of the headcut would be temporary bed degradation, probably less than 3 vertical feet of scour. The most important change in bed elevation is that higher river flows would be required to inundate the floodplain.

SAN MARCIAL REACH (TIFFANY AREA TO ~RM 60)

Prior to 2005, this reach was rapidly aggrading, with about 15 feet in the last 65 years. In 2003, a large headcut (>10 feet in vertical elevation) was identified within the upper section of Elephant Butte Reservoir, just downstream from this reach. In 2005, the headcut migrated upstream during spring runoff; the most upstream portion of the headcut migrated to approximately the Tiffany Sediment Plug area by 2006 and extended to approximately RM 78 by 2007. It is unknown whether the headcut will continue to migrate upstream from the river mile 78 area or whether a new stable slope has been reached.

The headcut caused significant bed elevation lowering (degradation as shown in Figure 11) in 2005 throughout most of this reach. This degradation varies, with the greatest amount at the downstream end of the reach (greater than 10 feet) to less than 3-4 feet at the upstream end of the reach. Regardless of the exact amount, degradation has abandoned most of the floodplain in this reach. Due to rapid base level lowering and subsequent water table elevation lowering, especially at the downstream end of the reach, riparian vegetation is being stressed with some mortality.

Along with the rapid bed degradation, several bends within this reach have begun to migrate. The two most notable locations are at RM 60 and at the Ft. Craig pumping station; in both locations, river flows intersect the bank below the root zone and are causing erosion. Also at both locations, the erosion began at pre-existing bends in the river but is now evolving to create new bends. On the inside of each of the migrating bends, large point bars have developed. The acknowledgement of this sediment deposition is important, as it indicates that the channel has formed a prominent thalweg which is located at or near the eroding bankline (across from the sediment deposition). This thalweg development indicates a shift from a uniform bed depth to that of varying depths and concentrated flow.

Although this reach has changed significantly within the last few years, the channel location at a broad scale remains stable. This reach was always the narrowest and least variable based on historical photo reviews. Much of this reach was relocated when the river channel was moved to the east side of the valley into floodplain deposits during Low Flow Conveyance Channel construction in the 1950-1960s. Although a major threat just a couple of years ago, channel avulsion is not likely until the channel bed aggrades back to elevations similar to that measured in 2003; right now the river is the lowest valley elevation in most of this reach. Bed material samples from 2006 show the grain size is medium sand which is much coarser than the previous samples of fine sand.

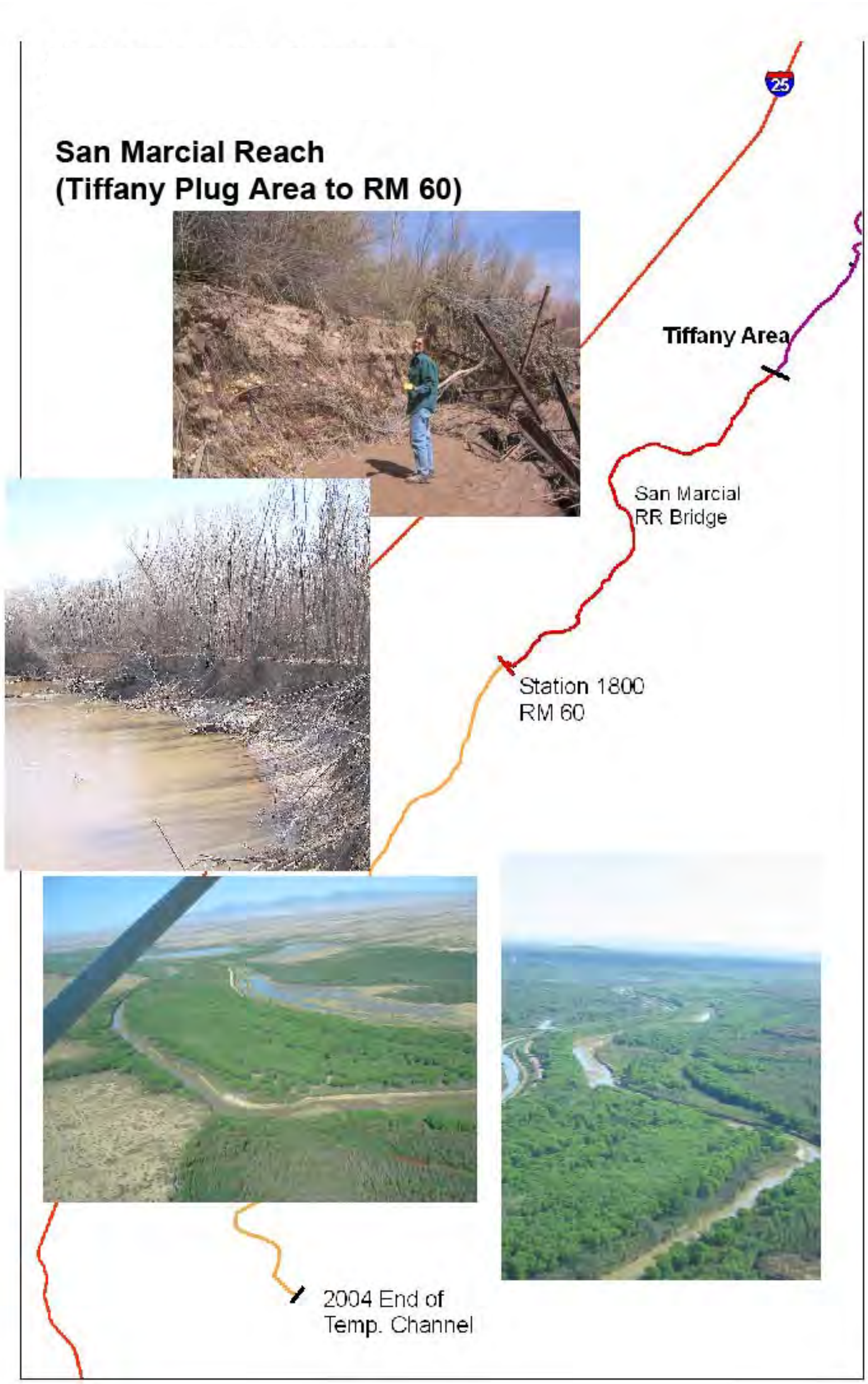


Figure 11 Tiffany Plug to River Mile 60 Reach

The recent bed incision has cause large scale abandonment of the floodplain which adversely affects aquatic and riparian species alike. As this reach is normally rapidly aggrading, and the source of the incision is from a rapidly lowered reservoir pool, this process is presumed to be temporary. Based on recent aggradation rates, once sedimentation processes return, the channel bed could fill to 2003 elevations within 10-15 years. However, any additional headcuts migrating into this reach from the Reservoir will extend this timeframe.

Channel migration is a recent process in this reach and is associated with the lowered bed elevation. The incised channel bed allows bank erosion to occur under the riparian root mass. This type of erosion is expected as long as the bed elevation continues to be lower than the vegetation roots. The incision and lowered water table are two important changes in this reach that affect habitat conditions. The incision and deepening thalweg has obvious consequences for aquatic species because the shallow flow areas are disappearing. Also, the once well connected floodplain is now abandoned. The lowered water table is already affecting the riparian vegetation; stress and mortality of the riparian vegetation has obvious negative implications for flycatcher habitat. These conditions are expected to exist until the reach resumes its aggradational processes and aggrades to a level at which the floodplain becomes active again and shallow groundwater returns to previous elevations.

Sediment plugs occur in this reach especially near the upstream boundary and particularly during years of extended high flows. As sediment plugs are the first stage in the avulsion process, the large amounts of deposited sediment in the channel, forces the channel flows to go overbank and flow around the plug. If not managed, a new prominent channel will develop thus becoming the new main channel. Repeated sediment plugs have formed in the Tiffany area, just upstream from the San Marcial Railroad Bridge crossing. The most recent plug formed during the 2005 runoff. For sediment plugs forming in this location, river flows have been re-established by partially excavating the filled channel and re-directing the water into this excavated pilot channel. As these plug sediments are loose and often still wet, the water flowing through the pilot channel easily erodes the deposits and re-establishes a channel similar if not identical to channel prior to the plug formation.

TEMPORARY CHANNEL IN ELEPHANT BUTTE RESERVOIR POOL

As this reach is within the Elephant Butte Reservoir pool area, it has experienced periods of substantial and rapid aggradation. At the upstream end of the Narrows (RM 46), the bed elevation has risen about 40 feet since 1915. The most sustained period of near maximum reservoir storage occurred in the 1980s through the mid-1990s. The reservoir pool elevation started decreasing in 1999, moving the head of the reservoir pool downstream of the Narrows in 2002. This rapid lake recession disconnected the river from the lake, such that a temporary channel had to be excavated through the reservoir sediments. Over 20 miles of channel was constructed between the late 1990s and 2005 (Figure 12).

Once the constructed channel had at least partially stabilized in 2003, a headcut formed upstream from Silver Canyon and began progressing upstream. By 2004 the headcut had moved upstream to the location of the 1992 temporary channel where it temporarily stalled in a thick clay deposit. In August of that year, the main headcut drop was estimated at 10 feet high. In 2005, the headcut moved upstream and tapered out at the downstream end of the Tiffany sediment plug. By 2007, the bed slope continued to flatten with a bit more degradation upstream to RM 78. It is possible that additional headcuts could form in the reservoir channel if the pool remains low.

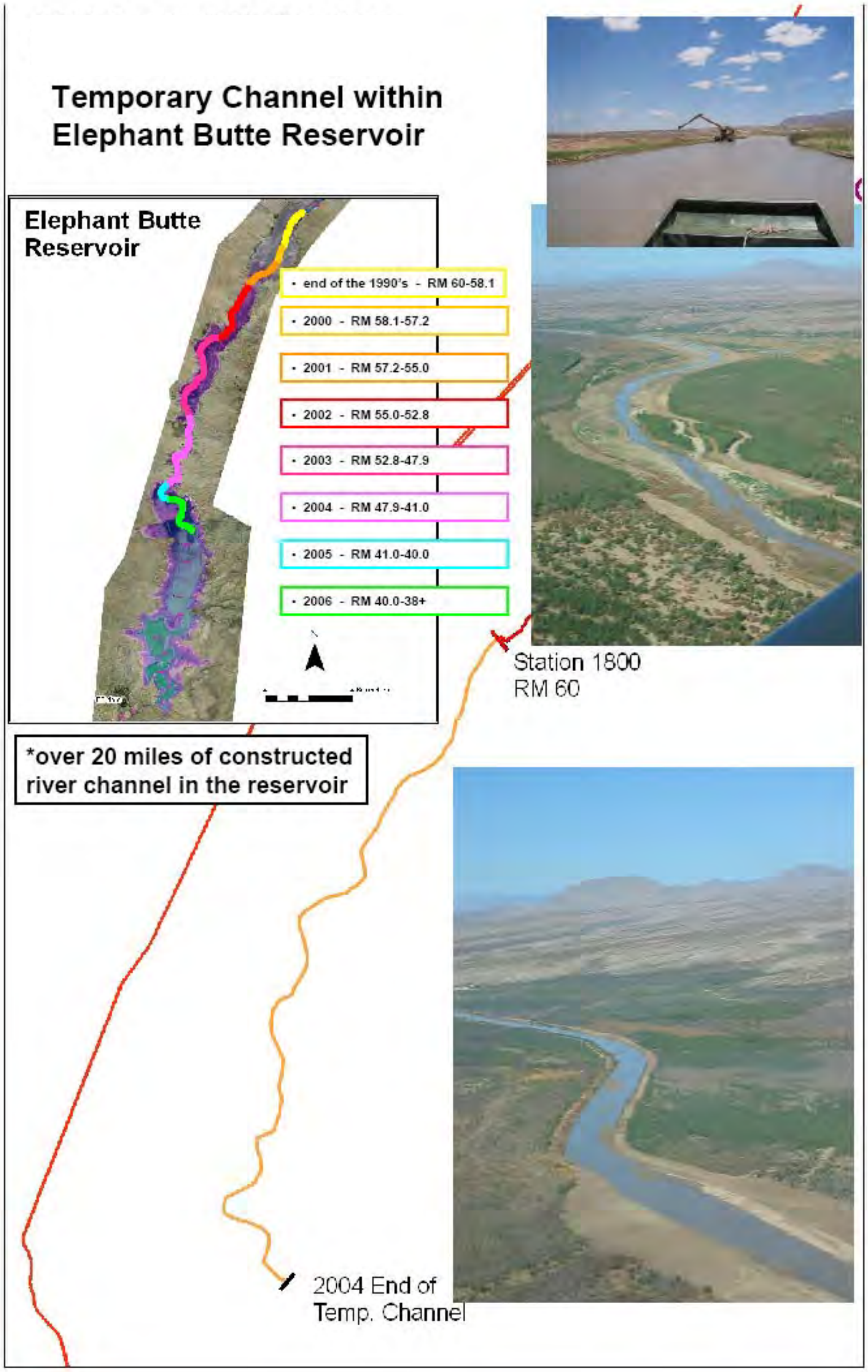


Figure 12 Temporary Channel Reach

The main portion of the temporary channel (upstream of the Narrows) has started to evolve since it was first constructed in 2001-2004; in 2006, silvery minnow were found throughout this part of the channel. As long as the reservoir pool does not fill over this channel, it will continue to evolve. A slight meander pattern is beginning to set up and is likely to progress as the reservoir sediments are soft and easily eroded, however, vegetation growth along the channel could slow planform development. The meandering pattern adds complexity to the channel bed through the development of inset point bar growth (shallow surfaces within the main channel) and a deeper thalweg which alternates between banklines.

As long as the Reservoir pool stays low, there is continued potential for additional headcuts to form and migrate upstream. These headcuts would increase channel capacity within the constructed channel, while lowering the water table. As discussed in the San Marcial Reach, a lower water table may negatively impact the riparian vegetation and reduces the potential for overbank flooding for aquatic species.

CABALLO REACH (ELEPHANT BUTTE DAM TO CABALLO RESERVOIR)

The Rio Grande between Elephant Butte Dam and Caballo Reservoir is extensively controlled in terms of regulated river flows and bed elevation (Figure 13). All of the upstream sediment supply for this reach is stored in Elephant Butte Reservoir, such that released water is clear and cold; local tributaries (Cuchillo Negro Arroyo, Mescal Arroyo, and Arroyo Hondo) which contribute to this reach flow infrequently but can deliver large amounts of coarse and fine sediments. In times of excessive sediment deposition, the channel is dredged to maintain channel capacity. As an apparent result of the low sediment supply, the channel appears to be slightly incised.

Water releases to this reach are maximized for water delivery to downstream irrigators. Reclamation's main authority for this reach is to maintain a channel capacity of 5,000 cfs to Los Palomas Creek. As part of this authority, in 1985, Reclamation channelized this reach which included lowering the bed elevation. This work decreased natural flows to local hot springs along the river, so Reclamation constructs a temporary dike as needed in the winter (when releases are stopped) to artificially raise the stage in the river, which increases hot spring flows. The bankline is very stable throughout the reach despite a limited amount of bank reinforcement.

As this reach is heavily managed and releases have been controlled since 1915 when Elephant Butte Dam began operations, it is not likely to evolve significantly in the future. The current availability and type of habitat is likely stable unless manipulated by humans.

Figure 13 Elephant Butte Dam to Caballo Reservoir Reach

REFERENCE LIST

Bauer, T., 2006, Longitudinal Profile of the Rio Grande and its temporary channel in the San Marcial Reach U.S. Department of the Interior, Bureau of Reclamation Draft Technical Report, Technical Services Center, Sedimentation and River Hydraulics Group, Denver, Colorado.

Bauer, T.R., T.M. Massong and M.D. Porter, 2005, Working with a Changing River to Create Nursery Habitat, Rio Grande, American Fisheries Society Annual Meeting, Anchorage, AK.

Bureau of Reclamation, 2003, Geomorphic Assessment of the Rio Grande San Acacia Reach, Albuquerque Area Office, Albuquerque, NM, 73 p.

Bureau of Reclamation, 1967, Annual Project History Volume XVII Calendar Year 1967, Albuquerque Area Office, Albuquerque, NM

Lagasse, P. F., 1980, An Assessment of the Response of the Rio Grande to Dam Construction-Cochiti to Isleta, U. S., Army Corps of Engineers Technical Report, Albuquerque, New Mexico, 133 p.

Makar, P., T. Massong, T. Bauer, and K. J. Oliver, 2006, Channel Width and Flow Regime Changes along the Middle Rio Grande NM, Joint 8th Federal Interagency Sedimentation Conference and 3rd Federal Interagency Hydrologic Modeling Conference, Reno, Nevada.

Makar, P.W., and Strand R.I. (2002). Geomorphological Assessment of the Rio Grande: Escondida Bridge to near Fort Craig. U.S. Department of the Interior, Bureau of Reclamation Draft Technical Report, Technical Services Center, Sedimentation and River Hydraulics Group, Denver, Colorado.

Massong, T. M., 2006, Summary of Geomorphic Processes, Rio Grande at the Fort Craig Bend, U.S. Department of the Interior, Bureau of Reclamation Technical Report, Environment Division, Albuquerque, New Mexico, 2006.

Massong, T. M., 2006, River Maintenance Priority Site at River Mile 60, Geomorphic Trends Assessment, U.S. Department of the Interior, Bureau of Reclamation Technical Report, Environment Division, Albuquerque, New Mexico, 2006.

Massong, T. M., 2006, Drain Unit 7 River Maintenance Priority Site, Geomorphic Review, U.S. Department of the Interior, Bureau of Reclamation Technical Report, Environment Division, Albuquerque, New Mexico, 2006.

Massong, T. M., 2006, River Maintenance Priority Site at Corrales Siphon, Geomorphic Review, U.S. Department of the Interior, Bureau of Reclamation Technical Report, Environment Division, Albuquerque, New Mexico, 2006.

Massong, T. M., 2006, River Maintenance Priority Site at Arroyo de las Cañas, Geomorphic Trends Assessment, U.S. Department of the Interior, Bureau of Reclamation Technical Report, Environment Division, Albuquerque, New Mexico, 2006.

Massong, T. M., P.W. Makar, and T.R. Bauer, in prep., Middle Rio Grande Conceptual Planform Model, Department of the Interior, Bureau of Reclamation DRAFT Technical Report, Environment Division, Albuquerque, New Mexico—*IN PREP*.

Massong, T.M., R. Doster, and C. Rolland, 2006, Impacts of persistent drought on habitat in the Rio Grande at Elephant Butte Reservoir, Water Resources Research Institute 2006 Annual Technical Symposium, Socorro, NM.

Massong, T. M., and P. Makar, 2006, Evolution of the Bends at River Mile 110, U.S. Department of the Interior, Bureau of Reclamation Technical Report, Environment Division, Albuquerque, New Mexico, February 2006, 7 p.

Massong, T., P. Tashjian, and P. Makar, 2006, Recent Channel Incision and Floodplain Evolution within the Middle Rio Grande, NM, Joint 8th Federal Interagency Sedimentation Conference and 3rd Federal Interagency Hydrologic Modeling Conference, Reno, Nevada.

Massong, T. M., 2005, San Acacia River Mile 111 Priority Site, Bend Migration Assessment, U.S. Department of the Interior, Bureau of Reclamation Technical Report, Environment Division, Albuquerque, New Mexico, March 2005, 12 p.

Massong, T.M, 2005, Bernalillo River Maintenance Priority Site, Bend Migration Monitoring, Spring 2005, U.S. Department of the Interior, Bureau of Reclamation Technical Report, Environment Division, Albuquerque, New Mexico, August 2005, 7 p.

Massong, T. M., 2005, Geomorphology Summary, Rio Grande-Bernalillo Bridge Reach, U.S. Department of the Interior, Bureau of Reclamation Technical Report, Environment Division, Albuquerque, New Mexico, December 2005, 20 p.

Massong, T. M., 2005, Geomorphology Summary, Rio Grande-Corrales Reach, U.S. Department of the Interior, Bureau of Reclamation Technical Report, Environment Division, Albuquerque, New Mexico, December 2005.

Massong, T. M., 2005 Bank Erosion Monitoring Report, San Acacia Reach of the Rio Grande, NM, U.S. Department of the Interior, Bureau of Reclamation Technical Report, Environment Division, Albuquerque, New Mexico, December 2005, 11 p.

Massong, T. M., and J. AuBuchon, 2005, San Ildefonso Pueblo River Maintenance Priority Site, Geomorphic Trends Assessment, U.S. Department of the Interior, Bureau of Reclamation Technical Report, Environment Division, Albuquerque, New Mexico, September 2005, 22 p.

Massong, T.M., and M.D. Porter, 2005, Predicting Future Fish Nursery Habitat using Geomorphology, Proceedings of the 2005 American Fisheries Society 2005 Annual Meeting, Anchorage, AK.

Massong, T.M, 2004, Rio Grande River Maintenance Priority Sites on the Pueblo of Cochiti: Historical Channel Information, U.S. Department of the Interior, Bureau of Reclamation Technical Report, Environment Division, Albuquerque, New Mexico, November 2004, 10+ p.

Massong, T.M., and Porter, M D., 2004, Changes in the Middle Rio Grande Due to the Altered Hydrology, Geological Society of America Abstracts with Programs, Denver, Colorado, Vol. 36, No. 5, p.12.

Massong, T.M., M.D. Porter, and T. Bauer, 2004, Design Improvements for Constructed Rio Grande Silvery Minnow Nursery Habitat, U.S. Department of the Interior, Bureau of

Reclamation Technical Report, Environment Division, Albuquerque, New Mexico, September 2004, 23 p.

Massong, T.M. and M.D. Porter, 2003, Using Fluvial Geomorphology to Design Successful Habitat Features, Geological Society of America 2003 Annual Meeting, Abstracts with Programs, Seattle WA.

Massong, T., K.I. Smith, A. Glover, K. Candelaria, and M. Bullard, 2002, Overview of Geomorphology for the Middle Rio Grande, U.S. Department of the Interior, Bureau of Reclamation unpublished Technical Note, River Analysis Team, Albuquerque, NM, July 2002.

Porter, M.D., and T.M. Massong, 2004, Analyzing Changes in River Channel Morphology using GIS for Rio Grande Silvery Minnow Habitat Assessment, Proceedings of the Second International Symposium on GIS/Spatial Analysis in Fishery and Aquatic Sciences, University of Sussex, Brighton, UK: 3-6 September 2002, Editors: T. Nishida, P. Kailola and C. Hollingworth, vol. 2: pp 433-446.

Richard, G.A., P.Y. Julien, and D.C. Baird. 1999. Morphological Changes of the Rio Grande Downstream from Cochiti Dam. *In press*.

Rittenhouse, G. 1944. Sources of Modern Sand in the Middle Rio Grande Valley, New Mexico. Geological Society of America Bulletin, v 54, no 12.

Tashjian, P., and T. M. Massong, 2006, The Implications of Recent Floodplain Evolution on Habitat, Joint 8th Federal Interagency Sedimentation Conference and 3rd Federal Interagency Hydrologic Modeling Conference, Reno, Nevada.

APPENDIX F

USFWS COMMENTS ON DRAFT BIOLOGICAL ASSESSMENT AND CORPS RESPONSES

United States Department of the Interior

U.S. FISH AND WILDLIFE SERVICE
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June 22, 2011

Ms. Julie A. Alcon Chief,
Environmental Resources
U.S. Army Corps of Engineers 4101 Jefferson Plaza N E Albuquerque, New Mexico 87109-3435

Dear Ms. Alcon:

Thank you for the opportunity to review and comment on the U.S. Army Corps of Engineers preliminary Draft Biological Assessment of Reservoir Operation on the Middle Rio Grande of New Mexico (preliminary BA). We have reviewed the preliminary BA and offer the attached comments. We provide general and specific comments that we hope will be helpful to the Corps.

Thank you for your concern for endangered species and New Mexico's wildlife habitats. If you have any questions, please contact Ms. Lori Robertson of my staff at (505) 761-4710.

Sincerely,

Wally Murphy
Field Supervisor

cc:

Regional Water Policy Coordinator, U.S. Fish and Wildlife Service, Albuquerque, N M (Attn: Janet Bair) Assistant Regional Director, Ecological Services, U.S. Fish and Wildlife Service, Albuquerque, N M (Attn: Michelle Shaughnessy)

Preliminary Service Comments on Corps' April 2011 Draft BA on Reservoir Operation and Flood Control on the MRG

June 17, 2011

[The Corps' responses to the Service's comments have been added in italic typeface.]

GENERAL COMMENTS

1) The Service recommends that any species that are currently candidates for listing under the ESA be included in this reinitiated section 7 process via Conference Opinion. The advantage of including a Conference for candidate species is that upon listing of these species, if the conference analysis is still accurate, the Service can roll that Conference Opinion over into a Biological Opinion. Given your stated interest in minimizing reinitiating in the future, we recommend addressing candidate species during this consultation. Current candidate species for listing under the ESA, and which are relevant to this consultation, include the yellow-billed cuckoo *(Coccyzus americanus)* and the New Mexico meadow jumping mouse *(Zapus hudsonius luteus).*

Response: We have elected not to confer on candidate species at this time. The current consultation is sufficiently complex due to extensive coordination on the Long-Term Plan for recovery of listed species.

2) The Service's current understanding is that this is a reinitiation of the existing 2003 BO. As such it is appropriate and necessary for the Corps to include any and all actions covered by the 2003 BO, in order to seek continuing coverage for its actions under section 7, unless those actions no longer occur.

Response: The Corps is consulting on the operation of their four dams within the Middle Rio Grande basin of New Mexico. The Corps is reinitiating Section 7 consultation because the 2003 BO will expire on February 28, 2013. All Corps actions that were included in the 2001 and 2003 consultations on Middle Rio Grande water operations are included in the current Biological Assessment (BA).

The present consultation is not a reinitiation of the 2003 BO. Consultation #2-22-03-F-0129 analyzed a different action, within a different action area, than those that the Corps or Reclamation are currently (October 2011) proposing in their individual consultations.

The 2003 BO evaluated all water depletions within the Middle Rio Grande, e.g.: "...this biological opinion analyzes the effects on the listed species from existing depletions that result from both Indian and non-Indian water uses within the action area, and extends incidental take coverage for all those uses." (2003 BO, p. 7). Currently, neither the Corps nor Reclamation is individually proposing actions that would include all water depletions, even when their agency-specific actions are considered cumulatively.

The action area of the 2003 BO was defined (on page 6) as "the area of the Rio Chama watershed and the Rio Grande, including all tributaries, from the Colorado/New Mexico Stateline downstream to the headwaters of Elephant Butte Reservoir." The action area of the Corps' current consultation entails the Rio Chama, including, and downstream from, Abiquiu Reservoir, and the Rio Grande from the confluence with the Rio Chama downstream to the headwaters of Elephant Butte Reservoir. Reclamation has defined the action area of their current consultation as "the Rio Chama downstream of the confluence with Willow Creek and in the Rio Grande from the confluence of the Rio Chama downstream to San Marcial above the full reservoir pool of Elephant Butte Reservoir." (Reclamation draft BA, dated 18 August 2011). Neither of the currently proposed action areas equate to the much larger action area considered in the 2003 BO.

3) In reviewing the draft BA, the Service finds evidence of an "interrelated-interdependent" connection between the Corps' proposed action and what we presume will be Reclamation's proposed action. The following examples from the draft BA support this finding and are provided here for your consideration.

a. Page 9 of the draft BA discusses storage of San Juan-Chama (SJ-C) water (Reclamation's proposed action) in the Corps' Abiquiu Reservoir. This appears to be a connection between Corps' and Reclamation's Proposed Actions, as Corps' storage of SJ-C water at its Abiquiu Reservoir would not happen "but for" Reclamation's SJ-C project operations.

Response: True, as stated in the Corps draft BA, and also in Reclamation's draft BA (dated Aug. 18, 2011) for their concurrent consultation. Therefore, in Reclamation's consultation, the Corps' storage of SJ-C water is interrelated / interdependent with Reclamation's proposed action. The storage of SJ-C water at Abiquiu Reservoir is a proposed action in the Corps' consultation, not an interrelated / interdependent action.

Similarly, delivery of SJ-C water by Reclamation for storage at Abiquiu would not happen "but for" the Corps' flood control activities and the presence of Abiquiu Reservoir.

Response: The proper consideration of "interrelated and interdependent" actions relative to the Corps' consultation is whether other activities are related to / dependent on the Corps' actions, not vice versa*. However, since Reclamation is consulting on their actions simultaneously with the Corps, we understand that the Service needs to consider what may be related to / dependent on Reclamations actions. Reclamation's delivery of SJ-C water to Abiquiu Reservoir is not related to, nor is it dependent upon, the Corps flood regulation operations. Both of these activities function completely independently. Secondly, Abiquiu Reservoir is not the sole destination available for such storage; Reclamation also may deliver SJ-C water for storage in El Vado or Elephant Butte reservoirs. Lastly, the Corps proposed action is ongoing storage of SJ-C water in a previously dedicated space at an existing dam and reservoir facility. The existence of the Abiquiu Dam and Reservoir project is part of the baseline for this consultation, not part of the proposed action.*

In addition, if storage of native Rio Grande water (presumably Reclamation's proposed action, if included - see question 24 below) at the Corps' Abiquiu Reservoir is to be considered part of the consultation, this could be another case for interrelated or interdependent actions, similar to SJ-C storage above.

Response: There are no agreements for the storage of Rio Grande system water in Abiquiu Reservoir; nor is this activity part of the Corps' proposed action. Reclamation's draft BA (dated Aug. 18, 2011)) on MRG water management actions did not propose to store Rio Grande system water in Abiquiu Reservoir.

b. On page 11, the draft BA describes replacement water for the permanent pool at Corps' Cochiti Lake, which comes from SJ-C project water (Reclamation's proposed action). The Corps' Cochiti recreation pool therefore, would not occur "but for" Reclamation's SJ-C project; similarly, transfer of SJ-C water by Reclamation for storage at Cochiti as part of the Corps' operation and maintenance of the permanent pool would not occur "but for" the Corps' Cochiti dam facility and operations.

Response: The Corps' proposed action is the annual replenishment of evaporation losses from *the permanent pool at Cochiti Lake from Reclamation's SJ-C Project water in Heron Lake. Both the Corps (draft BA dated Apr. 30, 2011) and Reclamation (draft BA dated Aug. 18, 2011) have stated that this replenishment is related to / dependent on Reclamation's SJ-C Project. Lastly (similar to the response for comment 3a), Cochiti Dam and the permanent pool already exist; their creation is not part of the Corps' proposed action.*

c. On page 22, the draft BA describes the primary authorization from Congress for both Corps' and Reclamation's actions in the MRG - e.g., Flood Control Acts of 1948 (P.L. 80-858) and 1950 (P.L. 81-516). There is also a joint agreement signed by the Corps, Reclamation, and the Department of the Interior in 1947, which describes a unified plan for the "control of floods, irrigation, and use of water in the Middle Rio Grande Basin in New Mexico."

Response: The primary intent of the joint agreement was to formally identify the separate and independent authorities and responsibilities of the Corps and Reclamation. The fact that agencies coordinate in the planning or implementation of their specific actions does not invoke the intent of interrelated or interdependent activities as defined in 50 CFR §402.02.

d. Page 18 of the draft BA describes the Proposed Actions for this consultation as *"all discretionary reservoir operation activities or programs of any kind..."* In the Service's analysis for the BO, analysis will need to examine interrelated and interdependent actions to what is proposed by the Corps. This may include other aspects of Corps flood control or actions by other parties that are considered interrelated or interdependent to the Proposed Action. The draft BA states that *"Limiting peak flows to prevent unreasonable damage to spoilbank levees and other protective works is non-discretionary, and, therefore, does not require consultation under Section 7 of the ESA."* It appears that this limitation of peak flows would only happen because of operation of Corps flood control in the MRG, and is therefore interrelated or interdependent to the Proposed Action.

Response: We were somewhat confused by the vague terms in the last sentence of this comment. The term "this limitation in peak flows" apparently refers to non-discretionary operation; "Corps flood control" is a generic term; and the Corps "Proposed Action" entails discretionary operation. As best we parse, the Service appears to be stating that non-discretionary flood-control operation is interrelated to or interdependent on discretionary flood-control operation. However, Federal agencies are not required to consult on non-discretionary actions.

e. Page 23 of the draft BA also states that activities by non-federal SJ-C contractors who use that water *are* interrelated or interdependent to the Corps' proposed action, but *not* in terms of Reclamation as the federal agency responsible for the SJ-C operations. The analysis during consultation would have to consider all interrelated or interdependent action to the Corps' proposed action, and not separate out federal involvement by Reclamation in SJ-C if it is found to be interrelated or interdependent as well.

Response: We did not find this statement on page 23 (nor on adjoining pages) of the draft BA. Regardless, it is not the responsibility of the Corps to determine the interrelated or interdependent nature of activities relative to Reclamation's proposed action.

The Corps is concerned about the portion of the Service's comment that states they would "... not separate out Federal involvement by Reclamation in SJ-C if it is found to be interrelated or interdependent..." The storage of SJ-C water in Abiquiu Reservoir and its subsequent release is part of the Corps' proposed action in this consultation. Section 7(b)(3) of the ESA states: "Promptly after conclusion of consultation under paragraph (2) or (3) of subsection (a), the

Secretary shall provide to the Federal agency and the applicant, if any, a written statement setting forth the Secretary's opinion, and summary of the information on which the opinion is based, detailing how the agency action affects the species or its critical habitat." [Underlining has been added for emphasis.] Regardless of how the Service views the interrelatedness or interdependence of Federal actions during this consultation, the Corps fully expects the Service to fulfill their regulatory obligation and detail how the Corp's action affects listed species or their critical habitat.

4) The draft BA does not appear to provide information on how the annual operations are conducted relevant to the Annual Operating Plan (AOP) developed with the U.S. Bureau of Reclamation each year.

a. Please note the AOP was included in the 2003 consultation (see page 17 of 2003 BO) and addresses cooperation between the Corps and Reclamation annually for water operations. This should be included in the reinitiation (draft BA) unless it will no longer occur.

b. The draft BA also does not describe the coordination efforts with other agencies (such as coordination on release and delivery of SJ-C water), or the process involved with daily operations of the Corps' responsibilities on the MRG. The Service believes this is information relevant to the proposed action and should be included in the BA.

c. Similarly, the Corps 2007 Record of Decision for the Upper Rio Grande Water Operations Review states that one of the goals is more efficient operation of federal reservoirs and facilities as an integrated system. The Service believes information regarding how the Corps participates in managing federal reservoirs and facilities as an integrated system is relevant to the proposed action and should be included in the BA.

Response: The AOP and other operational coordination have been described in Section 2.6.5 of the final BA, and have been included in the Corps proposed action.

5) In addition to the authorities described in the draft BA, the Corps also has other authorities that allow for habitat restoration work in the MRG (not necessarily pursuant to the 2003 BO's RPA requirements), as well as authority to participate in the MRG Endangered Species Collaborative Program. The Service believes these activities should be described as part of the Proposed Action for this consultation to be consistent with the Corps' responsibilities as a federal agency under ESA section 7(a)(1) and 7(a)(2).

Response: This consultation only addresses the operation of Corps dams and reservoirs in the MRG. We will consult on future activities stemming from separate Congressional authorities when such projects are proposed for implementation.

The Corps has received appropriations and authority to conduct studies related to listed species in the Middle Rio Grande. The likely future activities relating to this authority has been described in Chapter 7 of the final BA, along with other environmental commitments.

6) Please update biological and hydrological information with the best available scientific and commercial data.

Response: Information in the BA has been updated accordingly.

7) The future effects of the existence of levees on the MRG are not included in this draft BA; however, levee maintenance was considered part of Reclamation's action for the 2003 BO. The P.L. 86-645 cited as the Corps' authority to conduct flood regulation specifically refers to the levees and channel protective

works. Operation of the Corps' facilities for flood control is directly related to safe channel capacity - which is in turn, determined by the existence of those levees and other structures. It may be that the Service must consider the presence of levees and ongoing effects in our analysis as something that is interrelated or interdependent to flood control in the MRG by the Corps or Reclamation's river maintenance program.

Response: This consultation addresses the operation of Corps dams and reservoirs in the MRG. Neither the existence of protective works nor their maintenance is dependent on the operation of dams for their utility or justification. Spoilbank levees in the action area were constructed in the early 1930s, well before the construction of flood-control dams in 1950 through 1975. The engineered levees in the action area (at Albuquerque and Corrales) were designed to reduce the risk of flood damage from precipitation events occurring downstream from Corps dams. The presence and operation of flood regulation dams does not preclude the need for, or function of, downstream levees, nor the need for their ongoing maintenance.

8) The draft BA mentions available storage limits and that volume of SJ-C storage at Abiquiu decreases over time as sediment retention in the reservoir increases.

a. Is there information on this rate of sediment build up and how much SJ-C storage will decrease over time? How will this affect river operations?

Response: SJ-C storage at Abiquiu Reservoir occupies a portion of the flood-control pool. As stated in the BA, at the end of 2009, an estimated 36,423 ac-ft of sediment has accumulated since the dam's closure in 1963, at a gross rate of 792 ac-ft per year. The actual rate of accumulation in a given year or period varies widely depending on the frequency and magnitude of inflow during that period.

The sediment reserve space is a design feature of the dam-and-reservoir project. The filling of the remaining sediment reserve space will not affect flood-control operation at Abiquiu Dam. The reduction in SJ-C storage space will reduce the maximum quantity of such water that can be stored at a given time. The use of SJ-C water is the discretion of the individual contractors. The Corps has no discretion or responsibility regarding the use of SJ-C water <u>not</u> stored in Abiquiu Reservoir.

b. Also, does the Corps do any sediment management activities at its dams to reduce this build up (other than flushing the Jemez stilling pool as described in the draft BA)?

Response: There are no specific management activities that reduce the rate sediment accumulation at Corps dams. The sediment trapping efficiency does vary according to the volume and elevation of water present at a given time.

For clarification, the sediment flushed from the stilling basin at Jemez Canyon Dam has already passed through the dam. It is not part of the detained sediment behind the dam.

9) Please note the Service does not necessarily agree with all the effects determinations for the species and critical habitat presented in the draft BA. We are in agreement that formal consultation on both the silvery minnow and flycatcher, and their critical habitats, is warranted for the Corps' proposed action.

Response: Your comment has been noted.

10) Please note that in the Service's analysis must consider all of the effects whether or not they worsen over time. We do not analyze just incremental differences in effects, but must do a comprehensive analysis of both beneficial and adverse effects related to the full scope of the proposed action under consultation.

Response: Your comment has been noted.

11) Please note that where migrant flycatchers are known to use riparian habitat in the MRG there is the potential for indirect effects to the species by effects to habitat when birds are not present.

Response: We have reviewed the draft BA with this in mind and revised it where necessary.

12) Please note there is the potential for future occurrence of nesting flycatchers if their breeding range expands from current nesting areas. Given the goal of facilitating recovery of this species, future range expansion of the flycatcher within the MRG should be considered during this consultation in terms of effects to suitable flycatcher habitat and species recovery. Any effects of the action that prevent future expansion of the flycatcher within this recovery unit may preclude recovery and would be considered in the Service's analysis.

Response: We have reviewed the draft BA with this in mind and revised it where necessary.

13) Please note that effects of changes in sediment within the system will be considered with respect to silvery minnow and its critical habitat, in particular regarding water quality.

Response: Thank you for your comment.

14) Please include in the *Literature Cited* all available documents relevant to this consultation that the Corps would like the Service to consider.

Response: The Corps has included all relevant literature relative to their effects determination in the BA. We recognize that the Service is not limited to information provided in the BA when evaluating the effects of the proposed action.

15) Thank you for attaching the 2007 geomorphic study of the Rio Grande. Is there something more current within the past 4 years? Please also note that anything relevant to the BA analysis that the Corps would like the Service to consider should be pulled from that 2007 report and incorporated into the BA analysis where appropriate.

Response: The 2007 geomorphic study characterizes geomorphic processes that are current, ongoing, and relevant. As stated in Section 4.3.1, all information in the 2007 geomorphic study is incorporated by reference into the Corps' BA. Discussion has been added to Section 4.3 to address specific geomorphic changes subsequent to the 2007 document, referencing Makar (2010) and information in Appendix B of Reclamation's draft BA, dated Aug. 18, 2011.

16) Please include the Corps' expected timeframe of analysis. For example, if the Corps expects our analysis in the BO to cover a specific duration or to be open-ended, please let us know.

Response: Chapter 3 of the BA has been revised to include the following:

> *"The effect of longest duration evaluated in Chapter 6 of this BA is the maximum degradation (worst-case condition) of the downstream channel that would result from sediment retention at*

Corps dams and other locations, which may entail 30 or more years to be realized.

"Corps dams and reservoirs are designed to contain the probable maximum flood. Their operation for flood control is largely determined by the point at which damages result from downstream discharges, rather than being limited by the frequency or magnitude of inflow. As such, the present operating rules will continue until a change in downstream conditions warrants revision of the safe channel capacity. Corps flood-control operation is not limited by the availability of water. Given this, there is no reason to limit the timeframe of this consultation due to unpredictability of future flow conditions.

"The standard conditions contained in 50 CFR §402.16 are sufficient to address all contingencies for future reinitiation."

SPECIFIC COMMENTS

17) 1.1 Scope of the Biological Assessment Page 1
Page 1 of the draft BA states that *"The BA evaluates the effects of the Corps' continuing, discretionary reservoir operation actions..."* The Service recommends the Corps include an evaluation of the effects of any interrelated or interdependent actions as required by 50 CFR 402.02.

Response: As explained in Section 3.3 of the BA, the Corps has included interrelated or interdependent actions of others in the document. This has been reiterated on page 1 of the final BA

18) 1.1 Scope of the Biological Assessment Page 1
Page 1 of the draft BA states that *"Activities appropriate for inclusion as a proposed action are those that are* ***discretionarily*** *authorized, permitted, funded, or implemented by the Corps"* [emphasis added]. Per 50 CFR 402.02, an *Action* that undergoes section 7 consultation is defined as *"all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies in the United States or upon the high seas."* Accordingly, the full action for consultation should include activities with only partial Federal agency discretionary involvement. Additionally, 50 CFR 402.03 defines applicability of section 7 requirements *"to all actions in which there is discretionary Federal involvement or control!'* This language specifies the applicability of section 7 to discretionary involvement, not limiting consultation to agency discretion over every aspect of the action.

Response: The use of the term "discretionarily" here was a poor grammatical choice. This sentence was removed from the final BA.

19) 1.1 Scope of the Biological Assessment, Page 1
Page 1 of the draft BA cites the *American Rivers v. NOAA Fisheries and U.S. Bureau of Reclamation* 2006 litigation. We look forward to further discussions with the Corps on this case and Judge Redden's opinions.

Response: Thank you for your comment.

20) 1.2.9 Reconsultation on Programmatic Water Operations, 2003-2013, Page 5
Page 5 of the draft BA on lines 9-15 briefly describes Federal and non-Federal activities that have improved water operations and management since the 2003 BO. This is a very brief discussion, but this content is essential for the Service to evaluate effects of the action for this reinitiation and how conditions are different (including improvements that have been made) as compared to our analysis in 2003. It would be extremely beneficial for the Corps to provide additional explanation of these improvements and the

implications for any analysis of the effects of the action on listed species and critical habitat.

a. For example, the draft BA mentions *"levee and Low-Flow Conveyance Channel setback work in the San Acacia Reach."* What did this involve, and how did this improve water operations and management since 2003? What are the implications for ESA species and critical habitat?

Response: The levee and Low-Flow Conveyance Channel setback work were designed to reduce management of the floodway channel by moving the levee and channel away from the meandering river. The excavation of the realigned channel and construction of the new spoilbank levee moved these structures away from endangered species critical habitat at two sites (River-mile 111 and 113/114). The implications for endangered species include reduced in-channel construction for protecting the levee, and allowing the river to create pointbar habitat. (Refer to Consultation #22420-2008-I-0067.)

b. Also, the draft BA mentions *"various efforts to improve channel morphology."* What were these efforts, how did they improve channel morphology, and how did this improve water operations and management since 2003? What are the implications for ESA species and critical habitat?

c. Also, the draft BA mentions "*over 1,100 acres of habitat restoration*" have been completed. Where has this been done, what evidence of improvements to species habitat exists, and how long do such improvements persist?

Response to Comments 20 b & c: The Service has been involved in all habitat improvement activities and projects since 2003 through specific ESA consultations or through their technical involvement in the Middle Rio Grande Endangered Species Collaborative Program. Additionally, the Service annually receives habitat restoration monitoring reports from several agencies documenting the presence of silvery minnows onsite during spring inundation, or the presence / absence of flycatchers during the breeding season. We are confident that the Service possesses sufficient information on these activities to determine the baseline and cumulative effects on these species and their habitats, and to provide the environmental baseline data upon which the current consultation is based.

The functional duration of restoration projects varies widely depending on their objectives and targeted resources. For instance, riparian plantings intended to improve conditions for the flycatcher may take several years of growth before becoming functionally beneficial. On the other hand, alteration of river-channel morphology often produces results as soon as it is sufficiently inundated. For example, the Los Lunas Restoration Project, constructed by the Bureau of Reclamation and the Corps, has functioned at appropriate spring flow (greater than 2000 cfs) for nine years since its construction. The retrospective study completed by the Corps indicates the site continues to function as anticipated.

d. Also, the draft BA includes as an improvement in water operations "a reduction in the volume of MRGCD river diversions". At which diversions has this been done, what is the magnitude and timing of the reductions, how has it benefitted the species, and does it equate to a reduction in overall water use by the MRGCD?

Response: Section 5.4.2.8 of Reclamation's draft BA (dated Aug. 18, 2001) describes these efforts: "Early in the decade, an extensive effort was undertaken by the District, the ISC and New Mexico Water Trust Board, and Reclamation, to significantly cut District irrigation diversions. 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. ... Total District diversions during the 1990s were on the order of 600,000 acre-feet, but after 2001, typical total District diversions ranged from 300,000 to 350,000 acre feet.*

21) <u>2.2 Platoro Dam. Page 8</u>
Page 8 of the draft BA describes Platoro Dam on the Conejos River in southern Colorado. This is outside the Corps' defined project area and is not included in the Proposed Action section of the draft BA. The Corps states on page 8 that flood control of Platoro Dam *"does not affect listed species or the flow regime of the Rio Grande"* and *"will not be included in the proposed action for this ESA consultation."* However, inclusion of this information in the draft BA seems to imply it is relevant for some aspect of this consultation. It would be helpful if the Corps could explain why this information on page 8 is included in the draft BA, and what from this information is relevant for the Service to consider during consultation.

Response: As you have stated, Platoro Dam is outside of the action area for this consultation. This facility also was not in the action areas of reservoir operation consultations in 2001 and 2003; however, both pertinent BAs described the facility because it was on a tributary of the Rio Grande. To avoid confusion or misunderstanding, we have deleted the references to Platoro Dam from the final BA for the current consultation.

22) <u>2.3.1 Flood Regulation. Page 9</u>
On page 9 the draft BA states that *"Flows are regulated so as not to exceed 3,000 cfs at the Chamita gage or 10,000 cfs at the Otowi gage."* Please explain who is involved with regulating these flows.

Response: The text was amended to read: "Due to reach-specific safe channel capacity constraints, releases from Abiquiu Reservoir are restricted to 1,800 cfs directly below the dam; 3,000 cfs at the Chamita gage for the Rio Chama downstream from the dam; and, 10,000 cfs at the Otowi gage for the Rio Grande main stem. At the Chamita and Otowi locations, the Rio Chama and Rio Grande channels carry flow from sources other than Abiquiu Dam. The Corps limits releases from Abiquiu Dam such that those releases, in combination with current instream flows, do not exceed any of the three safe channel capacity limits."

23) <u>2.3.2 San Juan-Chama Water Storage. Page 10</u>
Page 10 of the draft BA describes releases of San Juan-Chama (SJ-C) water from Abiquiu Reservoir. This section states both that these releases are made by the Corps but that there is no discretion by the Corps, and that the Corps *"does ensure that such flows are passed in a manner that does not threaten the safety or structural integrity of flood-control facilities"* which implies there may be some discretion in the manner of passing flows. This is again stated on page 16 (lines 41-42) and page 17 (line 1). Please explain.

Response: Text was added to Section 2.6.4 (Other Operational Considerations) to read: "The Corps does ensure that <u>all</u> releases are passed in a manner that does not threaten the safety or structural integrity of flood-control facilities. For example, release discharges will not exceed channel capacity nor will release of this water be at a rate that will cause the flow in the river to spike up for a very short period of time. The change in release rate varies with the magnitude of flow. The frequency of changes to the outflow rate will be limited to one per hour. Generally, the increase and decrease in stage at the downstream gage should be held to a range of 0.25 to 0.50 feet per change. The limitation on the increase is based on public safety concerns, and limited decrease in stage is based on preventing downstream bank sloughing. To minimize bank instability within the reservoir and ensure structural integrity, the drawdown rate when evacuating storage should not exceed 3 to 5 feet per day. On occasion, conditions may dictate that these *general criteria be exceeded. The Corps reserves the right to take such measures as may be deemed necessary in the operation of the projects to preserve life, and to inspect, maintain, or repair the project. For example, concerns regarding structural integrity or functionality may cause the Corps to evacuate water stored for any purpose in order to perform repairs."*

24) <u>2.3.2 San Juan-Chama Water Storage, Page 10</u>
Because there has been an interest in this reinitiation leading to a more long-term BO, considering potential future actions for coverage is important. On Page 10 of the draft BA it describes the existing authority under P.L. 100-522, which authorizes the Corps to store Rio Grande system water at Abiquiu when space is no longer required for SJ-C water.

> a. Is this to be considered as part of the Corp's proposed action?
> b. If so, this would involve agreements. Please clarify with whom the Corps would hold agreements for this to occur.
>
> *Response: As stated several times in the BA, all water supply storage at Abiquiu Reservoir consists of SJ-C Project water; there are no agreements for storage of Rio Grande system water. The storage of Rio Grande system water in Abiquiu Reservoir is not a proposed action in this consultation.*
>
> c. Although no agreements for such storage are currently in place, if there is the possibility in the future that such an agreement could be entered into, please explain if this is to be included in the proposed action. If accounted for up front during this consultation, this may avoid triggering reinitiation when such agreements are in place.
>
> *Response: The possibility of receiving a request for the storage of Rio Grande system water in Abiquiu Reservoir is unknown: such a request from a New Mexico water-rights holder could be received at any time, or never. The proposed action does not include the unknown possibility of such a request. Federal agencies are not required to consult on unknown, future Federal actions, nor on the unforeseeable future actions of non-Federal entities.*

25) <u>2.4 Cochiti Dam and Lake. Page 11</u>
Page 11 of the draft BA describes two irrigation canals (Sile and Cochiti Main) that originate from the outlet of Cochiti Dam. Is operation of these irrigation canals affected by output from Cochiti, and if so please explain how.

Response: The physical capacities of all irrigation headings and diversion dams in the MRG are limited to a maximum of a few hundred cfs, or less, including the headworks of the Sile and Cochiti Main canals. The Corps does not begin flood regulation at Cochiti Dam until inflow reaches approximately 5,500 cfs, which is more than 10 times the capacity of these structures. The operation of Corps dams in the MRG does not limit, or otherwise affect, the diversion of water by other entities into the Sile and Cochiti Main canals, nor at any other permitted diversion structure in the action area.

At all four Corps dams in the MRG, the Corps must pass all inflow until it threatens to exceed the safe channel capacity downstream. Corps dams must pass native Rio Grande flow unimpeded below that threshold. There are, and will continue to be, times when the operation of diversion structures in the MRG by other entities is "affected" by the low discharge of Rio Grande system water, regardless if that water flows through Cochiti Dam or any Corps facility. However, as the Corps only has authority to regulate flood flows, it plays no role in deciding when and how much water to allocate to irrigation ditches during such low flow periods.

26) 2.5 Galisteo Dam. Page 12
Page 12 of the draft BA mentions a "fuse plug" installed in the spillway at Galisteo Dam. Please explain what a fuse plug is.

Response: A footnote was added to read: "A fuse plug's primary function is to restrict spillway outflow until flooding conditions make greater spillway capacity necessary. The Galisteo Dam spillway fuse plug consists of an erodible earthen embankment that extends approximately halfway across the emergency spillway cross-section. During a flood event, as stage and flow through the spillway increase, the fuse plug is designed to erode away, thereby increasing the capacity through the spillway."

27) 2.6.2 Maintenance Operation, Page 14
The draft BA describes operations at the 70-ft by 80-ft stilling basin downstream from Jemez Canyon Dam. The draft BA states that it *"must be flushed to prevent high flows from overtopping the sediment basin walls."* The term 'sediment basin' is used on page 14, line 5 and again on page 22, line 21. Please clarify if that term refers to the same thing as 'stilling basin' or if there is a separate sediment basin.

Response: There is only one basin. The text has been edited to refer to it only with the term "stilling basin."

28) 2.6.2 Maintenance Operation, Page 14
How often and at what time(s) of year is the flushing of the Jemez stilling basin conducted and what are the effects to listed species and designated critical habitat?

Response: The following text has been added to the action's description in Chapter 3: "The flushing operation will be performed when required. In the past, this operation has been required once or twice per year. Detention and flushing would occur only when there is sufficient inflow in excess of downstream demand at the time. Typically, this operation is performed at the beginning or end of the spring runoff peak on the Jemez River, or immediately following sufficiently large summer thunderstorm events. "

As was described in Section 6.1.9, this operation may affect, but would not likely adversely affect, the silvery minnow. It would have no effect on silvery minnow critical habitat.

29) 2.7.1 Flood Regulation. Page 15
On page 15, it is stated that the Corps may limit flood releases to protect downstream private features such as the San Marcial railroad bridge. Does the Corps also have the discretion to limit flood releases to protect the San Pascuale Indian ruins (page 19) and should that also be included on page 15?

Response: The San Pascual archeological site has been an area of concern in previous years. During high-flow runoff years, we have routinely coordinated with Bosque del Apache personnel to verify the status of the site. To date, we have not altered our flood regulation due to potential damage to this site, even during the relatively large and long runoff season of 2005. However, when considering long-term operations and the possibility of a sediment plugs forming, this is an area that will be closely monitored. Pursuant to the National Historic Preservation Act, Federal agencies have an obligation to preserve sites on the National Register of Historic Properties. The Corps does have discretion to limit flood releases to minimize damages to this structure.

30) 3.2.1 Discretionary Flood-control Operation, Page 18
The draft BA on page 18 states that *"The existing, primary channel capacity at Albuquerque of 7,000 cfs is part of the environmental baseline, not a newly proposed action."* While it is true that the past effects of this channel capacity (as addressed in the 2003 BO proposed action) will be part of the baseline for this reinitiation and new BO, it is important to remember that there are ongoing effects of this

constricted channel capacity on ESA listed species. This channel capacity was included in the effects analysis of the 2003 BO, and in order for coverage of those effects to continue into the future, it would also be included in any reinitiation of that 2003 BO. Therefore, the effects analysis of any new BO issued to replace the 2003 BO would include the effects of this channel capacity.

Response: Thank you for your comment.

31) 3.2.1 Discretionary Flood-control Operation, Spring Runoff, Page 19
On page 19, the draft BA discusses the San Marcial railroad bridge. Currently, there is an RPA element (U) addressing relocation of this bridge. The Service is aware of informal discussions regarding the Corps' authority to address the bridge relocation. We would appreciate any updated information pertaining to the Corps' authority and any changes related to the railroad bridge project.

Response: A summary of the history and current status of the San Marcial railroad bridge relative for reservoir operation has been included in the final BA in Section 1.2, History of Consultation.

32) 3.2.2 Delivery of "Carryover" Flood Water, Page 21
Page 21 describes that release of carryover water from Abiquiu and Cochiti Dams to Elephant Butte Reservoir will occur at a constant low-flow rate from November 1 through March 31 (for ~150 days), and that the duration of releases will be dependent on the actual volume to be evacuated. This information appears to indicate two separate and different options. Please clarify:

a. if a specific release rate will be selected that will be the same every year, what that rate is, and the range of expected days duration for that release (depending on volume each year), or

b. if the release will occur over the entire ~150-day timeframe each year at a rate of release selected based on volume to be released, and what the range of expected release rates will be.

Response: The following clarification was added to Section 3.2.2 (Proposed Action) of the final BA: "Based on this previous consultation and subsequent input from the Service, the Corps proposes to deliver future carryover water from Abiquiu Dam and/or Cochiti Dam to Elephant Butte Reservoir at a constant rate above the base flow of Rio Grande basin discharge during the period from November 1 through March 31 (152-153 days). The rate and duration of carryover releases will depend on the actual volume to be evacuated. Based on historical records, in most years Corps reservoirs would be able to safely pass spring runoff inflow without the need for carryover storage (see Table 2.2). In other years, carryover storage may range from as little as 1,700 ac-ft (as in 1984) to as much as 215,000 ac-ft (as in 1987). Therefore, the future rate of release of carryover storage could be as low as 50 cfs for 34 days (or less), or as high as 725 cfs (or more) for 150 days, depending on the detained volume. Per the requirement of P.L. 86-645, when carryover storage in Corps reservoirs may affect the benefits accruing to states under the Rio Grande Compact, releases from the reservoirs shall be regulated to the maximum safe flow, whenever such operation is requested by the Rio Grande Compact Commissioner for New Mexico or the Commissioner for Colorado, or both."

33) 3.2.5 Maintenance Actions, Page 21
The draft BA states that the proposed action includes *"maintenance operations at Corps-managed reservoirs in the middle Rio Grande valley."* Other than the fish screen replacement, Jemez stilling basin flushing, and Abiquiu tunnel inspection, what other maintenance of Corps facilities will be conducted? If anticipated to occur, please include those activities in the BA as well, along with a schedule of what maintenance will occur over what timeframes.

Responses: There are no additional maintenance activities that would alter streamflow conditions or *otherwise affect listed species.*

34) 3.2.5 Maintenance Actions, Cochiti Dam Fish Screen Placement, Page 22
Page 22 of the draft BA discusses replacement of fish screens at Cochiti Dam with bulkheads during the non-irrigation season. The document states that these operations *"routinely require reduction in flows to approximately 100 cfs for three to four hours to permit access..."*

a. Please explain how often this flow reduction to 100 cfs would occur each year (e.g., how many times during November placement of bulkheads, and how many times during February replacement offish screens).

Response: The text in the Proposed Action chapter of the final BA has been clarified to state:

> *"To exclude fish from passing from the Cochiti Dam stilling basin into adjacent irrigation canals, fish screens will be installed (and solid bulkheads removed) in February of each year, prior to the start of the irrigation season. In November of each year, the fish screens will be replaced by solid bulkhead gates to minimize leakage into the irrigation outlets during the winter. These operations routinely require reduction in flows downstream of Cochiti Dam to approximately 100 cfs for three to four hours to permit access by maintenance workers to the screen guides and bulkhead fasteners. Unusually high amounts of debris or sediment may require temporary removal of the fish screens for cleaning at any time during February through October, using the same protocol."*

b. Please explain where the reduction in flows is occurring - i.e., is this instream flow below Cochiti or is this referring to flows elsewhere such as through certain equipment or portion of the dam?

Response: The text and a figure in Chapter 6 of the draft and final BAs describes that the reduction in flow occurs in the Rio Grande channel immediately downstream from Cochiti Dam, and decreases in magnitude downstream to, approximately, the Isleta Diversion Dam.

35) 4.1 Recent and Contemporary Federal Actions, Page 24
Page 24 of the draft BA begins a discussion of recent and contemporary federal actions. Please note that the Service in our environmental baseline analysis does not just consider recent actions and will include more past activities than listed in this draft BA. Additional consultations for actions that would also be found in this section include, but may not be limited to, the following:

a. 2001 MRG Water Operations (Corps and BOR)
b. 2003 MRG Water Operations (Corps and BOR), including implemented activities under the RPA since 2003
c. 2011 Bosque Restoration (Corps)
d. 2005 Isleta Islands Removal project (Corps)
e. 1999, 2008 Pueblo of Santa Ana projects
f. 2003 Albuquerque Bernalillo County Water Utility Authority drinking water project
g. 2009 Phase Ha ISC Habitat Restoration project in the Albuquerque Reach
h. 2006 Bernalillo Priority Site project
i. 2008 MERES Restoration project
j. 2009 Pueblo of Sandia Habitat Restoration
k. 2010 Pueblo of Sandia Habitat Restoration
1. 2009 Isleta Reach Phase I Habitat Restoration

m. 2010 Isleta Reach Phase II Habitat Restoration
n. 2007 Drain Unit 7 Project (in addition to 2008 Drain Unit 7 Project as listed in draft BA)
o. 2008 San Acacia Diversion Dam Coring Project
p. 2005 Tiffany Sediment Plug Removal
q. Bosque del Apache Sediment Plug (multiple years)

Response: Thank you for your comment. In the final BA, we have relocated our list of recent and contemporary actions to Appendix B.

36) 4.3 Geomorphology, Page 32
Page 32 of the draft BA includes a section on *Geomorphology* summarizing current conditions and recent changes. Similar to our comment above, please note that the Service in our environmental baseline analysis does not just consider recent changes for the environmental baseline.

Response: The intent of this section of the BA is to provide updated, pertinent information regarding geomorphology since the 2003 BO.

37) 4.3.2 Lower Reach of the Rio Chama, Page 36
On page 36 of the draft BA it states that *"on a reach wide basis, these diversions* [dams located along the Rio Chama] *may help to stabilize the overall degradational or aggradational trends."*

a. Please cite the source for this statement.

Response: The source for this statement has been added to the text: U.S. Army Corps of Engineers (USACE). 1996b. Reconnaissance Report: Rio Chama, Abiquiu to Española, New Mexico, Albuquerque District, July 1996.

b. This also implies that, conversely, those dams may *not* help stabilize these trends. Please clarify what is meant by this statement (lines 23-25).

c. Please explain what is meant by a reach-wide basis - i.e., what particular reach and extent of the Rio Chama or Rio Grande would be stabilized.

Response to comments b & c: "Reach wide basis" is referring to the lower reach of the Rio Chama, that is, the Rio Chama from Abiquiu Dam to its confluence with the Rio Grande. Besides some local areas of aggradation or degradation (as noted in the text) the entire reach has been relatively stable in the vertical direction. Some of this stability may or may not be attributed to these diversion dams, which act as grade control structures. There is no evidence to suggest that these diversion structures contribute to reachwide instability.

38) 4.4 Hydrology. Page 37
Page 37 and elsewhere in the draft BA refer to periods of drought in the Rio Grande in the past. Please explain how 'drought' was defined (i.e., what criteria were used to classify a particular year as exhibiting drought conditions).

Response: A footnote was added to read: "Drought was defined as: "A period of below average water content in streams, reservoirs, Groundwater aquifers, lakes and soils." (Yevjevich Vujica, Hall, W.A., and Salas, J.D, eds., 1977, Drought research needs, in Proceedings of the Conference on Drought Research Needs, December 12-15, 1977: Colorado State University, Fort Collins, Colorado, 276 p.). Average *annual runoff volume for the period from 1919 to 2010 is approximately 1,000,000 acre-ft. During periods of drought, the average annual runoff volume is below this. While there may be isolated years within the drought period when the runoff volume exceeds this average, when combined with the previous years' volumes, the short period average volume remains below the 1,000,000 acre-ft entire period average volume."*

39) 4.4 Hydrology. Page 37
Figure 4.2 on page 37 shows droughts as occurring over a bar extending from 1943 to 1971. Please clarify if every one of these years was considered to exhibit drought conditions (see also question above on definition of drought used in the draft BA).

Response: See our response to comment 38.

40) 4.4.1 Rio Grande Basin Water Operations. Page 39
Page 39 of the draft BA states that only imported San Juan-Chama water is stored in Cochiti and Abiquiu reservoirs. Is this true for carryover waters that are stored by the Corps?

Response: The text was amended to read: "Except for temporarily detained flows due to flood regulation, all of the water stored in Heron, Abiquiu, and Cochiti reservoirs is imported SJ-C Project water."

41) 4.4.1 Rio Grande Basin Water Operations, Page 39
Page 39 of the draft BA states that the San Juan-Chama Project has *"increased the flow volume above historical conditions in the Rio Grande system."* The draft BA does not include information with the comparison of historical flow volume to current conditions during SJ-C input, which would help substantiate this statement. Please cite the source for this statement or provide that substantiating information.

Response: A figure illustrating SJ-C volumes was added, as well as text reading: "The SJ-C Project, which imports flows into the basin, began operating in late 1971, thereby increasing flow in the system downstream from Heron Reservoir as shown on the graph below.

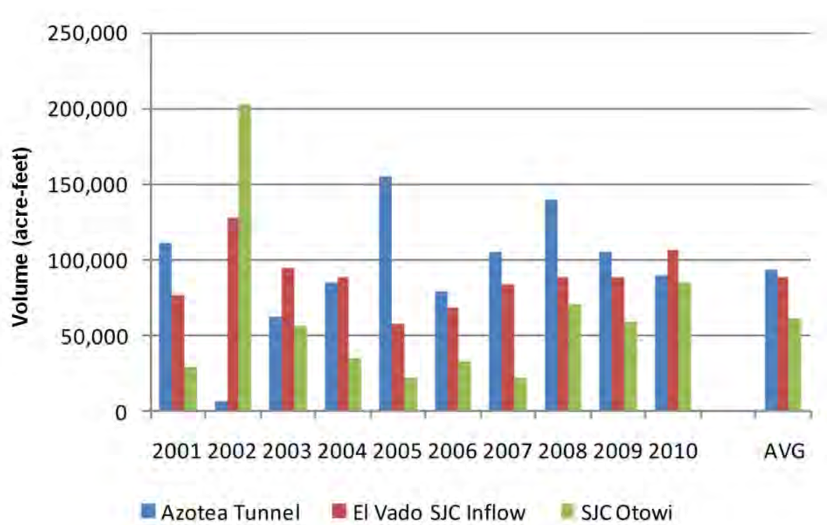

Figure 4.3. Summary of annual San Juan-Chama Diversions at Azotea Tunnel, releases from Heron Dam to El Vado Reservoir, and annual amounts of San Juan-Chama water crossing the Otowi gage for consumption within the Rio Grande or delivered to Elephant

Butte Reservoir. (Graphic courtesy of Bureau of Reclamation [2011b].)

The annual average for the ten year period shown in the graph, above, is approximately 61,500 acre-feet of San Juan-Chama water past the Otowi gage in response to downstream demands by contractors and Reclamation's Supplemental Water Program releases. The remainder of SJ-C water is stored in El Vado and Abiquiu Reservoirs. Since 2000 the range in flow of SJ-C water at the Otowi gage has ranged from a low of 2% in 2005 to a high of 60 % in 2002. In 2002 the annual flow at the Otowi gage was 337,069 acre-feet of which 202,800 acre-feet was San Juan-Chama water."

42) <u>4.4.2 Middle Rio Grande Discharge Characteristics, Page 39</u>
Page 39 of the draft BA states that *"the general character and shape of the annual hydrograph has remained similar"* It would be helpful to clarify what is meant by this statement. For example:

a. Please explain what is being compared and is "similar." I.e., is the hydrograph similar to historical hydrograph conditions, or just during the period of time the river has been a regulated system?

b. Figure 4.2 on page 37 shows what appears to be both decreasing magnitude and frequency of floods in the Middle Rio Grande since 1870, and in particular since 1940. This would be a potentially significant change in the hydrograph and counter to the statement above from page 39.

Response: Clarifying text was added to read: "While the Middle Rio Grande has become a regulated river system, the general character and shape of the annual hydrographs above and below Cochiti have remained similar from 1975-2010, as shown in the graph below. Figure 4.4 displays the maximum, median, and minimum monthly discharge (cfs) of the Rio Grande at three locations on the mainstem based on U.S. Geological Survey data from 1975 to 2010."

43) <u>4.4.2 Middle Rio Grande Discharge Characteristics, Page 40</u>
In Section 4.4.2 of the draft BA, which describes *Middle Rio Grande Discharge Characteristics,* Figure 4.4 on page 40 depicts mean monthly discharge at Otowi and Cochiti Dam outlet averaged across the years 1975-2008. The BA states that maximum and minimum discharges are not reflected on this figure.

a. Given the range in flows in this system, significant interannual variability, and the importance of peak and low flows to the status of ESA-listed species in the MRG, it would be beneficial to also show the range (minimum, maximum) of monthly discharges in this plot if possible, or refer the reader to where that is included elsewhere in the BA.

b. It would be helpful to include more current information as well, including years 2009 and 2010 data in this plot.

Response: Data through 2010 was added to the plot to include the maximum and minimum monthly discharges.

44) <u>4.4.2 Middle Rio Grande Discharge Characteristics, Page 41</u>
Figures 4.5 and 4.6 on page 41 include data up to 2008 and 2007, respectively. More current information should be included as well, including data from years 2008-2010 and then 2011 when available.

Response: A new figure (4.5) was created showing discharge characteristics including the years 2008-2010.

45) <u>4.4.3 Changes to Magnitude and Duration of Peak Flows, Page 42</u>
On page 42 of the draft BA it refers on line 18 to the *"early 1903s"*. We assume this is intended to read the "1930s." Please confirm if this is correct.

Response: This typographic error was changed to read "1930s."

46) <u>4.4.3 Changes to Magnitude and Duration of Peak Flows, Page 42</u>
On page 42 of the draft BA it is stated that carryover storage is not a common occurrence. Please provide more detail about the frequency and magnitude of carryover storage.

Response: Carryover storage information was added to Table 2.2. The text referred to in Chapter 4 was revised to read: "From 1963 through 2011, carryover storage has occurred at Abiquiu Reservoir 15 times and 3 times at Cochiti Lake (Table 2.2). The last year that carryover storage occurred was in 1995 at Abiquiu Reservoir. Channel conditions and release rates from downstream reservoirs can influence carryover storage."

47) <u>4.4.4 Low Flow Conditions and Historic River Drying (1956-2000), Page 44</u>
Page 44 of the draft BA states that *"River drying prior to implementation of current (2003 and later) water management practices was significant.""*

> a. Please explain what was significant about this river drying - i.e., extent, duration, frequency of events, impact (on species, on habitat, on something else), etc.
>
> b. Is this a statistical significance?

Response: The text and table describe the historic occurrence and frequency of river drying. The sentence referring to its significance was removed from the final BA. It was not intended to imply statistical significance

48) <u>4.4.5 Recent History of River Drying (1996-2008), Page 45</u>
The draft BA on page 45 divides historic and recent river drying into the years 1956-2000 and 1996-2008, respectively.

> a. These date ranges overlap, such that 2000 is considered "historic" and 1996 is considered "recent". It would be helpful to clarify what is meant by these date ranges and reconcile this overlap.
>
> *Response: The section titles were revised and clarifying text was added to read: "The previous section used river gage data to determine the number of days of river drying. In this section, the number of miles and days of river drying are based on recorded observations. From 1996 to 2010, the Service provided observations of river drying and intermittency incidental to Rio Grande silvery minnow monitoring, rescue, and salvage operations."*
>
> b. A discussion of recent drying should include the more recent years of information as well, e.g., 2009, 2010.
>
> *Response: This information has been updated through 2010.*

49) <u>4.4.5 Recent History of River Drying (1996-2008), Page 45</u>
Throughout Section 4.4.5 on page 45, the data used in the draft BA stops in 2008. This should include

more recent information as well - i.e., 2009 and 2010 (and 2011 when available).

Response: Information was added to include 2009 and 2010.

50) 4.4.6 Hydrologic Conditions Since the 2003 BiOp, Page 46
Page 46 of the draft BA shows annual flow on the Rio Grande at Del Norte, CO (Figure 4.7), as well as "reconstructed natural streamflows" at the Otowi gage.

a. Data throughout this section (4.4.6) are included only up to the years 2007 and 2008. More recent years (2008-2010 and 2011 when available) should also be included.

Response: Information was added to include 2009 and 2010.

b. Are flows at Del Norte, CO affected by upstream management and diversion in Colorado, or do they come from an isolated source free from water management or use?

Response: Rio Grande flows are managed and diverted in Colorado. To avoid confusion, flow data from the Otowi gage were used in the text in place of information from Del Norte.

c. Are Otowi flows considered natural (not affected by upstream management in the system) or how are natural streamflows "reconstructed"? Care should be exercised in articulating what conditions are 'natural' versus those affected by water management in the system, albeit occurring outside of the action area for this consultation.

Response: The term "natural" was used to denote Rio Grande system flow that was not being released from storage in El Vado nor from flood detention in Abiquiu Reservoir. We have edited the text to avoid the confusing usage of this term.

51) 4.4.7 Water Operations Since the 2003 BiOp, Page 47
Section 4.4.7 on page 47 and Section 4.4.8 on page 49 also use data only up until 2008. More recent years of information should also be included (2009, 2010; and 2011 when available).

Response: Data was added to include 2009 and 2010.

52) 4.4.8 River Drying since the 2003 BiOp, Page 50
Page 50 of the draft BA states that various management actions (see lines 10-12) *"resulted in average drying of only 25% over the six-year period."* Later it states that the San Acacia reach dried an average of 47% per year during the same timeframe. Please clarify what these percentages refer to - e.g., percent of each reach, percent of all reaches combined, percent of total area dried during those years, percent of drying events, etc.

Response: The text and tables have been revised to clarify this discussion.

53) 5.2.3 Life History and Ecology, Riparian Habitat Descriptions by Reach, Page 68 Information on page 68, lines 47-48, of the draft BA regarding the trend in the Isleta reach of current channel narrowing and degradation contradicts other sections of the draft BA describing a stable bed in the Isleta reach.

Response: Discussion of "channel narrowing and degradation" was referring to the Rio Puerco reach, not the Isleta reach. The reach descriptions have been separated into new paragraphs for clarity.

54) <u>6. Analysis of Effects of Proposed Actions, Page 81</u>
Page 81 of the draft BA provides the Corps' analysis of effects of the Proposed Action. Please note the consultation and the Service's biological opinion will also evaluate the effects of any interrelated or interdependent actions as well and conduct a comprehensive analysis of the entire action pursuant to our obligations under Section 7 of the ESA. As such, the Service may see the scope of this consultation as broader than what the Corps describes in the draft BA.

Response: Thank you for your comment.

55) <u>6.1 Rio Grande Silvery Minnow, Southwestern Willow Flycatcher, and Their Designated Critical Habitat, Page 81</u>
Page 81 of the draft BA states that "*flood control actions do not directly affect the Rio Grande silvery minnow or the southwestern willow flycatcher*." The Service may not agree with this conclusion, as any direct effects to habitat for such habitat-dependent species as the silvery minnow and the flycatcher may also represent direct effects to the species itself. Please note that indirect effects are defined as those that occur later in time, not those that occur via a pathway such as effects to habitat (which can be both direct and indirect effects).

Response: Flood-control actions do not directly result in adverse effects to the silvery minnow and the flycatcher. When there is sufficient volume of water for initiating flood-control operations, the regulated flows produce suitable habitat conditions for the silvery minnow and the flycatcher. Flood-control actions occur at flows sufficient to inundate adjacent terrestrial habitat which supports development of riparian vegetation for willow flycatchers, and may be used by silvery minnows as nursery habitat. This suitable habitat supports increased recruitment of silvery minnows. The total area of inundated habitat is sufficiently large during flood-control operations that there is no evidence of it limiting the Rio Grande silvery minnow or Southwestern Willow Flycatcher populations.

The cumulative effects on habitat degradation (i.e. channel incision) are indirect to flood-control water operations because they operate on a time scale over years from sediment control by the dams. The adverse effects of channel incision directly result from sediment control. The sediment control discussion has been revised to reflect the direct cause and effect actions on habitat quality.

When there is sufficient volume of water for initiating flood-control operations, the regulated flows produce suitable habitat conditions for the silvery minnow and the flycatcher. This suitable habitat supports increased recruitment of silvery minnows.

56) 6.1 Rio Grande Silvery Minnow, Southwestern Willow Flycatcher, and Their Designated Critical Habitat. Page 81 Regarding the effects conclusions in the draft BA, starting on page 81, the level of analysis currently does not allow the Service to fully consider the Corps' conclusions during consultation.

We would need to have information on the analysis that led to those conclusions, and therefore more detail than is currently provided in this section of the draft BA. For example:

a. for conclusions on effects to critical habitat it is beneficial to provide the analysis of critical habitat Primary Constituent Elements (PCEs) and how each one is affected by the proposed action - or not affected - and why

b. for effects on species, it is beneficial to provide the analysis of life history traits and species' needs along with an analysis of what effects may result, or not, and why. This should draw on the proposed action but also factor in the species information to derive the expected responses.

Response: The text of the final BA has been revised accordingly.

57) 6.1.1 Discretionary Flood Control Operation During Spring Runoff, Page 81
In Section 6.1.1 beginning on page 81, there is insufficient detail regarding the acres of inundated habitat or acres that are not inundated. Detail regarding where these acres are distributed and the duration of inundation should be included. This type of detail would facilitate effects analysis on the PCEs of species critical habitat and on the species.

Response: The text has been revised to provide additional detail.

58) 6.1.1 Discretionary Flood Control Operation During Spring Runoff, Page 82
Page 82 states that the mid-1980s to mid-1990s were "*a period of unprecedented storage levels in the reservoir*", referring to Elephant Butte Reservoir. However, Figure 6.1 appears to show a similar peak at Elephant Butte occurring in the 1940s. Please clarify.

Response: The text was changed to read: "…a period of unprecedented storage in the reservoir…" Although a single year (1942) attained a high storage volume, the mid-1980s to mid-1990 are still an unprecedented period for storage volume.

59) 6.1.1 Discretionary Flood Control Operation During Spring Runoff, Rio Grande Silvery Minnow, Page 85
On page 85, the sentence "*Flood control operations will reduce inundated floodplain habitat area and increase the duration of beneficial floodplain inundation*" should be explained and the effects on the species and their designated critical habitats described.

Response: The text of the final BA was revised to provide additional explanation and clarity.

60) 6.1.1 Discretionary Flood Control Operation During Spring Runoff, Rio Grande Silvery Minnow, Page 85
On page 85, it is not clear to us how the effects determination on lines 19-23 were arrived at based on the analyses presented.

Response: The discussion has been expanded with respect to affects on PCEs. Cochiti Lake flood-control operations have small effects on the silvery minnow critical habitat PCEs. The hydrologic regime (element (i)) upstream of Cochiti Lake determines water operations. Flood-control operations produce hydrographs that form a diversity of aquatic habitats within the floodway between the levees. Flood-control operations may affect, not likely to adversely affect the variety of instream refuge habitats (element (ii)) or the substrate (element (iii)). Cochiti Lake flood-control operations lower water temperatures within the prescribed 1-30°C range (element (iv)), but do not decrease dissolved oxygen or increase pH of river water (element (v)).

61) 6.1.1 Discretionary Flood Control Operation During Spring Runoff, Southwestern Willow Flycatcher, Page 85
For effects on the flycatcher beginning on page 85, in addition to effects on vegetation, it is also important to consider any effects on prey as a result of changes to inundation patterns or any other aspect of the proposed action.

Response: The text of the final BA has been revised accordingly.

62) 6.1.3 Effect of Sediment Control. Pages 87 and 88

Figure 6.3 on page 88 and its discussion on page 87 point to a significant loss of wetted surface area, especially at 2,000 cfs. It appears this action was not fully analyzed in the draft BA.

Response: The analysis used to estimate future incision and the subsequent reduction in wetted surface area was based on the best information available at the time. Also, this estimate is based on the maximum expected incision, and therefore reflects a "worst case" scenario.

63) 6.1.3 Effects of Sediment Control, Rio Grande Silvery Minnow, Page 89
The effects determinations for silvery minnow and its critical habitat on page 89 would benefit from an explanation in the BA, including how adverse effects to minnow habitat will not result in adverse effects to the species. On page 52, the Corps has already noted the connection between spring flows, overbanking, and October recruitment of silvery minnow.

Response: This section was revised to address PCEs and provide additional explanation: "The effects of Cochiti Lake sediment control on silvery minnow critical habitat PCEs are gradual channel incision over time (indirect effect on critical habitat). Sediment control and channel incision do not affect the hydrologic regime (element (i)), water temperature (element (iv)) or water conditions (element (v)).

"Channel incision reduces the variety of instream refuge habitats (element (ii)) with increasing depth and water velocity. The increasing depth and water velocity may reduce diatom production and have limiting effects on the silvery minnow food supply and population. Decreased sediment load and channel incision changes the substrate (element (iii)) from sand or silt to gravel or cobble. The future impacts of sediment control to critical habitat are relatively small compared to the current baseline condition. The formation of islands and pointbars are compensating for decreasing surface water inundation, demonstrated by silvery minnow population monitoring. Since 1992, the decrease in wetted channel surface area from incision has produced minimal changes in water surface elevations for inundation of silvery minnow nursery habitat (including islands and pointbars). "

64) 6.1.3 Effects of Sediment Control, Rio Grande Silvery Minnow, Page 89
Page 89 discusses channel capacity downstream of Abiquiu and that there would be "No Effect." Does operation of Abiquiu affect sediment in the system and, if so, how? How far downstream do effects to sediment because of Abiquiu extend? Do these effects stop at Cochiti Dam or, if not, where?

Response: The effects of sediment control by Abiquiu Dam may extend down to Cochiti Lake. Cochiti Dam controls sediment downstream from the outlet structure to Isleta Diversion Dam. The inflow of sediment from various arroyos between Cochiti Dam and Isleta Diversion Dam reduces the impact of sediment control moving downstream. Tijeras Arroyo is a major sediment source marking the endpoint for the effects of sediment control on channel morphology in the Angostura Reach.

65) 6.1.3 Effects of Sediment Control, Southwestern Willow Flycatcher, Page 89
Page 89 of the draft BA states that *"Even at the maximum regulated discharge of 7,000 cfs at the Albuquerque gage, river flow does not inundate riparian areas outside of the well-defined channel."* The Service is aware of numerous acres of habitat restoration intended to be successful at this flow level or lower. Please explain.

> a. Please clarify if this was intended to mean there are still *some* areas that would not inundate at that flow level. If that is the case, and for any conclusions on effects to the flycatcher, it would be helpful to have an analysis of how much habitat in riparian areas would not inundate (between levees) at 7,000 cfs, and then what portion of that area includes flycatcher habitat or suitable habitat.

Response: Very little of the overbank area in the Angostura reach is would be inundated at 7,000 cfs. A visual representation of the inundated may be the best method to clearly capture this; unfortunately, FLO2_D output cannot easily be represented graphically, In lieu of this, we have included—on a disc delivered to the Service along with the final BA—the GIS layer of the mapped extent of inundation in the Middle Rio Grande in 2005. The peak discharge for this event at Albuquerque was 6,510 cfs (mean daily).

66) <u>6.1.3 Effects of Sediment Control, Southwestern Willow Flycatcher, Page 89</u>
The analysis presented on page 89 lines 36-42 is unclear to us. It states that future channel incision will decrease the inundated area but that all substrates within the channel will be inundated at flows >5,000 cfs. This is not clear to the reader who is not familiar with the Corps' analysis for this section. What will and will not be inundated at 5,000 cfs, how is 'channel' defined, and how the connection is made to the conclusion on effects to flycatcher) should be provided.

Response: Text was added to read "Therefore, the areas with the highest potential to develop into suitable breeding habitat in the future are limited to river bars with developing riparian vegetation. Future channel incision will slightly decrease the inundated area within the channel in the future; however, groundwater will remain within the root zone of developing riparian vegetation on these river bars."

67) <u>6.1.5 Storage for San Juan-Chama Contractors at Abiquiu Reservoir, Page 91</u>
Page 91 concludes that because effects are only benign or beneficial that there is "no effect." Please note that if there are only beneficial effects of the action, these are still considered effects on the species. The appropriate determination where any effects are entirely beneficial is "may affect, not likely to adversely affect" (e.g., lines 14-18).

Response: The text was changed to read "may affect, but would not likely adversely affect" rather than "no effect" when only beneficial effects were determined.

68) <u>6.1.6 Deliver of Cochiti Recreation Pool Replacement Water, Southwestern Willow Flycatcher, Page 91</u>
Same as previous comment for lines 42-44.

Response: The text was changed to read "may affect, but would not likely adversely affect" rather than "no effect" when only beneficial effects were determined.

69) <u>6.1.7 Cochiti Dam Outlet Fish Screen Replacement, Page 91 and 92</u>
Section 6.1.7 of the draft BA on pages 91-92 discusses the reduction in flows from Cochiti during fish screen replacement with bulkheads (November) and reinstallment of screens (February). Line 11 states that "*the change in flow magnitude has a sufficiently short duration to resemble thunderstorm flow pulses from tributaries during the summer*." Flow pulses during thunderstorms represent <u>increases</u> to the existing flows; whereas, the screen replacement activity results in <u>decreases</u> to the existing flows. This should be factored in to the effects analysis of this action. Comparing short-term decreases in flows to short-term increases in flows does not appear appropriate. Please explain the analysis comparing these types of events and how it led to the conclusion provided.

Response: The changes in water surface elevations during fish screen installation and removal are rapidly attenuated downstream of Cochiti Dam at the San Felipe Gage, and within the normal variation at the Albuquerque Gage. Attenuation of the negative flow spike reduces the effects on the hydrograph downstream of Angostura Diversion Dam.

Rapid changes in flow / water surface elevations have similar potential for fish stranding (including silvery minnows) regardless of whether they are positive spikes (thunderstorms) or negative spikes (temporary flow suspensions). Fish screen replacement and thunderstorm events both produce rapid changes in water surface elevations that silvery minnows and other fish must respond to behaviorally. From a fish perspective, the likelihood of becoming stranded has a higher probability during a thunderstorm event when rapidly moving peak flows have the potential to leave fish on a terrace as the water recedes.

The principle difference is stranding during a negative spike (fish screen removal) is less likely to cause mortality because the flow will return to previous levels within a couple of hours. Stranding during a positive spike (thunderstorm event) may leave fish in pools that dry out prior to reconnecting with the river. Using a probabilistic approach, a naturally occurring thunderstorm event has a higher potential for mortality than replacing fish screens. Habitat restoration site monitoring reports have documented few fish (negative data) become stranded under rapidly changing flows following rainstorm events. The observations of these reports have not been compiled by the Collaborative Program or the Service.

Behaviorally, fish (including silvery minnows) have been selected through evolution to respond appropriately to rapidly changing riverine water surface elevations (positive and negative spikes). Fish behavior reducesthe probability of stranding during rapid changes in water surface elevations to undetectable levels under most flow conditions.

70) 6.1.9 Flushing Jemez Canyon Dam Stilling Basin, Page 95
Page 95 of the draft BA states that *"the occasional flushing of the stilling basin* [at Jemez Canyon Dam] *would result in a brief increase in flow below the dam, similar to natural thunderstorm runoff."*

a. Does this occur at the same time of year as thunderstorm runoff?

Response: Flushing occurs when the need and opportunity exist. The opportunity to flush sediment is based on the availability of water in the Jemez system in order to store a sufficient amount of water (to discharge approximately 600 cfs) in a short period of time (up to 4 or 5 days). Sediment flushing is not scheduled for certain times of year, such as late summer months. It should be noted, however, that thunderstorm runoff, while more frequent during the late summer monsoon months, can and does occur throughout the year.

b. What are the effects of sediment flushing downstream, how much sediment, and how far do those effects extend?

Response: Text was added to read: "Flushing the Jemez Canyon Dam stilling basin would provide fine sediments for substrate (element (iii)). Flushing does not affect the hydrologic regime (element (i)), instream habitat (element (ii)), water temperature (element (iv)) or water conditions (element (v)).

71) 6.1.9 Flushing Jemez Canyon Dam Stilling Basin, Page 95
Figure 6.6 shows unregulated discharge at Jemez Canyon Dam outlet from June through November 15 of the year 2010.

a. Is this typical for other years as well?

b. What is the discharge from November 16 to May?

Response: The figure was replaced with one showing the discharge for the entire year during 2001 through 2010.

72) 6.2 Pecos Sunflower, Page 96
Page 96 of the draft BA states for Pecos sunflower that *"the source of water for the seeps, springs, and ponds at La Joya does not depend on river water."*

a. Is there any water for sunflower habitats derived from the riverside drain (i.e., diversions from the MRG)?

b. Do changes in surface water in the MRG affect ground water levels, and therefore the availability of water for sunflower habitats? It would be helpful to provide some analysis to substantiate this content of the draft BA - such as the groundwater-surface water interaction (and if or how they are disconnected) in sunflower habitats.

Response: Rio Grande flow has only a negligible, if any, influence on groundwater conditions where Pecos sunflower is growing. The river channel is separated from the sunflower stand by the riverside drain (Unit 7 Drain Extension), the spoilbank levee, the BNSF Railroad berm, and the La Joya drain.

73) 6.3 Interior Least Tern, Page 97
Please provide the basis for the conclusion on page 97 regarding the interior least tern. The draft BA states that the Corps' action would not measurably affect the density or availability of the tern's prey species and, therefore, there would be no effect on the species.

a. The draft BA provides minimal information on the tern's prey or analysis of why those prey species would not be affected. It would be helpful to address this and any other important aspects of the tern's life history or species' needs and why or why not those would be affected.

b. What current survey or other information in the MRG is available with respect to the presence of the tern in the action area? Is there evidence of presence, stop-over habitat, nesting, etc? Conversely, what evidence exists that documents species in not regularly or otherwise present?

Response: Updated information has been included in the final BA.

APPENDIX G

ADDITIONAL INFORMATION PROVIDED TO USFWS, January 15, 2013.

DEPARTMENT OF THE ARMY
ALBUQUERQUE DISTRICT, CORPS OF ENGINEERS
4101 JEFFERSON PLAZA NE
ALBUQUERQUE, NM 87109-3435

REPLY TO
ATTENTION OF

January 15, 2013

Planning, Projects and Program Management Division
Planning Branch

SUBJECT: Response to Request for Information, Corps of Engineers Reservoir Operations

Mr. Wally Murphy
Field Supervisor, New Mexico Ecological Services Field Office
U.S. Fish and Wildlife Service
2105 Osuna NE
Albuquerque, NM 87113

Dear Mr. Murphy:

I am writing in response to the request for additional information regarding the U. S. Army Corps of Engineers' (Corps) Biological Assessment (BA) for reservoir operations on the Middle Rio Grande. The U.S. Fish and Wildlife Service (Service) requested this additional information in a letter dated August 1, 2012, over nine months after the Corps' submission of its BA on October 31, 2011. We documented the Service's delinquency in providing comments in correspondence dated March 16, 2012 and August 30, 2012. The statutory timeframes provided in 50 CFR §§402.12(j) and 402.14(c) had long expired before the Service provided its identified insufficiencies, which would ordinarily render the Corps' BA complete and valid as submitted. Nonetheless, to demonstrate good faith, the Corps is providing complete responses to the Service's request herein, and will revise our BA accordingly.

The Corps remains unchanged in its requirement that the Service issue an agency-specific Biological Opinion (BiOp) with reasonable and prudent alternatives and measures based solely on the effects of the Corps' actions. Our position is supported by statute, regulation and case law. A BiOp issued by the Service must be based on an action agency's description of its proposed actions. *Center for Biological Diversity v. U.S. Bureau of Land Management and the U. S. Fish and Wildlife Service; American Rivers v. NOAA Fisheries and U.S. Bureau of Reclamation*; 50 CFR §402.14; ESA Consultation Handbook, Chapter 4, §4.3.

When our BA is revised with the information presented herein, we will consider it to be complete and final. However, we will not resubmit our revised BA until such time as we have received confirmation from the Service that we will be provided with an agency-specific BiOp. Accordingly, the Corps' reinitiation of consultation is now premised on the Service's willingness to resolve this issue.

The Service's comments and the Corps' specific responses are as follows:

1. The Corps is required to conference on proposed flycatcher critical habitat.

Response: Because the Service re-designated flycatcher critical habitat on Jan. 3, 2013, this comment is no longer applicable. The Corps's revised BA will address effects to this newly designated critical habitat.

2. Page 1 of the biological assessment states: "The BA also addresses actions that are interrelated or interdependent (as defined in 50 CFR§402.02) with Corps actions." The Service's review of the Proposed Action section finds that the Corps did not include any interrelated or interdependent activities although the effect of the release of San Juan-Chama Project water from Abiquiu Reservoir (presumably a Corps action) was evaluated in the biological assessment. Please clarify what, if any, non-Corps activities are being included as interrelated or interdependent to a Corps action and being evaluated for effects on endangered species.

Response: This question is succinctly addressed in the last paragraph of Section 3.4.1: "Section 3.2[.3] of this chapter describes the Corps' discretionary storage of San Juan-Chama Project water at Abiquiu Reservoir for non-Federal contractors. The subsequent release of that water, at the discretion of the non-Federal contractors, is evaluated as an interrelated and interdependent effect in Chapter 6 of this BA."

Additionally, the Bureau of Reclamation has, in that agency's separate consultation, assessed the effects of the storage, release, and use of San Juan-Chama (SJ-C) water by the Albuquerque-Bernalillo Water Utility Authority for their Drinking Water Project (Consultation # 2-22-03-F-0146*). Likewise, the U.S. Forest Service, in that agency's separate consultation, assessed effects of the release of SJ-C water by the City and County of Santa Fe for their Buckman Water Diversion Project (Consultation # 22420-2006-F-0045). The Corps will add brief descriptions of these agency-specific consultations to Appendix B of its revised BA.*

As stated in Section 3.4, there are no other Federal or non-Federal actions that are dependent on the Corps' discretionary reservoir operation for their utility or justification.

3. Conservation measures have not been identified in the biological assessment. We now understand that the Corps plans to propose participating in the Recovery Implementation Program as a conservation measure in its proposed action. Please include it and ensure that all aspects of the proposed action are

evaluated for effects on the endangered species, including the beneficial effects caused by conservation measures.

Response: The Middle Rio Grande Endangered Species Collaborative Program (MRGESCP) is in the process of developing implementation plans for recovery activities. As stated in Section 7.2 of the BA, the Corps has committed to continue its participation in the MRGESCP (contingent on funding) to fulfill our obligations under the Endangered Species Act. All aspects of the Corps' proposed action have been evaluated.

4. The Corps' discretion to limit flood releases to minimize damages to the San Pascual archeological site does not seem to be identified within the Corps proposed action. Please clarify and update the proposed action so that all aspects of Corps discretion is *[sic]* understood.

Response: See the first paragraph on page 22 in Section 3.2.1, Discretionary Flood-control Operation, for a succinct discussion of operations in regard to the San Pascual archeological site.

The Corps has previously provided information on this subject to the Service in their comments on the Corps' Draft Biological Assessment (see Appendix F of our BA, comment 29 on page 161). For clarity, this information will be included in our revised BA:

> *"The San Pascual archeological site has been an area of concern in previous years. During high-flow runoff years, we have routinely coordinated with Bosque del Apache personnel to verify the status of the site. To date, we have not altered our flood regulation due to potential damage to this site, even during the relatively large and long runoff season of 2005. However, when considering long-term operations and the possibility of a sediment plugs forming, this is an area that will be closely monitored. Pursuant to the National Historic Preservation Act, Federal agencies have an obligation to preserve sites on the National Register of Historic Properties. The Corps does have discretion to limit flood releases to minimize damages to this structure."*

5. The Action Area described in Section 3.1 may not be consistent with the regulatory definition of action area (see *50 CFR§402.02). Action area* means all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action.

Response: The Action Area, is described in Section 3.1: "The action area of the Corps proposed actions entails the Rio Chama, including, and downstream from, Abiquiu Reservoir, and the

Rio Grande from the confluence with the Rio Chama downstream to the headwaters of Elephant Butte Reservoir". This is wholly consistent with the regulatory definition articulated in 50 CFR §402.2 and encompasses all areas that may be directly or indirectly affected by Corps reservoir operations. The Corps has previously responded to a similar Service comment on the Corps' Draft Biological Assessment in Appendix F, (2) on page 150.

6. Section 3.2.4 of the Proposed Action states that the Corps uses discretion regarding the timing for delivery of San Juan-Chama Project water to Cochiti Reservoir to offset evaporative losses. The timing of this movement of water seems clear but the Corps' role is unclear. Please clarify if the Corps is delivering the water or calling for the water and whether the Corps is delivering / requesting the water from Abiquiu, El Vado, and/or Heron. Also, please clarify what other actions related to the San Juan-Chama Project water are interrelated or interdependent with the Corps action.

Response: The revised BA will clarify that the Corps requests the Bureau of Reclamation to release this water from Heron Lake.

Interdependent or interrelated effects have been addressed in comment 2 above. The Corps is not consulting on Reclamation's San Juan-Chama Project, nor is the Corps required to evaluate the effects of that action. The Service's comment here appears to confuse the "one-way" relationship between a proposed action and interrelated and interdependent effects as described in ESA regulations and the Services' Consultation Handbook.

As the Corps has consistently indicated, the Service's confusion regarding this problematic situation will be readily avoided when the Service analyzes the impacts of the Corps' agency-specific actions as clearly defined in the Corps' BA. For that reason, the Corps is consulting independently of Reclamation and requiring an agency-specific BiOp in 2013.

The Corps previously has responded to a similar Service comment on our Draft Biological Assessment; see Appendix F, (3b) on page 151.

7. Section 3.2.4 of the Proposed Action states that up to 5,000 ac-ft of San Juan-Chama Project water is accrued to Cochiti each year. Please provide the range of actual evaporative loss replaced in the past and the range currently being proposed by the Corps into the future. Can the pool be managed for a lower target volume?

Response: The Corps' reference to "5,000 ac-ft" in this section was an error. The text will be revised to state: "Public

Law 88-293 (see Appendix A in this BA) provided for the initial filling of a 1,200-acre permanent pool at Cochiti Lake with water from the San Juan-Chama Project, as well as 'sufficient water annually to offset the evaporation from such area.' " The revised BA also will describe the evaporative loss in the past (see table below). The future water requirements are dependent on the weather and concomitant evaporation conditions in a given year, which cannot be influenced by the Corps.

Annual evaporation(ac-ft) from permanent pool at Cochiti Lake, 1982-2012.

Calendar year	Depletion (ac-ft)	Calendar year	Depletion (ac-ft)
1982	3,473	2000	4,048
1983	3,535	2001	4,343
1984	3,650	2002	5,165
1985	2,255	2003	4,858
1986	2,177	2004	3,848
1987	2,922	2005	3,901
1988	3,162	2006	3,901
1989	4,476	2007	4,265
1990	3,604	2008	4,462
1991	3,166	2009	4,288
1992	3,678	2010	4,803
1993	4,309	2011	4,329
1994	3,994	2012	4,381
1995	5,025		
1996	5,263	Average	3,991
1997	3,698	Median	3,994
1998	5,155	Minimum	2,177
1999	3,583	Maximum	5,263

8. Section 3.2.6 of the Proposed Action states "However, a changed condition at Cochiti Lake — the presence of a pair of Southwestern Willow Flycatchers — requires the Corps to reinitiate consultation for this activity." Since this discussion occurs specifically in the Proposed Action section that describes the "Temporary Deviation," the Service assumes it is part of the action being proposed by the Corps for consultation. Please clarify if the Corps already has ESA compliance for the remaining year of the deviation operation or

if the Corps is requesting to consult on that component of the Proposed Action.

Response: The Corps' quoted statement was intended to describe that ongoing reservoir operations (i.e., the proposed action of the BA) will address the potential presence of flycatchers at Cochiti Lake. ESA compliance requirements for the temporary deviation to alter the Corps' schedule for flood control operation to facilitate recruitment or overbanking flows were completed in 2009 (see USCAE 2009 in the Literature Cited section).That evaluation concluded that this action would not adversely affect the flycatcher, and would indirectly benefit the species and its designated critical habitat through increased inundation. No additional compliance is required to conduct this activity during the runoff season of 2013.

The Service's comment has caused the Corps to more clarify the status of the proper treatment relative to the ensuing consultation. As stated, considering that ESA compliance has been completed for the temporary deviation, and that this action will expire in July 2013, the Corps' revised BA will remove this activity from its proposed action and refer to it in Appendix B, Recent and Contemporary Federal Actions, as it is not relevant to this consultation.

9. Section 3.2.6 on the Temporary Deviation for Recruitment and Overbanking Flows states that a changed condition at Cochiti Lake — the presence of a pair of Southwestern Willow Flycatchers- requires the Corps to reinitiate consultation for this activity. It is our understanding from our conversation with Corps staff on July 25, 2012, that this statement was intended as a request for incidental take coverage for those flycatchers through this consultation to address this change in species presence as it relates to this proposed action. Please indicate if this is correct, or if there was additional meaning intended by this statement.

Response: As described in the previous comment, the Corps has previously completed ESA compliance requirements for the temporary deviation, and this action will undoubtedly expire before a final biological opinion is issued. In our BA, the Corps has requested incidental take coverage for ongoing reservoir operations, not the temporary deviation.

10. Section 3.2.7, "Coordination Among Management Entities" needs to describe all components of the action being proposed by the Corps for formal consultation. The chapter on Proposed Action is insufficient if it does not contain all activities proposed for consultation (citing other information is not sufficient).

Response: Coordination among management entities is completely described in the BA. Section 3.2.7 states that such coordination will be performed "as described in Section 2.6.5" of the BA.

11. The Service is comparing actions currently being proposed with actions currently addressed by the 2003 biological opinion. The Corps has included "San Juan-Chama Water Storage at Abiquiu Reservoir" in its currently proposed action. The Service is unable to find that action explicitly addressed within the 2003 consultation. Could the Corps please clarify which of its currently proposed action components that were not addressed within the 2003 biological opinion?

Response: All of the Corps' currently proposed actions were included in the 2001 and 2003 consultations. Specifically, all Abiquiu Reservoir operations were included in the 2003 consultation, most succinctly evidenced by the Service's description of Corps actions on page 10: "Abiquiu Reservoir operates for flood control, sediment retention and water supply." The Corps' water supply operation at Abiquiu Reservoir is described in context of Reclamation's San Juan-Chama Project in both the 2003 joint Corps/Reclamation BA and the Biological Opinion. As was the case for all proposed actions, the effects of this operation were analyzed in terms of aggregate depletions during this consultation; that is, the 2003 did not specifically identify effects of each consulting agency.

As the Corps has consistently indicated, the Service's confusion regarding this problematic situation will be readily avoided when the Service analyzes the impacts of the Corps' agency-specific actions as clearly defined in the Corps' BA. For that reason, the Corps is consulting independently of Reclamation and requiring an agency-specific BiOp in 2013.

12. Section 4.4.2 on Middle Rio Grande Discharge Characteristics used to include the following statement (in the draft BA dated April 30, 2011), which was removed for the October 31, 2011 BA: *"Since completion of Cochiti Dam, the frequency of large magnitude peak discharges has decreased in all reaches of the Rio Grande downstream of the dam as shown on Figure 4.5 (USACE 2007)."* Please explain why this statement and the corresponding Figure 4.5 were removed, and if this report and statement from the draft BA were incorrect (and if so, please explain).

Response: The figure and text were deleted because they were both inaccurate and contained erroneous information. Figure 4.5 made improper comparisons of gage data from widely differing periods-of-record, and did not account for differences in inflow magnitudes between periods. The statement in the text refers to *the frequency of flows and incorrectly refers to Fig. 4.5 which depicts discharge rates. Lastly, the information in the deleted is not attributable to USACE 2007 (Environmental Assessment for a Temporary Deviation in the Operation of Cochiti Dam, Sandoval County, New Mexico).*

13. Section 4.4.2 should include historic information (since about 1870) to show how stream flow regulation has altered the hydrograph and what that means to the species, their habitats, critical habitat in terms of acres and numbers.

Response: Corps operations began operations in 1953, prior to passage of the Endangered Species Act (1973). Accordingly, flood control effects are baseline conditions for the Rio Grande. Section 4.4.3 provides an overview of Changes to Magnitude and Duration of Peak Flows in a historical context. There is no quantitative data for the species of interest (numbers) or their habitats (acres) prior to the 1990's.

14. Section 4.4.7 Water Operations Since the 2003 BO on page 49 no longer includes Table 4.5 that was in the draft BA (dated April 30, 2011). This table showed *"Summary of the Middle Rio Grande Operations (2003-2008)."* Please explain why this table was removed, and if that table and its contents in the draft BA were incorrect (and if so, please explain).

Response: Table 4.5 was a deleted because the majority information pertained to the operation of Reclamation's San Juan-Chama Project and was not relevant to the Corps' proposed action. In formation in the table regarding river drying was revised and expanded upon in the October 2011 BA.

15. Section 6 of the BA provides the Analysis of Effects of Proposed Actions starting on page 85. In order for the Service to use the effects information provided by the Corps in its BA, the Corps needs to provide in the BA the best available information (50 CFR 402.14(d)), including citations of that information used to evaluate effects of its actions, as well as the analysis for each effects determination made in the BA. Specific examples of information needed on this content are included below.

a. Channel capacity effects were included in the 2003 biological opinion and effects into the future should be evaluated by the Corps.

Response: USACE provided a complete and detailed response for this question in Appendix F (30), pages 161. Table 6.1 on pages 87-88 provided detailed information on channel capacity for the effects of flood control operations.

b. This Section should include hydrographs with and without Corps operations.

Response: The BA includes Table 6.1 (on pages 87-88) with concise information on peak river flow and channel capacity for the effects of flood control operations. The Corps' proposed action does not include – nor have we ever entertained – the cessation of flood control operation in the Middle Rio Grande valley. Both the environmental baseline and the likely future condition for this consultation include the existence of the dams and their continued operation by their Corps. Therefore, please consider the information provided in the Corps' BA as complete in this regard.

c. Section 6.1.1 on Discretionary Flood-control Operation during Spring Runoff states on page 89 of the BA that *"Flood control operation may be initiated by ramping up flows when the discharge at Albuquerque reaches 4,500 cfs."* Please explain how flood control operations ramp up flows and which entity is involved with ramping up these flows. Please clarify if flood control objectives and time periods and specifically if flood control has the objective of holding back flows, increasing/ramping up flows, or both.

Response: As stated in the BA's description of the proposed action, flood control operations are the sole responsibility of the Corps, and we have discretion for safely ramping flow up during flood control operations. In Section 3.2.1, Discretionary Flood-control Operation, the paragraph at the bottom of page 21 succinctly describes the ramping procedure: "If snowmelt runoff increases abruptly, releases will be staged up at increments of approximately 500-cfs while downstream channel conditions are monitored. These staged increases normally are not necessary below a total combined release from Corps reservoirs of 4,500 cfs."

d. Section 6.1.1 on Discretionary Flood-control Operation during Spring Runoff on page 89 states that *"Flood-control actions in the Middle Rio Grande-regardless of discretion-do not directly result in adverse effects to the silvery minnow"* based on a conclusion that regulated flows during flood-control still produce suitable silvery minnow habitat conditions, flows are sufficiently large to inundate overbank areas, this overbanking supports increased recruitment of silvery minnows, and this inundated habitat is sufficiently large that it does not limit silvery minnow populations. However, there are no adequate, objective analyses, concrete examples, citations, or references provided to support these conclusion statements. Please provide the analysis that supports these conclusions, including citing the best available information used by the Corps, as required by 50 CFR 402.14(d).

Response: See response to comment 15e below.

e. Section 6.1.1 on Discretionary Flood-control Operation during Spring Runoff states on pages 89-90 of the BA that *"The patchy distribution of adults and larvae indicate that densities are below the threshold to fully exploit the inundated area provided by even moderate flow peaks."* Please provide the analysis including citations to the reference(s) or data that substantiate this statement.

Response: This statement is a qualitative analysis based on basic principles of ecology or fishery management. Any contemporary ecology textbook that discusses Leibig's Law of the Minimum should provide sufficient background to identify limiting factors that affect populations in the real world.

Multiple habitat restoration project monitoring annual reports document the presence of silvery minnow adults and eggs on inundated floodplain. These reports are provided to the MRGESCP and the Service (permit requirements). None of these many reports has documented sufficiently high densities of silvery minnows captured on inundated habitat to warrant data analysis that floodplain habitat may be limiting the population. The Population Viability Analysis workgroup and the Silvery Minnow Recovery Team have NOT identified inundated area as limiting the population.

Furthermore, if silvery minnows or other fish species saturated the floodplain during inundation, the effects on silvery minnows would be attributable to ecology, natural selection and evolution in a desert river system. Therefore, please consider the information provided in the Corps' BA as complete on this regard.

f. Section 6.1.1 on page 90 of the BA under the heading *Rio Grande Silvery Minnow* the BA provides brief summary conclusions on the effects of the Corps' Discretionary Flood-control Operation During Spring Runoff on critical habitat PCEs. This does not appear to be substantiated by any analysis. Please provide the analysis that supports these conclusions, including citing the best available information used by the Corps, as required by 50 CFR 402.14(d).

Response: USACE responded to a similar comment from the Draft Biological Assessment in Appendix F, (60) on page 170. The BA will be revised with additional detail.

g. Section 6.1.1 on page 90 of the BA under the heading *Rio Grande Silvery Minnow* the BA provides brief summary statements on the effects of the Corps' Discretionary Flood-control Operation During Spring Runoff including the statement that *"although flood-control operation reduces the potential maximum extent of inundated floodplain habitat, it increases the duration of beneficial floodplain inundation.* " Please provide the analysis that supports these statements, including how much does it reduce maximum extent of floodplain habitat, when, where, how often, duration; how much does it increase the duration of floodplain inundation, where, when, how often; and amounts of habitat changed. This needs to include citations of the best available information used by the Corps, as required by 50 CFR 402.14(d).

Response: A 2010 USACE report (to be included in the electronic documents provided with the revised BA) estimated the area of inundation by subreach as a function of flow. Non-discretionary flood control has been implemented 27.02% of the years, while discretionary flood control has occurred 8.1% of the years (see Table 6.1). The extended duration on inundation is a function the time required to evacuate flood storage at the facility.

h. Section 6.1.1 on page 90 of the BA under the heading *Rio Grande Silvery Minnow* the BA provides brief summary conclusions on the effects of the Corps' Discretionary Flood-control Operation During Spring Runoff on the silvery minnow, stating that the difference in the peak discharge is slight. If effects occur, even if "slight", then those effects need to be analyzed in the BA. Please provide the analysis that describes the effects to the silvery minnow and its critical habitat, both direct and indirect, from flood-control operations by the Corps, including magnitude, duration, extent, frequency, and nature of those effects citing the best available information used by the Corps in its BA analysis, as required by 50 CFR 402.14(d).

Response: See response to comment 15e. The presence of silvery minnow adults and egg has been documented in reports to the MRGESCP and the Service (permit requirements).The presence of adults, eggs, and larvae are indicators that inundated floodplain provides important habitat. The patchy occurrence and low densities of these life stages supports the qualitative inference of the value *of inundated floodplain. However, quantitative analysis will depend on future studies.*

i. Section 6.1.1 on page 90 of the BA under the heading *Southwestern Willow Flycatcher* the BA provides brief summary conclusions on the effects of the Corps' Discretionary Flood-control Operation During Spring Runoff on the flycatcher, stating that because of the relatively infrequent occurrence and the relatively small amount of riparian inundation prevented by the Corps' action, that the flycatcher is not likely to be adversely affected. If effects occur, even if infrequent or over a small area, those effects need to be analyzed in the BA. Please provide the analysis that describes the effects to the flycatcher and its critical habitat and proposed critical habitat, both direct and indirect, from flood-control operations by the Corps, including magnitude, duration, extent, frequency, and nature of those effects citing the best available information used by the Corps in its BA analysis, as required by 50 CFR 402.14(d).

Response: The summary statement on page 90 is based on the detailed and quantitative analysis of discretionary flood control operation on pages 85 through 89. The information provided in the current BA is complete.

j. Section 6.1.2 on page 91 under the heading *Rio Grande Silvery Minnow* the BA provides brief summary conclusions on the effects of the Corps' Middle Rio Grande Flood-Control Operations During Summer Thunderstorms on silvery minnow critical habitat PCEs. This does not appear to be substantiated by any analysis. Please provide the analysis that supports these conclusions, including citing the best available information used by the Corps, as required by 50 CFR 402.14(d).

Response: Section 3.2.1 describes operations during summer thunderstorms. The specific conditions determining the pattern of release of summer floods include: 1) the existing downstream discharge (both actual and forecasted); 2) a safe rate of increase; 3) evacuation within a short time period (usually about 24 to 48 hours) of the event; and 4) weather forecasts. Additional clarification has been added to the BA.

These criteria minimize changes to the natural hydrologic regime (Primary Constituent Element [PCE] (i)) downstream of Cochiti Lake and would principally reduce peak flows with potential to cause flood damages. The short-term detention of summer thunderstorm inflow would replace low frequency (occurrence), high-magnitude spike *flows with lower-magnitude, longer duration flows downstream of dams.*

Minimal alternation of the natural hydrograph provides more consistent downstream flow for stable instream refuge habitats (PCE (ii)) within the channel under whatever flow is present in the system. In contrast, thunderstorm events that produce inflow from arroyos or other tributaries producing natural hydrographs have greater potential to transport fish downstream away from refuge habitats into subreaches that may become rapidly intermittent following the storm event. See Service reports on minnow salvage for the effects of unregulated storm events on downstream fish movement.

Summer flood-control operations bracket the range of flow for sediment transport. These operations would not change the substrate composition (PCE (iii)) downstream of the dams. The effects of sediment retention are addressed separately.

Flood-control operations would maintain water temperatures within the prescribed 1-30°C range (PCE (iv)), and not decrease dissolved oxygen or increase pH water conditions (PCE (v)) downstream from the dams for upstream thunderstorm events. In contrast, thunderstorm events that produce inflow from arroyos or other tributaries would have natural, highly variable effects to water quality parameters (temperature, oxygen, pH).

k. Section 6.1.4 on Effects of Sediment Control states on page 99 for *Rio Grande Silvery Minnow* that future impacts of sediment control to critical habitat are relatively small compared to the current baseline condition. Please note that where there are effects from the Corps' action, even if smaller in some comparison to other types of effects, those effects need to be analyzed in the BA. Please provide the analysis that describes the effects to critical habitat from sediment control, including magnitude, duration, extent, frequency, and nature of those effects citing the best available information used by the Corps in its BA analysis, as required by 50 CFR 402.14(d).

Response: The Corps has responded to a similar comment from the Draft Biological Assessment in Appendix F, (63) on page 171. Therefore, please consider the information provided in the Corps' BA as complete in this regard.

l. Section 6.1.4 on Effects of Sediment Control concludes on page 99 that the Corps sediment control is likely to adversely affect the silvery minnow. However, what those effects are (to the minnow) is not included in the BA. Please provide the analysis that describes the effects to the silvery minnow, both direct and indirect, from sediment control, including magnitude, duration, extent, frequency, and nature of those effects citing the best available information used by the Corps in its BA analysis, as required by 50 CFR 402.14(d).

Response: The Corps has responded to a similar comment from the Draft Biological Assessment in Appendix F, (63) on page 171. Additional detail on geomorphology was provided in Appendix E of the current BA. The analysis in this section focuses on the indirect changes to silvery minnow critical habitat resulting from sediment retention. These effects are fully discussed in section 4.3.1 Rio Grande on channel geomorphology including the magnitude, extent and nature of how channel incision changes habitat parameters. The duration continues into the foreseeable future (geological time scale), while the frequency of this cumulative effect is functionally constant.

m. Section 6.1.4 on page 99 states that the formation of islands and pointbars are compensating for decreasing surface water inundation, demonstrated by silvery minnow population monitoring (Figure 5.1, 1993-2010). The minnow population monitoring trends provided in Figure 5.1 do not substantiate this conclusion as they provide no information on area of surface water inundation. Please provide the analysis showing how much increased surface water inundation is occurring from the formation of islands and pointbars, compared to decreased area of surface water inundation, to substantiate this statement in the BA. Please cite the best available information used by the Corps in this analysis, as required by 50 CFR402.14(d).

Response: The BA will be revised with the appropriate citation.

n. Section 6.1.4 on pages 99-1 00 the BA provided conclusions on effects of sediment control for *Southwestern Willow Flycatcher.* Please explain if there are also any effects from sediment control at Abiquiu Dam, which is noted to extend from Abiquiu downstream to Cochiti Lake, in particular on flycatchers. Please provide cited information to substantiate this analysis, including explanations of any effects or why no effects would be expected, if that is the case.

Response: Section 4.3.2 describes the geomorphological condition of the Rio Chama as it relates to the presence of Abiquiu Dam. The revised BA will clarify these conditions in both Chapters 4 and 6. No flycatchers are known to breed along the Rio Chama, or along the Rio Grande from the Rio Chama confluence downstream to Cochiti Lake.

o. Section 6.1.4 on page 100 for *Southwestern Willow Flycatcher* the BA concludes that effects from sediment control including future channel incision are *"expected to decrease the open water surface area within the channel at a given flow rate; however, groundwater will remain within the root zone of developing riparian vegetation on these river bars. Any decrease in wetted surface area within the channel would be replaced by vegetated bars. Southwestern Willow Flycatcher habitat is not expected to decrease due to future channel incision."* However, there is no analysis or any cited references or other information to substantiate these statements in the BA. Please provide the analysis showing (a) the expected decrease in open water surface area and at what flow rates due to channel incision, (b) changes to groundwater and how that relates to the root zone for this vegetation, (c) the comparison of decrease in wetted surface area and replacement by vegetated bars, and (d) why flycatcher habitat is not expected to decrease due to channel incision in order to substantiate these statements in the BA. Please cite the best available information used by the Corps in this analysis, as required by 50 CFR 402.14(d).

Response: Section 6.1.4 describes the HEC-RAS hydraulic modeling conducted by the Corps to analyze the effects of incision. If the Service has the capability to run the HEC-RAS model, the Corps will provide the model runs. Figure 6.7 depicts the decrease in water surface area expected as a result of future incision over the range of flows from 50 to 10,000 cfs. The revised BA describes the very limited extent of suitable flycatcher habitat within the affected reach, and small expected change to groundwater elevations based on data from monitoring piezometers within the area.

p. Section 6.1.8 addresses effects on silvery minnow from drops in flows during Cochiti Dam Outlet Fish Screen Replacement, using an inverse comparison to natural storm events (flow spikes vs. flow drops). Please note that where there are effects from the Corps' action, even if similar in nature to some natural event, those effects need to be analyzed in the BA. Please provide the analysis that describes the effects to silvery minnow and its critical habitat from fish screen replacement, including drops in flows, citing the best available information used by the Corps in its BA analysis, as required by 50 CFR 402.14(d).

Response: The Corps responded to a similar comment from the Draft Biological Assessment in Appendix F, (69) on page 173. The current BA will be revised accordingly. There are no additional analyses available to include in the BA. Citations will be added to the revised BA to complete the analysis.

q. Section 6.1.8 addresses effects on silvery minnow from drops in flows during Cochiti Dam Outlet Fish Screen Replacement. Pages 102-103 discuss effects on *Rio Grande Silvery Minnow;* however, there are no references cited or analysis to substantiate statements made in this section. Please provide the analysis including citations to the reference(s) or data that substantiate these statements, including (a) statements that fish have a higher likelihood of stranding during flow spikes than during drops in flows, (b) that drops in flows are less likely to cause mortality than spikes in flows, (c) a description of the "probabilistic approach" mentioned on page 103, (d) the Corps' compilation and review of habitat restoration monitoring reports supporting statements on page 103 that few fish are stranded following rainstorm events, (e) statements on fish evolution, response to water elevations, and reduced probability of stranding, and (f) statements as to "sufficient time" for fish to respond to water elevation changes. Please cite the best available information used by the Corps in this analysis, as required by 50 CFR 402.14(d).

Response: Thank you for your comment. See responses to comments 15e and 15p above. Therefore, please consider the information provided in the Corps' BA as complete in this regard.

r. Section 6.1.9 on Abiquiu Tunnel Inspection states on page 105 that *"the periodic tunnel inspection at Abiquiu Dam would have no effect on the flycatcher or its designated or proposed critical habitat."* It states there would be a decrease of about 30 cfs at the Chamita and Otowi gages as a result of this activity. However it also states that effects to flows attenuate before reaching the Otowi gage. This information is contradictory. Given that there are breeding flycatchers in the vicinity, and water flows would be affected downstream to at least the Chamita and Otowi gages, this needs to be evaluated for how it "may affect" flycatchers directly or indirectly. Please include an assessment of effects on flycatchers from this 30 cfs drop in flows, including accounting for the timing, duration, and frequency of that drop in flows due to Abiquiu Dam tunnel inspection.

Response: The definition of attenuate is "to make smaller, to lessen, or to weaken" (American Heritage Dict., 1972, Dell Publishing Co.). Figure 6.9 depicting discharges during a typical tunnel inspection clearly show that a decrease in flow of 70 cfs immediately below Abiquiu Dam attenuates to a 30 cfs difference at Chamita and a 20 cfs at Otowi Bridge.

As stated in the BA, tunnel inspections are normally conducted when flows are low during the winter, in interest of safety to inspecting personnel who must enter the tunnel. Flycatchers are not present in the action area during the winter months. If required because of dam safety concerns, inspections may be performed at other times of the year. Flycatchers are known to breed along the Rio Grande channel at Ohkay Owingeh, upstream from its confluence with the Rio Chama. The small decreases in flow during tunnel inspections would have no effect on the flows within the Rio Grande channel upstream from the confluence.

s. Section 6.1.10 on Flushing Jemez Canyon Dam Stilling Basin on page 107 for *Rio Grande Silvery Minnow* states that "Because the proposed flushing flows are similar to natural thunderstorm flows, and continuous flow from the dam to the Rio Grande would be maintained." This is an incomplete sentence, please clarify what is being communicated in this sentence.

Response: The revised BA will correct this sentence's grammar.

t. Section 6.1.10 on Flushing Jemez Canyon Dam Stilling Basin on page 107 for *Rio Grande Silvery Minnow* provides conclusion statements for effects on silvery minnow and its critical habitat, including mentioning some of the critical habitat PCEs. This does not appear to be substantiated by any analysis. The BA also does not explain how much sediment or how far those effects extend downstream. Please describe how much sediment and how far downstream those effects extend, the available information and any limitations on what is known (and why), and provide the analysis that supports the conclusions in this section, including citing the best available information used by the Corps, as required by 50 CFR 402.14(d).

Response: The Jemez River is the largest tributary delivering sediment to the Rio Grande between Cochiti Dam and the Rio Salado. The sediment volume flushed from the stilling basin is included in the 191 acre-feet currently transported annually through Jemez Canyon Dam. Section 4.3.1 Rio Grande [Geomorphology] and Appendix E, Section Angostura Diversion Dam to Isleta Diversion Dam, provide detailed description of sediment effects with the essential citations representing the best available analysis.

Based on the size of the outlet channel and stilling basin, and that approximately 3 to 5 feet of sediment are removed by flushing, we estimate that approximately 0.8 to 1.3 ac-ft of sediment may be flushed during a given performance of this maintenance action. Although this activity increases the contribution to the sediment-starved Middle Rio Grande, it only equates to 0.4% to 0.7% of the 191 ac-ft of bedload material that currently passes through the dam annually. Flows greater than 600 cfs – such as spring runoff flows, or thunderstorm events as depicted in Figure 6.10 – transport substantially larger bedload volumes than flushing-maintenance operation.

One new reference will be included in the revised BA that addresses sediment dynamics in the Middle Rio Grande system is: Makar, P., and J. AuBuchon. 2012. Channel Conditions and Dynamics of the Middle Rio Grande. U.S. Department of the Interior, Bureau of Reclamation, Technical Service Center, Sedimentation and River Hydraulics Group, Denver, Colorado, and Upper Colorado Region, Albuquerque Area Office, Technical Services Division, Albuquerque, NM.

u. Effects of non-native species (such as quagga, plants, fish) and the measures being taken by the Corps to limit those effects should be addressed.

Response: The Corps is only consulting on Water Operations, therefore, non-native species are not relevant for inclusion in this BA, as they are not properly considered as part of the Corps' agency-specific actions. The Corps does coordinate with the appropriate agencies (and staff) on these issues (see comment 10 above). Therefore, please consider the information in the Corps' BA as complete in this regard.

v. Section 6.3 addresses effects on the Interior Least Tern on page 97 and states that *"none of the proposed Corps reservoir operations would result in an altered flow regime that would measurably affect the density or availability of the tern's prey species."* This is not supported by any analysis or supporting information in this section. Please describe anticipated effects on the interior least tern, including if and why such effects are not expected, using citations of the best available information used by the Corps for this analysis, as required by 50 CFR 402.14(d).

Response: The revised BA will explain that the Corps analysis of potential effects on the Rio Grande silvery minnow also would apply to other, similarly sized fish species, all of which may be prey items for the Least Tern.

16. Please provide a copy of all references cited and indicate page numbers of the information being used to support the analysis or conclusions.

Response: Electronic copies of references cited in the BA will be submitted with our revised BA.

17. The Corps should explain why current RPA Element U has not been implemented.

Response: This topic is succinctly explained in the BA in Section 1.2.13, Summary of Previous Consultations Regarding the San Marcial Railroad Bridge. This issue was also resolved in a letter to the Service dated January 22, 2007.

18. Section 7.2 on page 111 states that *"Congress appropriated a total of $5,866,000 over the period beginning in the last quarter FY 2009 through FY 2011."* Please clarify to whom and for what purpose, and what this is intended to communicate to the Service for the purposes of ESA section 7 consultation.

Response: The Service's comment has brought to our attention that the current text poorly explained the Corps' efforts to date to fulfill its obligations under the ESA and contribute to the goals of the MRGESCP. The revised BA will clarify this text and these efforts.

This information addresses all factors related to the sufficiency and completeness of the Corps' BA. By revising our BA to include this information, the Corps will have met the requirements as described in 50 CFR §402.12, and satisfied the requirements to initiate formal consultation with the service as described in 50 CFR 402.14(c). Although we are not reinitiating consultation until the issue of consultation until the issue of an agency-specific BiOp is resolved, we are certainly hopeful that timely resolution can be achieved.

Sincerely,

Kristopher T. Schafer, P.E.
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APPENDIX H

AGREEMENT REGARDING AGENCY-SPECIFIC BIOLOGICAL OPINION

U.S. Fish and Wildlife Service, NM Ecological Services Field Office
U.S. Army Corps of Engineers, Albuquerque District

Summary points of Jan. 23, 2013, meeting on Corps Reservoir Operation

Attendees: USFWS: Janet Bair, Wally Murphy
USACE: Kris Schafer, Dennis Garcia, Ryan Gronewold, Michael Porter, William DeRagon, Susan Bittick.

1. The Service will produce two or three Biological Opinions, one for the Corps, one for both Reclamation and Bosque del Apache NWR, or two separate Opinions for Reclamation and Bosque del Apache NWR.

2. Each BiOp will contain a comprehensive effects analysis, based on information from the Corps' BA and Reclamation's BA, as well as environmental baseline and cumulative effects within the composite action area. To the extent feasible, each BiOp also will contain agency-specific effects which form the basis of respective Terms and Conditions (T&Cs).

3. The Corps' success in securing support and funding for Section 7 responsibilities, and for specific T&Cs, is greatly facilitated by the agency-specific Biological Opinion.

4. Both agencies acknowledge that the process of attributing specific effects on listed species and designated critical habitat to individual action agencies may be difficult. A framework for the partitioning of responsibilities entails the development of T&C's based upon the following categorization:

a) those clearly attributable to the Corps;
b) those clearly attributable to Reclamation;
c) those clearly attributable to BDANWR;
d) those attributable to two or more agencies (shared responsibility);
e) those where responsibility remains vague or confounded.

The Corps' BiOp will contain T&C's that are clearly Corps responsibilities, as well as those that are shared responsibilities. Further clarification and coordination will be needed regarding vague or confounded effects in order to determine responsibility among the parties. The parsing of responsibilities among parties may also be guided by existing authorities, capabilities, or the aggregate effects of agency actions.

5. The Corps will include conservation measures within its proposed action. The Service understands that these conservation measures are subject to authority, funding, proponency by another entity, etc.

6. The Corps agrees that participation in the RIP, subject to the final documents being acceptable, can be added as a conservation measure at a later point in the consultation.

7. To reinitiate consultation prior to the expiration of the 2003 BiOp, the Service needs the Corps to submit its revised BA no later than February 15, 2013.

8. Both agencies acknowledge that the draft BiOps are working drafts, and that further evaluation and iteration may be necessary prior to completing the consultation process.

Janet Bair, USFWS 1/29/13

Kristopher Schafer, USACE 1/29/13