United States Department of the Interior

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February 28, 2013

Consultation No. 02ENNM00-2012-F-0015
Previous Consultation No. 2-22-95-F-0180

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Department of the Army Corps of Engineers
4101 Jefferson Plaza NE
Albuquerque, New Mexico 87109-3435

Dear Ms. Alcon:

This document transmits the U.S. Fish and Wildlife Service's (Service) final programmatic biological opinion (Opinion) on effects of the U.S. Department of the Army, Corps of Engineers, Albuquerque District (Corps) proposed action of construction, operation and maintenance of the Rio Grande Floodway, San Acacia to Bosque del Apache Unit, in Socorro County, New Mexico (i.e., proposed action or San Acacia Levee Project). The Corps proposes construct a new 43-mile levee by replacing an existing, earthen spoil bank in order to better protect nearby communities from a 100-year flood. The levee plan was divided into six segments, with construction occurring within those segments at approximately two miles per year, over a period of 20 years. Some of the excavated spoil bank material will be used in the construction of the new levee, but a large amount of excavated material will be transported and disposed on a 300-acre location at the south end of the project area. With continued operations and maintenance, the new levee will have a functional regional flood control life of 50 years. Construction is estimated to occur over the next 20 years, so this project will continue to at least 2082.

This Opinion addresses the effects of the San Acacia Levee Project on the endangered Rio Grande silvery minnow (*Hybognathus amarus*) (silvery minnow), its designated critical habitat, the endangered southwestern willow flycatcher (*Empidonax traillii extimus*) (flycatcher), and its designated critical habitat. Your request for formal consultation, in accordance with Section 7 of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531 et seq.), was received as complete on May 8, 2012. A draft Opinion was issued by the Service on August 16, 2012. A request to extend the deadline to allow Corps to comment on the draft Opinion was received on September 20, 2012. The Corps and Service met multiple times and exchanged information regarding the project and analysis of effects to endangered species. No permit or license applicants (16 U.S.C. 1532 and 1536(3)) were identified by Corps as part of this ESA consultation.

This Opinion is based on information submitted in the May 8, 2012, San Acacia Levee Project Biological Assessment (BA; USACE 2012a), the draft General Reevaluation Report and Supplemental Environmental Impact Statement II (USACE 2012b), Geographic Information System (GIS) files and information from Restoration Analysis and Recommendations for the San Acacia Reach of the Middle Rio Grande, New Mexico (Parametrix 2008), and the Conceptual Restoration Plan for the Active Floodplain of the Rio Grande San Acacia – San Marcial, New Mexico (Tetra Tech EM Inc. 2004), conference calls, e-mails, and meetings between Corps and the Service, supplemental information provided electronically (USACE 2012d,e), and other sources of information available to the Service. The administrative record for Consultation No. 02ENNM00-2012-F-0015 is on file at the Service's New Mexico Ecological Services Field Office in Albuquerque, New Mexico.

The Service concurs with Corps' findings that the proposed action "may affect, but is not likely to adversely affect" Aplomado falcon (*Falco femoralis*) (falcon) or least tern (*Sternula antillarum*) (tern). As documented in Corps BA (USACE 2012a), the timing and location of Corps activities are unlikely to disturb foraging or resting behavior of the falcon or the tern and therefore, are discountable. No critical habitat is designated for the falcon or the tern in the project area and therefore, none is affected by the proposed action.

Critical habitat is currently designated for flycatcher and silvery minnow within the San Acacia Levee Project area. This Opinion assesses effects of the proposed action on designated flycatcher critical habitat, and designated silvery minnow critical habitat. The Service does not rely on the regulatory definition of "destruction or adverse modification" of critical habitat at 50 CFR 402.02. Instead, the Service relied upon the statute and August 6, 2004, Ninth Circuit Court of Appeals decision in Gifford Pinchot Task Force v. USDI Fish and Wildlife Service (CIV No. 03-35279) to complete the following analysis with respect to designated critical habitat. This consultation analyzes the effects of the action and its relationship to the function and conservation role of the physical and biological features of critical habitat to determine whether the current proposed action adversely affects or adversely modifies silvery minnow or flycatcher designated critical habitat.

The Service is unable to concur with Corps findings that the San Acacia Levee Project "may affect, is not likely to adversely affect" flycatcher, or flycatcher designated critical habitat because effects of the proposed action are not wholly beneficial, discountable, or insignificant. As described in this Opinion, direct and indirect effects of the proposed action to flycatchers and flycatcher habitat are likely to adversely affect flycatchers, and their designated critical habitat. Additionally, Corps found that the proposed action, "may affect, likely adversely affect" silvery minnow and silvery minnow designated critical habitat. Therefore, this Opinion describes adverse effects to silvery minnows, flycatchers, and their designated critical habitats.

BIOLOGICAL OPINION

I. DESCRIPTION OF PROPOSED ACTION

Structural Flood Control

Historically, the predominant approach to flood control in the United States has been the use of engineered structures, such as levees, floodwalls, and dams. Human development within the historical floodplain near Socorro, New Mexico, has resulted in the need for structural flood control measures including engineered levees to limit the area over which the Rio Grande can move (USACE 2012b). Twelve alternatives were considered and presented in the Draft General Reevaluation Report/Supplemental Environmental Impact Statement II (GRR/SEIS) by the Corps (USACE 2012b). The GRR/SEIS provides details as to the plan formulation process, the entire array of alternatives considered, alternatives not considered, and why the proposed action considered in this Opinion was chosen. The BA (USACE 2012a) also described the purpose and need for the proposed action, details of the proposed action, the environmental consequences, details of the Corps conservation measures for fish and wildlife, and Corps findings of effects of the proposed action on silvery minnows, flycatchers, and their critical habitats. Corps (USACE 2012d, 2012e, 2013) provided supplemental material specifying additional conservation measures for silvery minnow and flycatcher.

The purpose of the proposed action is provision of improved flood control to the portion of the Middle Rio Grande Valley (MRGV) extending from San Acacia, New Mexico downstream to San Marcial, New Mexico (Figure 1). The proposed action includes construction, operation and maintenance of engineered levees and other associated activities associated with the Corps Rio Grande Floodway, San Acacia to Bosque del Apache Unit (San Acacia Levee Project or Project or proposed action). The Project area specifically occurs in the southern most section of the MRGV, from approximately one-half mile upstream of the San Acacia Diversion Dam (SADD) and the Rio Grande to just below the Burlington Northern Santa Fe Railroad crossing of the Low Flow Conveyance Channel near Tiffany and San Marcial, New Mexico, and next to the Low Flow Conveyance Channel (LFCC) (Figure 1).

The design limits of engineered, earthen levees must be considered in river valleys because variations in flow and the sinuosity of the river channel can result in uncertainty in flow trajectory within a valley under high river flow conditions as well as levee integrity. The Corps refers to the probabilities of a particular flow or flood event as a percentage exceeded in any one year, such as, 0.2%, 1%, 5%, 10%, 14 %, 20%, and so on (USACE 2012b). The previous nomenclature often referred to the “100-year flood,” but is more properly defined as the flood having a 1 percent chance of being exceeded in any one year (USACE 2012b). Similarly, the 5% flood was previously called the “20-year” flood, the 2% flood was previously called the “50-year” flood, and the 0.2% flow was called the “500-year” flood (USACE 2012b).

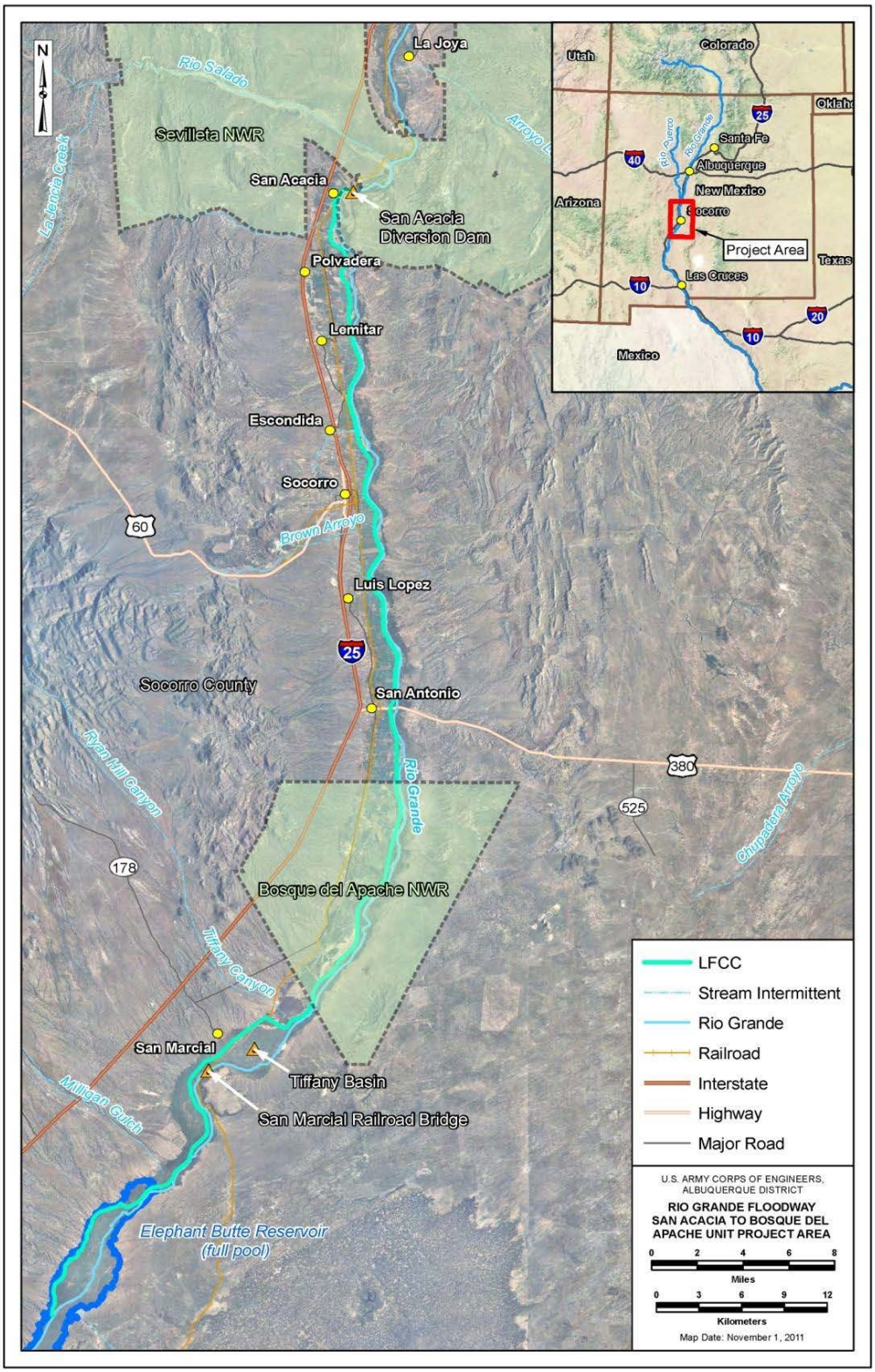

Figure 1. Map of the San Acacia Levee Project area. (Source: USACE 2012a)

The proposed levees would be designed such that they would convey the 1%-chance flood event with a high level of confidence of not failing during flows as high as 29,900 cfs measured at SADD. The proposed action would further reduce potential flood-damage to inhabitants of the historical floodplain, the LFCC, open space, historic and archaeological sites, natural vegetation and trees, agricultural land and facilities, residential and commercial development, recreation, and numerous railroad, irrigation, drainage, transportation, industrial, and municipal facilities within the historical floodplain west of the levee and in the San Acacia Levee Project area.

The proposed action consists of replacing approximately 43 miles of non-engineered spoil banks with engineered levees along the west bank of the Rio Grande from the SADD to Tiffany, New Mexico. The spoil banks range from 3 to 19 feet tall and were constructed in the late 1960s by the United States Bureau of Reclamation (Reclamation) using spoil (i.e., soil and materials removed from an excavation) excavated from the adjacent river valley to create the LFCC (USACE et al 2007; USACE 2012b). The spoil bank is not an engineered structure and is estimated to fail at river flows in the range of 11,800 to 13,240 cubic feet per second (cfs) measured at the gage at the SADD (USACE 2012a). Without replacement the spoil bank would not contain future flood events, even with "flood fighting" activities and maintenance, and which would result in significant hydrological and environmental impacts (USACE 2012b,c; MRGCD and NMISC 2012). There are no spoil banks or engineered levees on the east side of the Rio Grande floodway in the San Acacia Levee Project area.

The proposed levee alignment would generally follow that of the existing spoil bank that is between the LFCC and the Rio Grande. The new levee design height is equivalent to the water surface elevation corresponding to the 1% chance flood event, plus an additional 4 vertical feet (i.e., levee height ranging from approximately 4 to 14 feet; BA, page 10). The discharge for the one percent chance flow is 29,900 cfs at the upstream end, attenuating to 15,000 cfs at the downstream end of the project (USACE 2012b). After construction is complete, Corps requires agreement on operation, maintenance, repair, and rehabilitation of the levee by local governments or sponsors. If structural protection is not maintained, over time the levee may fail to provide the level of protection it was designed for, increasing the flood risk. The proposed construction action is scheduled to take up to 20 years, or until 2032, and Corps (USACE 2012b) considers 50 years as the functional life of flood control, or until 2082.

The Corps (2012a) refers to the river channel and its overbank areas between the spoil banks (and soon levee) and the high ground on the east side of the river as the "floodway." The term "floodplain" or "historical floodplain" typically refers to those areas outside of the floodway (and currently associated with a one percent chance flow event), to the west of the spoil banks or levee (Figure 2).

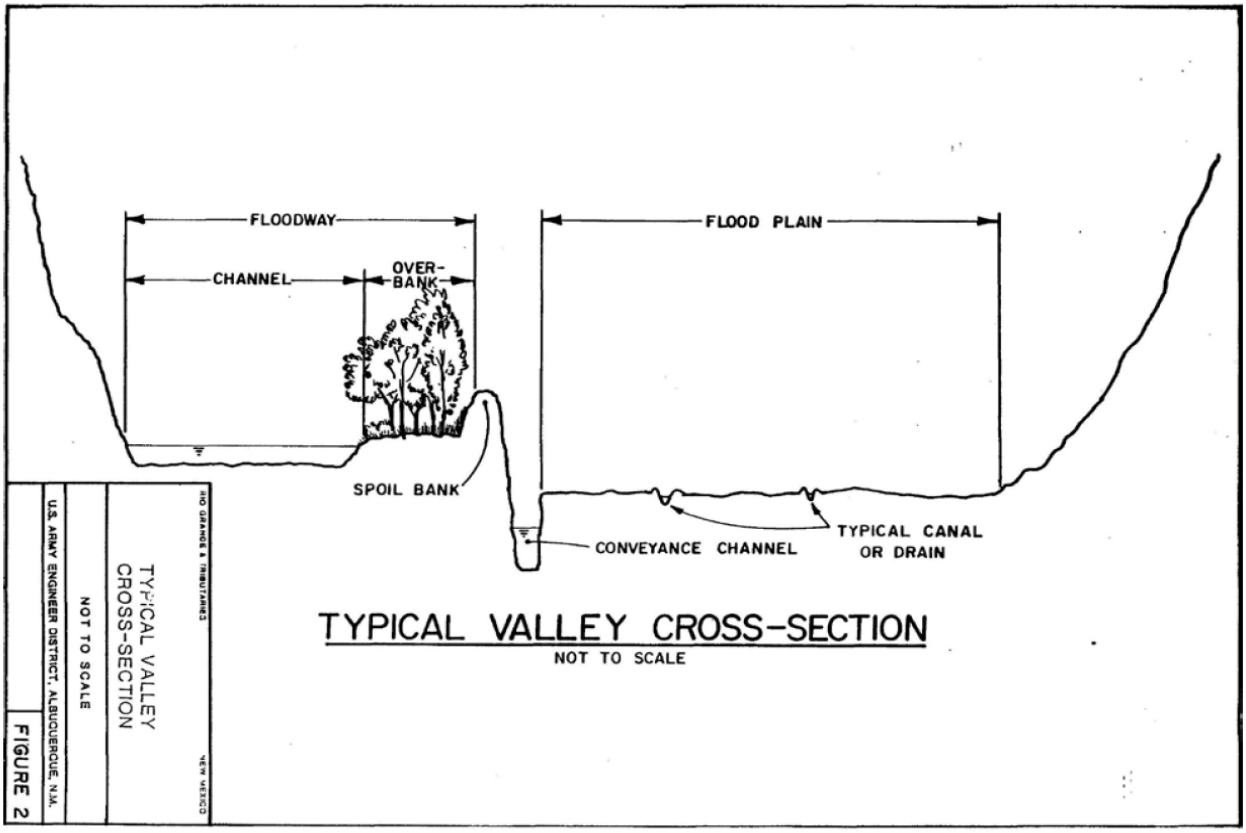

Figure 2. Typical Middle Rio Grande Valley cross section depicting the floodway with river channel and overbank areas and the floodplain in the San Acacia Levee Project area.

Appendix A of the BA contains plates showing the preliminary layout for the proposed action. Appendix B of the BA depicts the MRGV floodplain affected by the one percent chance flood event with and without the San Acacia Levee Project. The Service has identified the action area for this Opinion as all floodplains and proposed levee areas as depicted in six plates in Appendix B of the Corps BA (USACE 2012a) (Opinion, Appendix A). Additional phases of the San Acacia Levee Project in the floodway and historical floodplain are discussed below, by topic.

East Side Excavation, Temporary River Crossing, and Floodwall Installation

The floodway of the Rio Grande is constricted between higher grounds on either side of the river at the SADD (USACE 2012a). Special design features are required in this area of the levee to provide west side bank protection and excavation on the east side is necessary to decrease the velocity and erosive potential of the design flood (USACE 2012a). To provide a wider corridor for flood flows, excavation of approximately 9.3 acres of the east bank would create a terrace at the 10 percent-chance (10-year) flood event water surface elevation along approximately 300 yards of the channel's east edge. At the base of the proposed terrace, an additional 3.1 acres of the existing bank would be excavated to the approximate 50 percent-exceedance (2-year) water surface elevation, sloping downward to the existing channel. Overall, the excavation and widening would increase the cross-sectional flow area and proportionally decrease the velocity

(USACE 2012a). Corps would plant up to 1.1 acres of willows (*Salix* spp.) along the edge of the new bank line within the 3.1 acres and the 9.2-acre terrace. Excavation would be scheduled for four months during fall and winter when river flow is relatively low.

During construction, a temporary river crossing would be required to access the east bank from the LFCC service road on the west bank of the Rio Grande. The temporary crossing would consist of an earthen ramp approximately 300 feet long, with a 15-foot top width and 2.5 horizontal to 1 vertical side slopes. Six, 60-inch corrugated, metal pipes would be installed below the crossing to allow low flows to pass through the crossing to maintain a wet river channel during construction. Conservation measures would be used to minimize impacts to water quality for this temporary crossing. These include the use of rubber cofferdams and silt curtains for the reduction of turbidity, ease of construction, and to provide a barrier between construction activities and river waters (and fish). Other conservation measures would include slope protection for the culverts and specialized grading to prevent runoff of sediment from entering the river at the location of the ramps. Rubber cofferdams would be employed along the east bank to minimize contact between construction activities and the river waters.

Cofferdams and silt curtains would be deployed to minimize disturbance to fish in the immediate area. These barriers would be deployed by Corps biologists from the shoreline into the current to exclude fish from the area where the temporary ramp is constructed. These barriers also would be deployed to exclude fish from the construction activities when the ramp is removed. Near the SADD, the corridor between the western bank of the river and the railroad track is too narrow to accommodate an earthen levee. Therefore, a concrete floodwall would be constructed on top of the bank beginning at a point about 400 feet upstream of the diversion dam and extending 650 feet downstream. The floodwall will be approximately 4 feet high and would be flanked by a roller-compacted concrete apron along the downstream portion (see Soil Cement Embankment below). Nearly the entire area encompassing the floodwall and apron is currently disturbed and devoid of vegetation. Approximately 0.25 acres of upland vegetation would be removed to accommodate the floodwall at its upstream terminus.

Soil Cement Embankment and Riprap Blankets

Although the East Side Excavation decreases the velocity of the design flood, there still would be a high potential for bank erosion along the west bank, especially in along the river bank where the channel and flow bends westward downstream from the SADD for about one mile. Corps proposes installation of a soil-cement embankment along 5,700 feet of the west bank immediately downstream from the SADD. Soil cement would be placed in a series of horizontal lifts resulting in a stepped (terraced) wall with an overall slope of 1:1 varying to the crest of the levee supporting the railroad tracks. The riverbank is sufficiently high within this reach that a floodwall or levee would not be required to contain flood flows; however, the soil-cement embankment would be required to prevent erosion and undermining of the railroad track. Vegetation would not grow on or within the soil-cement slope after construction and any soil accumulation would likely be thin. Vertically, the soil-cement embankment begins at the base of railroad embankment and would be buried approximately 12 feet below the existing base of the riverbank slope. The base of the soil-cement wall would fill approximately 0.6 acres of the

present river channel. During excavation and placement of the soil-cement embankment, construction precautions similar to those described above for the temporary channel crossing would be employed to minimize the potential for water quality degradation or entrapment of fish.

It is estimated that the cofferdam will be in place for approximately 3 months to include time for setup and teardown and completion of the soil-cement armoring work. It is estimated that the construction of the soil cement armoring requires the clearing and grubbing trees and small brush. Trees are chipped and disposed of at a local landfill, within a thirty-mile radius of the job site. Clearing and grubbing activities are accomplished using a crew consisting of hydraulic excavator, bulldozer, front-end loader, chipper, dump trucks, and laborers. It is assumed that 314,247 cubic yards of excavation is required in order to place the soil cement at the required scour depth. The material is removed using a bulldozer and temporarily stockpiled adjacent to the work area.

Ten portions of the levee would require riprap toe protection based on hydraulic analysis of scour velocities and proximity of the river channel to the proposed levee. The protected portions range from 500 to 4,850 feet long, and the total length of erosion protection with riprap blankets is approximately 31,700 linear feet (6.0 miles). Riprap protection would blanket the riverward slope of the levee from crest to toe, and would be buried to a depth of 6.5 to 12 feet beneath the levee toe. Self-launching riprap (i.e., launchable stones are proposed to be placed along areas expected to erode or scour. As flood events result in erosion below the stone, the stone is undermined and rolls or slides down the slope, stopping the erosion (USACE 1994)),would be buried below the ground surface at the toe of the levee for potential scour depths greater than 12 feet but not exceeding 17 feet. Rock sizes used for riprap would vary from 0.75 to 3.5 feet in diameter depending of the velocities at potential scour locations. Coloration for rock used for riprap would vary; however, suitable material in the local area consists of dark colored basalt or grey metamorphic rock. Jetty jacks are currently located in and around the proposed project area and would continue to provide erosion protection to the proposed project.

It is estimated that construction of the deep toe portions of the soil-cement embankment and riprap protection require groundwater excavation and dewatering for their proper placement. The toe key for the riprap slope protection will have a minimum depth of 5 feet and a maximum depth of 17 feet. The water table in the area of excavation was estimated at 8' below the levee toe. The dewatering is accomplished using a deep well type system consisting of wells placed at 50' on center. The depth of the wells is varied based on the depth of the construction excavation. Each well will have an electric submersible pump and discharge piping. Power is estimated to be supplied by a skid-mounted generator, which can power a line of pumps up to 500 ft long. It is estimated that the pumps are operated continuously for the duration of the toe riprap placement from 1 to 8 months.

Engineered Earthen Levee, Trenches, and Levee Drainage Features

The new earthen levee would generally follow the alignment of the existing spoil bank throughout the reach. The earthen levee would begin where the soil-cement embankment ends (at 1.2 river-miles downstream from SADD). The proposed levee would terminate at the railroad embankment near Tiffany, New Mexico, approximately 43.6 river-miles from the SADD. The construction of the proposed levee would entail removing the existing spoil bank with heavy machinery and processing the material removed to obtain suitable fill material for new construction. All sorting and material mixing would occur within the footprint of the existing spoil bank during construction. Selected materials required for construction (i.e., riprap and bentonite) would be acquired from commercial sources or borrowed at approved sites. The landward toe of the proposed levee would be separated from LFCC maintenance road by an 18-foot-wide drainage ditch (the LFCC). Generally, the base of the proposed levee would be narrower than that of the existing spoil bank north of U.S. Highway 380, and would be equal to or greater than the base width of the spoil bank south of Highway 380. Positioning the landward toe as close as practicable to the maintenance road in order to minimize floodway encroachment by the structure and the required vegetation-free zone was one of the design objectives for the new levee.

The proposed levee would remain trapezoidal in cross-section with a 15-foot-wide crest (USACE 2012b, Appendix A, Sheet C-141). Side slopes would vary between 1 vertical (V) to 2.5 horizontal (H) and 1 V to 3 H, depending on the height of the levee. Levee height would range from 4 to 14 feet, increasing gradually from north to south. Perforated-pipe toe drains with discharge pipes into the LFCC, and risers would be required for levee heights greater than 5 feet. An 8-foot-wide by 4-foot-high inspection trench, with 1V:1H side slopes, would be installed under the levee and is required for levee heights greater than 5 feet.

In addition, a 2-foot-wide bentonite (i.e., fine earth having small particle size and a clayey consistency) slurry trench extending downward from the design water surface elevation to the top inspection trench and would be required for levee heights greater than 5 feet. The slurry trench would extend from 2 feet below the levee embankment crest to 5 feet into the foundation material. The slurry trench and toe drain system decrease the likelihood of the levee becoming saturated during long-duration floods. For levee heights greater than 5 feet, 6-inch perforated-pipe, toe drain that, discharges into the LFCC, and risers as well as an 8-foot-wide by 4-foot-high inspection trench with 1V:1H side slopes would be required. Because the proposed levee embankment would be constructed on thick deposits of pervious materials overlain with little or no impervious material, foundation seepage is a serious problem. A method of protecting the levee embankment toe from seepage and a method of intercepting shallow foundation seepage is required (USACE 2012b, Appendix F).

Several seepage control measures were considered during design and it was determined that a network of subsurface seepage collector pipes and a landside drainage blanket would be the best alternative. The new levees embankment would include a landside foundation drainage blanket, extending approximately one-third the foundation width, and a network of toe collector pipes and

drains to control seepage and eliminate sloughing. The toe drain system required for seepage control consists of a perforated main line with risers and clean-outs every 300 feet and outlets every 900 feet throughout the entire alignment. (USACE 2012b, Appendix F, page 203).

The contractor would not be allowed to construct any new haul roads for the construction of this project. However, vehicle turnarounds would be located on the levee or existing disturbed locations used for spoil bank and LFCC maintenance. Specific locations would be determined after further coordination with all parties using the levee. The existing haul road adjacent to and between the existing spoil bank and the LFCC would be used for the construction of the levee. A relatively small amount of surplus material would be stockpiled during construction of a given levee segment. Short-term stockpiles would be located within the disturbed footprint during construction of a given segment. Long-term stockpiles will be located at staging areas or previously disturbed sites outside of the floodway.

Vegetation-Free Zone

The Corps' Engineer Technical Letter 1110-2-571 (10 April 2009) provides guidelines to assure that landscape planting and vegetation management provide aesthetic and environmental benefits without compromising the reliability of levees. The vegetation-free zone requires that no vegetation, other than approved grass species be allowed, to grow on the levee or within 15 feet of the riverward or landside toes of the levee. During construction, existing vegetation would be removed adjacent to the riverward and landside toes by clearing and grubbing, and root-plowing where salt cedar occurs. Since the landward side of the levee is currently maintained as an access road very little vegetation exists in that area, but riparian vegetation may occur along the LFCC. Following construction, disturbed soils including the levee side slopes would be seeded with native grass species to prevent wind and water erosion. A 15-foot-wide vegetation-free zone would be permanently maintained to be devoid of any vegetation other than grasses. Vegetation-free zones would be mowed, when dry in fall or winter, any time the grass reaches a height of 12 inches. Mowing would be triggered by grass heights of less than 12 inches if important to the health maintenance of the particular grass species.

Structures to Accommodate Tributary Flow

Three tributary arroyos in the project area empty into the Rio Grande from the west, crossing the LFCC and existing spoil bank: 1) San Lorenzo Arroyo enters the Rio Grande approximately 2.9 river-miles downstream of the SADD; 2) the Socorro Diversion Channel captures flows from the Socorro Canyon Arroyo (approximately at decimal degree coordinates 34.061100,-106.887618), Nogal Canyon Arroyo (approximately at decimal degree coordinates 34.064100,-106.887890), and several smaller arroyos, and empties into the Rio Grande just upstream of the city of Socorro, at 13.7 river-miles downstream from SADD; and 3) Brown Arroyo (approximately at decimal degree coordinates 34.002619, -106.871334) enters the Rio Grande approximately 22.2 river-miles downstream from the SADD. Each of these tributaries was evaluated in order to determine if closure structures were needed to prevent flood flows on the Rio Grande from escaping the floodway. Closure structures were determined not to be needed at San Lorenzo Arroyo and the Socorro Diversion Channel. Instead, levee tiebacks were designed to prevent

overtopping of the interior drainage facilities at these places. It was determined that a closure structure was needed at Brown Arroyo to prevent the one percent-chance flood event from backing into Brown Arroyo for a distance of approximately 7,500 feet and a depth of up to 9 feet. Brown Arroyo is confined by non-engineered spoil banks that have a high risk of failure at high flood stages. This gated closure structure would be designed to pass Brown Arroyo flood flows while preventing longer-duration Rio Grande flood flows from potentially breaching the existing interior drainage facilities and is described below. The gated floodwall structure would be located where the new levee intersects the outfall channel of Brown Arroyo. The gate structure would consist of 10 sluice gates. The Brown Arroyo inlet is skewed relative to the Rio Grande Floodway, so the gates are aligned in a zigzag configuration that allows for flows from Brown Arroyo to enter directly into the gates.

Approximately 11.7 river-miles downstream from SADD, the "Nine-Mile Outfall" consists of three large conduits that direct flow from the LFCC to the river when the LFCC is operated. The Corps would replace these with conduits equipped with flap gates to prevent flood flows from entering the LFCC. There currently are three locations along the proposed levee alignment where Reclamation pumps water from the LFCC through the levee to the river when required to benefit endangered species. Currently, pumps are located approximately 3 miles north of Highway 380, and at both the north and south boundaries of BDANWR. The pumps provide flexibility for future water operations and adaptive management tools. The Corps would install permanent conduits through the proposed levee to accommodate these pumps at their current locations (or at alternate locations agreed to by Reclamation and the Service). Appropriate measures to ensure levee performance would be incorporated to the conduit design, including concrete encasement, appropriate filter materials, and slope protection.

Material Quantities and Waste Spoil

The existing spoil bank was built from material excavated for the LFCC rather than being designed relative to a specific flood discharge. The height of the proposed levee was initially designed to accommodate the mean water surface elevation of the one percent-chance flood event. According to Corps (USACE 2012b, Appendix F, Table F-61), the existing spoil bank provides no protection from any of the flood events evaluated. After construction of the new levee, a large amount of excavated spoil material would remain unused. Hauling the waste spoil to a disposal location can be more expensive than incorporating that material into a larger levee structure. As required for all Corps-built flood risk management projects, the proposed levee was designed to maximize National Economic Development (NED) benefits. The cost of increasing the levee's height in one-foot increments was evaluated relative to the increment benefit of reduced flood damages afforded by the taller levee. NED benefits were maximized by a levee structure 4 feet taller than the 1percent-chance event structure. Still, a significant amount of spoil material requiring disposal results from the proposed levee's design. Table1 summarizes the amount of excavation, usable soil material, and disposal material, showing that there would be approximately 3 million cubic yards (1,881 acre-feet) of spoil material requiring disposal.

Table 1. Excavation and disposal quantities for the proposed action.

Item	Material Volume (cubic yards)
Excavated from spoil bank	5,233,730
Excavated from East Side Excavation	152,650
Excavation subtotal	*5,386,380*
Used as random fill in new levee	2,176,901
Used in rip rap toe protection (screened oversized waste)	174,152
Used subtotal	*2,351,053 (43.7percent of excavated)*
Disposal total	3,035,327 (1,881 acre-feet)

Three potential alternatives for the disposal of spoil waste would be employed in the proposed action. A number of existing borrow areas occur near the project area and could be used as disposal locations for the spoil waste generated during levee construction. The Corps would evaluate the cost effectiveness of utilizing these disturbed areas as disposal locations. Only locations that are devoid of significant ecological or cultural resources would be utilized. Secondly, where the proposed levee would be narrower than the existing spoil bank, there may be opportunities to slightly shift the base of the new levee riverward while remaining within the disturbed footprint of the spoil bank. In these instances, some waste spoil (up to 656,000 cubic yards) could be deposited on the landward slope of the new levee structure. The default location for the disposal of spoil waste evaluated in this Opinion is within the undeveloped Tiffany Basin at the south end of the project area.

Although the ground surface in the Tiffany Basin is lower than the current riverbed, the basin would only be inundated due to failure of the spoil bank along its eastern edge. Corps estimated that a 10 percent chance exceedance flow (15,400 cfs at SADD; or over 10,000 cfs near San Marcial, New Mexico) would not be contained in the floodway (USACE 2012b, Appendix F). A spoil deposition area of up to 300 acres would accommodate the waste material from the proposed levee (3 million cubic yards, or 1,881 acre-feet). At the higher discharge 10.0%-chance exceedance probability, breaching in the two, modeled potential locations does occur and reaches a point sufficient to divert all of the river flow into the Tiffany Basin (USACE 2012b, Appendix F, page 44). The area considered for spoil deposition is currently vegetated by species of tamarisk (*Tamarix* sp.), a nonnative, riparian shrub (USACE 2012a).

Conservation Measures

The Corps proposes to implement the following conservation measures as part of its proposed action.

1. Corps proposes to establish 50.4 acres of dense woody plantings in the action area due to footprint effects of the San Acacia Levee Project (USACE 2013).

2. Beginning with the breeding season prior to the initiation of each phase of construction, the Corps will perform or fund annual flycatcher protocol surveys (five visits per site per season) along the western bank of the floodway, eventually extending from San Acacia to San Marcial. Annual surveys would continue until the completion of construction and would continue for five years following the phased construction of each levee segment. (USACE 2012a)

3. Levee and floodwall construction may occur throughout the calendar year; however, no construction would be performed within 0.25 mile of occupied flycatcher breeding territories (generally, late May through August 15). Traffic associated with construction activities may continue along the construction alignment adjacent to occupied flycatcher breeding territories. All construction equipment and large trucks would be restricted to the maintenance roads adjacent to the LFCC. The levee and/or spoil bank would serve as a buffer between this traffic and flycatchers within the floodway. Small vehicles (*e.g.*, pickup trucks and SUVs) would occasionally travel along the top of the spoil bank / levee, as they do currently. (USACE 2012a)

4. Vegetation removal and clearing-and-grubbing activities would be performed between August 15 and April 15. If needed, vegetation removal between April 15 and August 15 would only be performed if inspection by a qualified biologist determines that flycatchers (including both migrant and territorial birds) are not present within 500 feet of the vegetation patch to be removed. (USACE 2012a)

5. If stream flow exists, it would be maintained during construction and the streambed contoured so that fish can migrate through the project area during and after construction. (USACE 2012a)

6. Silt curtains, cofferdams, dikes, straw bales and other suitable erosion control measures would be employed to prevent sediment-laden runoff or contaminants from entering any watercourse. (USACE 2012a)

7. Work would be performed below the elevation of the ordinary high water mark only during low-flow periods. This includes placement of the lower portions of the soil-cement wall, riprap blankets, and excavation along the east bank downstream from the SADD. No erodible fill materials would be placed below the elevation of the ordinary high water mark (USACE 2012a)

8. Qualified fisheries biologists would evaluate measures to exclude fish from in-channel construction areas. Cofferdams and silt curtains would be deployed by Corps biologists from the shoreline into the channel to exclude fish from construction areas where possible. If appropriate, biologists would coordinate with Service's Fisheries personnel to seine areas prior to placement of barriers in the construction area. (USACE 2012a)

9. Concrete would be poured in forms and would be contained to prevent discharge into the river. Wastewater from concrete batching, vehicle wash down, and aggregate processing would be contained, and treated or removed for off-site disposal. (USACE 2012a)

10. Fuels, lubricants, hydraulic fluids and other petrochemicals would be stored outside the 1%-chance floodplain (i.e., not within the floodway), if practical. At the least, staging and fueling areas would be located west of the LFCC and would include spill prevention and containment features. (USACE 2012a)

11. Construction equipment would be inspected daily to ensure that no leaks or discharges of lubricants, hydraulic fluids or fuels occur in the aquatic or riparian ecosystem. Any petroleum or chemical spills would be contained and removed, including any contaminated soil. (USACE 2012a)

12. Only uncontaminated earth or crushed rock for backfills would be used. (USACE 2012a)

13. Water quality would be monitored during construction to ensure compliance with state water quality standards for turbidity, pH, temperature, oxygen, and dissolved solids. (USACE 2012a)

II. STATUS OF THE SPECIES

The proposed action considered in this BO may affect the silvery minnow and the flycatcher that is provided protection as an endangered species under the ESA. A description of these species, its status, and designated critical habitat are provided below and informs the effects analysis.

RIO GRANDE SILVERY MINNOW (SILVERY MINNOW)

Description

The silvery minnow currently occupies a 170-mile reach of the Rio Grande, from Cochiti Dam in Sandoval County, to the headwaters of Elephant Butte Reservoir in Socorro County (Service 2010). This includes a small section of the lower Jemez River, a tributary to the Rio Grande north of Albuquerque. The silvery minnow's current habitat is limited to approximately seven percent of its former range, and is split into four discrete reaches by three river-wide dams (Figure 3).

Silvery minnows are a stout fish, with a small, subterminal mouth, with long pharyngeal dentition with a distinct grinding surface and a pointed snout that projects beyond the upper lip (Sublette et al. 1990). The back and upper sides of silvery minnow are silvery to olive, the broad middorsal stripe is greenish, and the lower sides and abdomen are silver. The fins are moderate in length and variable in shape, with the dorsal and pectoral fins rounded at the tips. The body is fully scaled, with breast scales slightly embedded and smaller. The scales about the lateral line are sometimes outlined by melanophores, suggesting a grid pattern. The eye is small and orbit diameter is much less than gape width or snout length (Bestgen and Propst 1996). Maximum total length attained in New Mexico specimens is about 3.5 inches (90 mm) (Sublette et al. 1990). The only readily apparent sexual dimorphism is the expanded body cavity of ripe females

prior to spawning (Bestgen and Propst 1994); however, there are some notable differences. The pectoral fins of males flare broadly from their base to a triangular fan shape, while those of females are shorter, narrower, and oval shaped. The pectoral rays of breeding males are thickened, while those of females are slender, and the pectoral fin length in males is also significantly greater.

In the past, the silvery minnow was included with other species in the genus *Hybognathus* due to morphological similarities, including a distinct, convex jaw. Phenetic and phylogenetic analyses corroborate the hypothesis that *Hybognathus amarus* is a distinct valid taxon, and separate from other species of *Hybognathus* (Cook et al. 1992; Bestgen and Propst 1994), particularly the placement of its subterminal mouth. It is now recognized as one of seven species in the genus *Hybognathus* in the United States and was formerly one of the most widespread and abundant minnow species in the Rio Grande basin of New Mexico, Texas, and Mexico (Pflieger 1980; Bestgen and Platania 1991). Currently, *Hybognathus amarus* is the only remaining endemic, pelagic-spawning minnow in the Middle Rio Grande. The speckled chub (*Macrhybopsis aestivalis*), Rio Grande shiner (*Notropis jemezanus*), phantom shiner (*Notropis orca*), and bluntnose shiner (*Notropis simus simus*) are either extinct or have been extirpated from the Rio Grande (Bestgen and Platania 1991).

Legal Status

The silvery minnow was federally listed as endangered under the ESA on July 20, 1994 (58 Federal Register [FR] 36988, see USFWS 1994). Primary reasons for listing the silvery minnow are described below in the *Reasons for Listing/Threats to Survival* section. The Service designated critical habitat for the silvery minnow effective March 21, 2003 (68 FR 8088, USFWS 2003b). See description of designated critical habitat below. The species is also listed as an endangered species by the state of New Mexico (19 NMAC 33.1), the state of Texas (sections 65.171–65.184 of Title 31 Texas Annotated Code), and the Republic of Mexico (SDS 1994). Silvery minnows were also introduced into the Rio Grande near Big Bend, Texas, in December 2008 as an experimental, nonessential population under section 10(j) of the ESA.

Habitat

Silvery minnows travel in schools and tolerate a wide range of habitats (Sublette et al. 1990), yet

are commonly found in waters with low velocity (less than 10 centimeters per second [cm/s] (0.33 feet per second [ft/s])) in areas over silt or sand substrate associated with aquatic habitats such as shallow braided runs, backwaters, or pools (Dudley and Platania 1997, Watts et al. 2002). Habitat for silvery minnows includes stream margins (i.e., shoreline or shoal), side channels, and off-channel pools where water velocities are low or reduced. Stream reaches dominated by straight, narrow, incised channels with rapid flows are not typically occupied by silvery minnows (Sublette et al. 1990; Bestgen and Platania 1991). This preference for low velocity habitat, especially for survival and recruitment of larval and juvenile silvery minnows, characterizes the habitat use and recruitment conditions of most common native Rio Grande fishes (Pease et al. 2006).

Passively drifting eggs and larvae are found throughout all habitat types, whereas adult silvery minnows are most commonly found in backwaters, pools, and habitats associated with debris piles, and young of year (YOY) (age-0) fish occupy shallow, low velocity backwaters with silt substrates (Dudley and Platania 1997). Dudley and Platania (1997) reported that silvery minnows were most commonly found in habitats with depths less than 50 cm (19.7 in). Over 85 percent were collected from low-velocity habitats (less than 10 cm/s [0.33 ft/s]) (Dudley and Platania 1997; Watts et al. 2002). During winter, silvery minnows tend to concentrate in low velocity areas in conjunction with vegetation or debris for cover, (Dudley and Platania 1996; Dudley and Platania 1997; Bixby and Burdett 2009). Silvery minnows are generally not found associated with cool water, cobble substrates, strong velocities, high salinity, highly channelized reaches, low oxygen conditions, or dry river bed areas (USFWS 2003a, 2003b; 2010, 2011a).

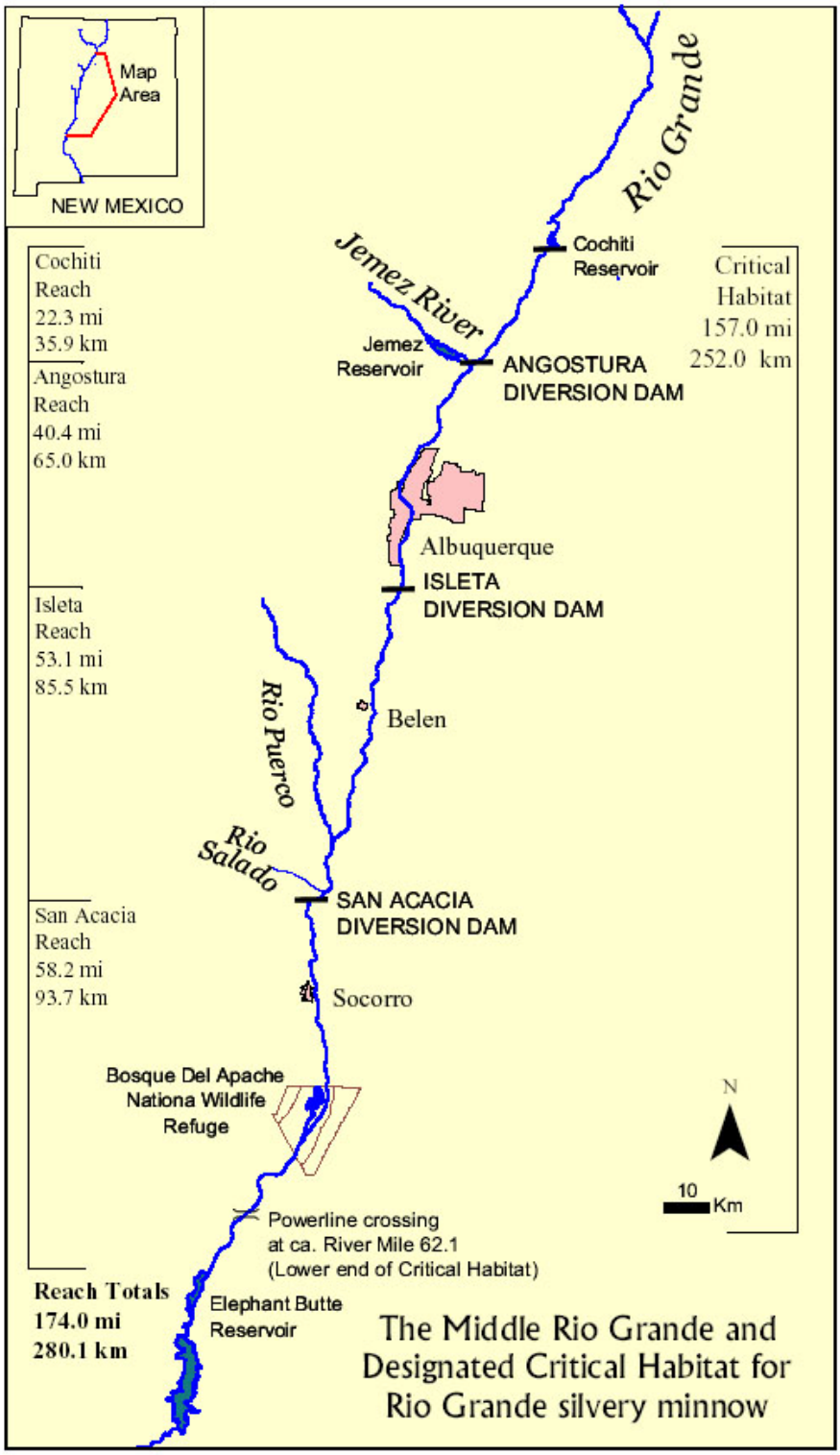

Figure 3. Location of the Cochiti, Angostura, Isleta, and San Acacia Reaches and selected major features in the Middle Rio Grande, New Mexico.

Designated Critical Habitat

Silvery minnow critical habitat designation extends approximately 157 miles from Cochiti Dam in Sandoval County, New Mexico, downstream to the utility line crossing the Rio Grande just east of the Bosque Well demarcated on USGS (1980) Paraje Well 7.5-minute quadrangle map at the Universal Transverse Mercator coordinates in Zone 13, 311474 meters East by 3719722 meters North. The utility line crossing is a permanent, identified landmark in Socorro County, New Mexico, just north of Elephant Butte Reservoir at River Mile 62.1 (USFWS 2003b). The interior boundaries of the Pueblos of Sandia, Santo Domingo, Santa Ana, and Isleta within the MRGV are not included in designated critical habitat because each Pueblo has management plans to protect their own silvery minnows. The remaining portion of the silvery minnow's occupied range in the Middle Rio Grande is designated as critical habitat (USFWS 2003b).

The critical habitat designation defines the lateral extent (width) as those areas including the Rio Grande and riparian zone bounded by existing levees or, in areas without levees, 300 feet of riparian zone adjacent to each side of the bankfull stage of the Rio Grande. Some developed lands within the riparian zone are not considered designated critical habitat, as they do not contain the appropriate the primary constituent elements (PCEs), and are therefore not essential to the conservation of the silvery minnow. Lands located within the lateral boundaries of the critical habitat designation, but not considered critical habitat include: developed flood control facilities, existing paved roads, bridges, parking lots, dikes, levees, diversion structures, railroad tracks, railroad trestles, water diversion and irrigation canals outside of natural stream channels, the Low Flow Conveyance Channel, active gravel pits, cultivated agricultural land, and residential, commercial, and industrial developments that existed at the time critical habitat designation became effective (i.e., March 21, 2003; USFWS 2003b).

The Service (USFWS 2003b) recognized that the lateral width of riparian area along the river channel provides an important function for the protection and maintenance of the PCEs and is essential to the conservation of the species. The Service selected the 300-ft (91.4-m) lateral extent, rather than some other delineation, for three reasons: 1) The biological integrity and natural dynamics of the river system are maintained within this area. The floodplain and its riparian vegetation provide space for natural flooding patterns and latitude for necessary natural channel adjustments to maintain appropriate channel morphology and geometry, store water for slow release to maintain base flows, provide protected side channels and other protected areas for larval and juvenile silvery minnow, allow the river to meander within its main channel in response to large flow events, and recreate the mosaic of habitats necessary for the conservation of the silvery minnow; 2) Conservation of the adjacent riparian zone also helps provide essential nutrient recharge and protection from sediment and pollutants, which contributes to successful spawning and recruitment of silvery minnows; and, 3) vegetated lateral zones are widely recognized as providing a variety of aquatic habitat functions and values (e.g., aquatic habitat for fish and other aquatic organisms, moderation of water temperature changes, and detritus for aquatic food webs) and help improve or maintain local water quality (USFWS 2003b). Riparian areas are seasonally flooded habitats that are major contributors to a variety of vital functions within the associated stream channel (Federal Interagency Stream Restoration Working Group 1998, Brinson et al. 1981). They are responsible for energy and nutrient cycling, filtering runoff,

absorbing and gradually releasing floodwaters, recharging groundwater, maintaining streamflow, protecting stream banks from erosion, and providing shade and cover for fish and other aquatic species. Healthy riparian areas help ensure watercourses maintain the habitat components essential to the silvery minnow (USFWS 2003b).

The Service determined the PCEs of silvery minnow designated critical habitat based on studies on silvery minnow habitat and population biology. Critical habitat containing these PCEs provide for the physiological, behavioral, and ecological requirements essential to the conservation of the silvery minnow. These PCEs include:

1. a hydrologic regime that provides sufficient flowing water with low to moderate currents capable of forming and maintaining a diversity of aquatic habitats, such as, but not limited to the following: backwaters (a body of water connected to the main channel, but with no appreciable flow), shallow side channels (anabranches), pools (that portion of the river that is deep with relatively little velocity compared to the rest of the channel), and runs (flowing water in the river channel without obstructions) of varying depth and velocity, all of which are necessary for each of the particular silvery minnow life history stages in appropriate seasons (e.g., the silvery minnow requires habitat with sufficient peak flows from early spring (March) to early summer (June) to trigger spawning, flows in the summer (June) and fall (October) that do not increase prolonged periods of low or no flow, and relatively constant winter flow (November through February));

2. the presence of eddies created by debris piles, pools, or backwaters, or other refuge habitat within unimpounded stretches of flowing water of sufficient length (i.e., river miles) that provide a variation of habitats with a wide range of depth and velocities;

3. substrates of predominantly sand or silt; and,

4. water of sufficient quality to maintain natural, daily, and seasonally variable water temperatures in the approximate range of greater than 1 degree Celsius (C) (35 degrees Fahrenheit [°F]) and less than 30 °C (85 °F) and reduce degraded conditions (e.g., decreased DO, increased pH).

These PCEs provide for the physiological, behavioral, and ecological requirements essential to the conservation of the silvery minnow. While all of these PCEs are found in each of the four reaches of the MRGV, it does not imply that optimal conditions for silvery minnow occur equally throughout this designated critical habitat. Therefore, it should not be assumed that silvery minnows will occur in all portions of this critical habitat at all times.

Significantly and detrimentally altering the characteristics of the 300-ft (91.4-m) lateral width (e.g., parts of the floodplain) in the designated critical habitat of the middle Rio Grande can include vegetation manipulation, timber harvest, road construction and maintenance, prescribed fire, livestock grazing, off-road vehicle use, power line or pipeline construction and repair, mining, and urban and suburban development with a Federal nexus. Significantly and

detrimentally altering the channel morphology (e.g., depth, velocity) of any of the river reaches within the designation can include channelization, impoundment, road and bridge construction, deprivation of substrate source, reduction of available floodplain, removal of gravel or floodplain terrace materials, reduction in stream flow, and excessive sedimentation from mining, livestock grazing, road construction, timber harvest, off-road vehicle use, and other watershed and floodplain disturbances with a Federal nexus.

Federal actions that are found likely to destroy or adversely modify critical habitat may often be modified, through development of reasonable and prudent alternatives, in ways that will remove the likelihood of destruction or adverse modification of critical habitat. Such project modifications may include such things as adjustment in timing of projects to avoid sensitive periods for the species and its habitat; replanting of riparian vegetation; minimization of work and vehicle use in the main river channel or the 300-ft (91.4-m) lateral width; restriction of riparian and upland vegetation clearing in the 300-ft (91.4-m) lateral width; fencing to exclude livestock and limit recreational use; use of alternative livestock management techniques; avoidance of pollution; minimization of ground disturbance in the 300-foot lateral width; use of alternative material sources; storage of equipment and staging of operations outside the 300-foot lateral width; use of sediment barriers; access restrictions; and use of best management practices to minimize erosion.

Life History

Silvery minnow is a pelagic spawner and a female may produce as many as 3,000 to 6,000 semibuoyant, nonadhesive eggs during a spawning event (Platania 1995; Platania and Altenbach 1998; Dudley and Platania 2008a). The majority of adults in the wild spawn in about a 1-month period in late spring to early summer (May to June) in association with spring runoff. Platania and Dudley (2000) found that the highest numbers of silvery minnow eggs collected from the river channel occurred in mid- to late May. These data suggest silvery minnow spawning events during the spring are concurrent with peak flows. Artificial flow spikes in spring have apparently induced silvery minnows to spawn (Platania and Hoagstrom 1996; USACE 2009).

High spring flows, high water levels, and turbidity (i.e., particles preventing observation depth or spectra in the water column) generally preclude direct observations of silvery minnow spawning behavior and location(s) in the wild (Platania and Altenbach 1998; Caldwell 2003). In captivity, silvery minnows have been induced to spawn up to four times in a year (Altenbach 2000); however, it is unknown if individual silvery minnows spawn more than once per year in the wild or if multiple spawning events during spring and summer represent same or different individuals. The spawning strategy of releasing semibuoyant eggs can result in the downstream displacement of eggs, especially in years or locations where overbank-flooding opportunities are limited. The presence of irrigation water diversion dams (Angostura, Isleta, and San Acacia Diversion Dams) prevents the movement of adults to recolonize habitats upstream of these dams (Platania 1995) and has reduced the species' effective population size to critically low levels (Alò and Turner 2005; Osborne et al. 2005). Adults, eggs, and larvae may also be transported downstream and into to Elephant Butte Reservoir. It is believed that few to none of these fish survive because of poor habitat conditions and predation from reservoir fishes (USFWS 2010a). Also, silvery

minnow eggs that enter Elephant Butte Reservoir may settle out along with substrate as velocity decreases in the delta area (i.e., where the river meets the reservoir) and subsequently suffocate as they are buried with silt and sediment (Platania and Altenbach 1998, p. 55).

Platania (2000) found that development of larval fish and hatching of eggs are correlated with water temperature. Eggs of silvery minnows raised in water at 30 °C (86 °F) hatched in approximately 24 hr while eggs reared in 20 to 24°C (70 to 75 °F) water hatched within 50 hr. Eggs were 1.52 mm (0.06 in) in diameter upon fertilization, but quickly swelled to 3.05 mm (0.12 in) during water exposure. Salinity and suspended sediment may affect the specific gravity of silvery minnow eggs, potentially affecting their survival and rate of downstream transport (Cowley et al. 2009).

Recently hatched larval fish are about 3.81 mm (0.15 in) in standard length and grow about 0.13 mm (0.005 in) per day during development though various larval stages. Eggs and larvae have been estimated to remain in the drift for 3 to 5 days, and could be transported from 216 to 359 km (134 to 223 mi) downstream depending on river flows, obstructions to flow, and availability of nursery habitat (Platania and Dudley 2000; Fluder et al. 2007). Approximately 3 days after hatching the larvae move to low velocity habitats where food (mainly algae (i.e. phytoplankton) and small animals (i.e. zooplankton)) is abundant (Pease et al. 2006). The Age-0 fish attain lengths of 39 to 41 mm (1.53 to 1.61 in) by late autumn (USFWS 2010a). Age-1 fish are approximately 46 mm (1.8 in) by the start of the spring spawning season. Most growth occurs between June (post spawning) and October, but there is some growth during the winter months. Maximum longevity is about 30 months for wild fish (inferred from length-frequency), or up to 36 months based on findings from a study of otolith and scale examinations on wild fish (Horwitz et al. 2011), and up to 36 months for hatchery-released fish (USFWS 2010a).

In laboratory experiments, Bestgen et al. (2010) found that adult silvery minnow are capable of relatively high-speed and long-distance swimming. Mean critical swimming speed for silvery minnows was 51.5 cm/s, with faster sustained swimming speeds for larger fish. Silvery minnow were capable of swimming for longer durations at lower water velocities and warmer water temperatures. Endurance is a function of significant effects of water velocity, water temperature, and fish total length. Individual have the ability to swim several kilometers is just a few hours (up to 125 km) and are capable of moving long distances upstream as part of their life history. In 2006, the Service's New Mexico Fish and Wildlife Conservation Office conducted an experimental study of stocking success for silvery minnows reared in captive propagation facilities and released throughout their current range. The data from this study provided addition information on movement of hatchery reared silvery minnows following their release. The recapture data indicated that movement was generally downstream, with the majority of recaptures within 16 to 24 km (10 to 15 mi) downstream of the release site. The maximum distance traveled from release to recapture was 59.4 km (36.9 mi) downstream 300 days following release. Upstream movement was minimal; however, some individuals were documented upstream from their release sites. The maximum upstream distance traveled was 37.7 km (23.4 mi) 246 days following release (Remshardt and Archdeacon 2011).

Based on estimated length groups for assigning an age class, it is possible that some individuals in the wild survive to be Age-3 fish; however greater than 95 percent of the population in any given year is estimated to comprise Age-0 and Age-1 fish (USFWS 2010a). In the wild, the silvery minnow is a very short-lived species that exhibits similar patterns of growth, survival, and longevity as compared with several other closely related species of *Hybognathus* (Horwitz et al. 2011). In comparison to longevity in the wild, it is common for captive-reared, silvery minnows to live beyond 4 years, especially at lower water temperatures. For example, the USGS Columbia Environmental Research Center research station in Yankton, South Dakota, has several silvery minnows in captivity with a maximum age of 11 and that range in size from 46 to 73 mm (1.8 to 2.9 in) standard length (USFWS 2010a).

Silvery minnow foraging strategies are often demersal (feeding along or near the river substrate) and primarily herbivorous (largely feeding on algae and other plant materials); this is indicated indirectly by the elongated and coiled gastrointestinal tract (Sublette et al. 1990); also Shirey (2004) and Magaña (2009) found diatoms (algae with cell walls made of silica) were a main component of their identifiable gut contents. Silvery minnows reared in a laboratory have been directly observed grazing on algae in aquaria (Platania 1995; Magaña 2009; USFWS 2010a). Additionally, in wild silvery minnows, organic detritus, larval insect exuvia, and small invertebrates, as well as sand, and silt are often filtered from the bottom and ingested (Sublette et al. 1990; USFWS 1999; Magaña 2009). The presence of this sand and silt in the gut of wild-captured specimens suggests that epipsammic algae (i.e., algae growing on surface of sand, such as species of diatoms) is an important food (Magaña 2009; USFWS 2010a). As silvery minnows age and grow, their feeding can include more prey variety (Pease et al. 2006; Magaña 2007).

Population Dynamics

Generally, a population of silvery minnows consists of only two age classes: Age-0 and Age-1 fish (USFWS 2010a; Horwitz et al. 2011). The majority of spawning silvery minnows is 1 year in age, with 2 year-old fish and older estimated to comprise less than 5 percent of the spawning population (USFWS 2010a). High mortality of silvery minnows occurs during or subsequent to spawning, consequently fewer adults have been found in late summer and fall. By December, in general, the majority of surviving silvery minnows are represented by Age-0 fish, those that hatched during the previous spring (Dudley and Platania 2007; Remshardt 2007, 2008a,b).

Platania (1995a) found that a single female in captivity could broadcast 3,000 eggs in 8 hr. Females produce 3 to 18 clutches of eggs in a 12-hr period. The mean number of eggs in a clutch is approximately 270 (Platania and Altenbach 1998). In captivity, silvery minnows have been induced to spawn as many as four times in a year (Altenbach 2000). It is not known if they spawn multiple times in the wild. The high reproductive potential of this fish appears to be one of the primary reasons that it has not been extirpated from the Middle Rio Grande. However, the short life span of silvery minnows and environmental variation in their habitat increases the instability of the population. For example, when two below-average flow years occur consecutively, a short-lived species such as the silvery minnow can be impacted, if not eliminated from drying reaches of the Rio Grande (USFWS 1999, 2003a, 2010a).

Distribution and Abundance

Historically, the silvery minnow likely occurred in 3,967 km (2,465 mi) of rivers in New Mexico and Texas and was one of the most abundant and widespread species in the Rio Grande Basin (Bestgen and Platania 1991). The species was known to have occurred upstream to Española, New Mexico (upstream from Cochiti Lake); in the downstream portions of the Rio Chama and Jemez River; throughout the Middle and Lower Rio Grande to the Gulf of Mexico; and in portions of the Pecos River from Sumner Reservoir downstream to the confluence with the Rio Grande (Sublette et al. 1990; Bestgen and Platania 1991). The current distribution of the silvery minnow is limited to the Rio Grande between Cochiti Dam and Elephant Butte Reservoir, which amounts to approximately 7 percent of its historical range. In December 2008, 2009, and 2010, silvery minnows were introduced into the Rio Grande near Big Bend, Texas, as a nonessential, experimental population under section 10(j) of the ESA (73 FR 74357, USFWS 2008a). The success of these efforts is evaluated through monitoring of the silvery minnows reintroduced into that portion of the Rio Grande and is ongoing. In 2010, the Service found evidence of successful reproduction with the detection of silvery minnow eggs, larval and juvenile fish. In 2011, silvery minnows had distributed 70 miles further downstream and 15 miles upstream of their distribution in 2010. Success of the Big Bend 10(j) population will continue to be evaluated and relevant information incorporated into the assessment for potential reintroductions in additional locations.

The Rio Grande, prior to widespread human influence, was a wide, perennially flowing, aggrading river characterized by a shifting sand substrate (Biella and Chapman 1977). The river freely migrated across a wide floodplain and was limited only by valley terraces and bedrock outcroppings. Throughout much of its historic range, the decline of the silvery minnow can be attributed in part to destruction and modification of its habitat due to dewatering and diversion of water, water impoundment, and modification of the river (channelization). The construction of mainstem dams, such as Cochiti Dam and several irrigation diversion dams, have contributed to the decline of the silvery minnow (USFWS 2010a). Cochiti Dam was constructed on the main stem of the Rio Grande in 1973 for flood control and sediment retention (Julien et al. 2005). The construction of Cochiti Dam affected the silvery minnow by reducing the magnitude and frequency of peak flow events and floods that help to create and maintain habitat for the species (Dudley and Platania 1997; Julien et al. 2005). In addition, the construction of Cochiti Dam has resulted in degradation of silvery minnow habitat within the Cochiti Reach downstream of the Cochiti Dam. Water released through Cochiti Dam is now generally clear, cool, and free of sediment. Below Cochiti Dam, there is relatively little channel braiding, and areas with reduced velocity and sand or silt substrates are now uncommon (Julien et al. 2005). Cochiti Dam also created a barrier for movement upstream by silvery minnows (USFWS 2010a). As recently as 1963, silvery minnows were collected upstream of Cochiti, New Mexico; however surveys since 1983 suggest that silvery minnows are now extirpated from in or above Cochiti Reservoir (USFWS 2010a).

Substrate immediately downstream of Cochiti Dam is often composed of gravel and cobble (rounded rock fragments generally 8 to 30 cm [3 to 12 in] in diameter). Farther downstream, the riverbed is gravel with some sand and silt substrate. Tributaries including Galisteo Creek and Tonque Arroyo introduce sand and silt during stormwater runoff to the lower sections of the Cochiti Reach, and some of this sediment is transported further downstream along with flows (Salazar 1998; USFWS 1999, 2001).

Long-term monitoring of silvery minnows in the Middle Rio Grande began in 1993 and has continued annually, with the exception of 1998 (Dudley et al. 2012a). The long-term monitoring of silvery minnows has recorded dramatic annual fluctuations in density, measured in October, over time (Figure 3). For example, silvery minnow catch rates declined two to three orders of magnitude between 1993 and 2003, but then increased three to four orders of magnitude by 2005 and continue to fluctuate (Figure 3). Catch rate data suggest that the population of silvery minnows declined through early 2000, increased by 2005, and during 2010 and 2011, were below their levels at the time of their listing as an endangered species in 1994. The recent capture of zero wild silvery minnows during October 2012 population monitoring indicated that silvery minnow populations are not stable and have declined precipitously (Dudley et al. 2012). Catch of silvery minnow, in October, was positively correlated with the magnitude and duration of the spring runoff (Dudley and Platania 2008b). However, errors associated silvery minnow catch and distribution appears to complicate direct comparisons of catch rates (Goodman 2012).

Augmentation with hatchery-reared silvery minnows has likely sustained the silvery minnow population throughout its range over the last decade (Remshardt 2008b). Nearly 1,750,000 silvery minnows have been released since 2002. Hatchery-propagated and released fish supplement the native adult population, most likely prevented extinction during the extremely low water years of 2002, 2003, and 2012, and allowed for quicker and more robust population response in all reaches due to improved water conditions observed in recent years (USFWS 2010a). Since 2008, augmentation has only occurred in the Isleta and San Acacia Reaches in order to monitor the success of previous stocking efforts in the Angostura Reach (USFWS 2011a).

Dudley et al (2012a) reported the catch rate of silvery minnows from 0 per 100 m^2 in the San Acacia Reach, whereas, average catch rate was 0.03 per 100 m^2 in September 2012. Population monitoring efforts from February 1993 to September 2011, had an average density of silvery minnows in the San Acacia Reach of 15.9 (±82.2) per 100 m^2 and ranging from 0 to 1,742 per 100 m^2 (without considering silvery minnow density in isolated pools, n=1,217). Approximately 144,000 hatchery-reared silvery minnows were released at sites in the San Acacia Reach during November 2012 (T. Archdeacon, Service, 26 November 2012, written communication). However, the low number of wild silvery minnow collected during September 2012 and their absence in October 2012 confirms that there was very poor survival and recruitment following spawning earlier in 2012 (Dudley et al. 2012a).

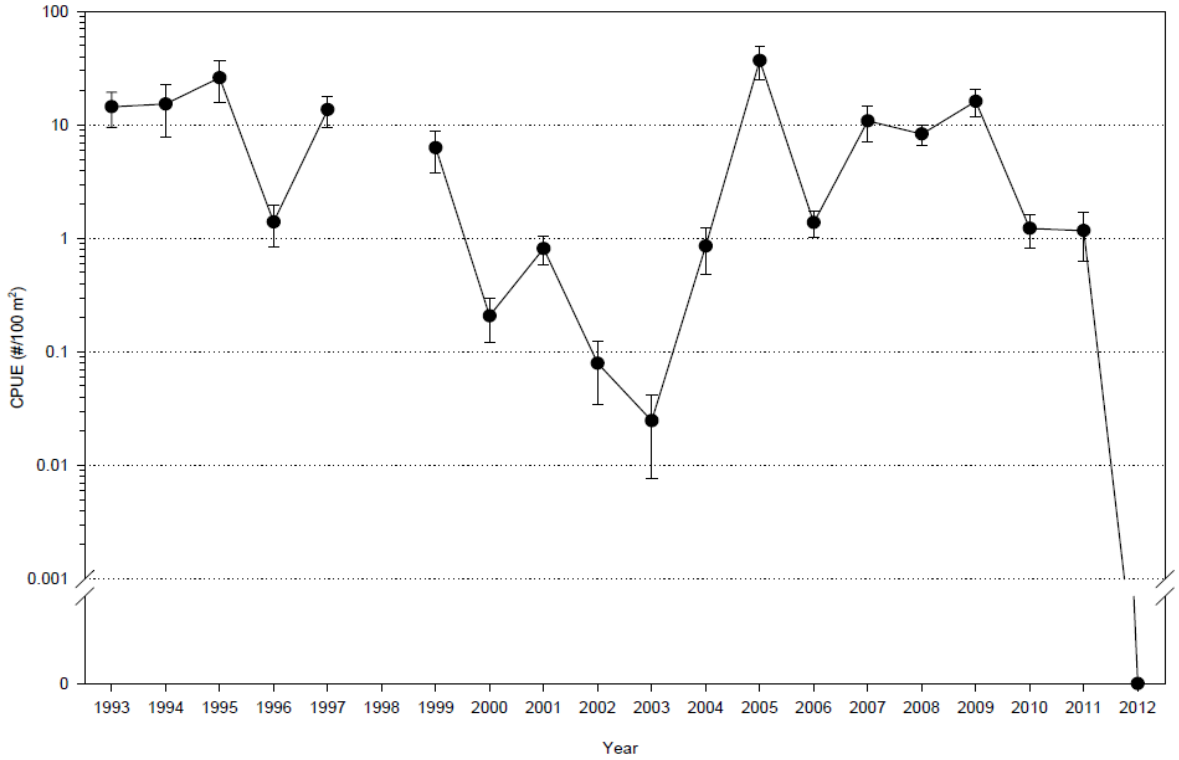

Figure 4. Annual October monitoring summary of silvery minnow catch per unit effort (number of fish per 100 square meters during 1993 to 2012 (Dudley et al 2012a).

Middle Rio Grande Distribution Patterns

During the early 1990s, the catch rates of silvery minnows generally increased from upstream (Angostura Reach) to downstream (San Acacia Reach). During surveys in 1999, over 98 percent of the silvery minnows captured were downstream of SADD (Dudley and Platania 2002). This distributional pattern can be attributed to downstream drift of eggs and larvae and the inability of adults to repopulate upstream reaches because of diversion dams. For this reason, an absence of continuous flow in the San Acacia Reach would likely have a disproportionately greater negative effect on silvery minnows when there is a large portion of the silvery minnow population affected by drying events. The San Acacia Reach is often the first of the four reaches of the Middle Rio Grande to experience drying (Platania and Dudley 2003).

This pattern shifted in several recent years. In 2004, 2005, and 2007, catch rates were highest in the Angostura Reach and lower in the Isleta and San Acacia Reaches. Routine augmentation of silvery minnows in the Angostura Reach (the focus of augmentation efforts started in 2001) may partially explain this pattern. Transplanting of silvery minnows (approximately 802,700 through 2009) rescued from drying reaches has also occurred since 2003. It is not possible to quantify the effects of those rescue efforts on the silvery minnow population distribution patterns (Remshardt 2010b). Good recruitment conditions (high and sustained spring runoff) throughout the Middle Rio Grande during April and May followed by wide-scale drying in the Isleta and

San Acacia Reaches from June to September may also explain the shift. High spring runoff greater than 86 m^3/s (3,000 cubic feet per second [cfs]) for 7 to10 days and perennial flow tends to lead to increased nursery habitat and survivorship. In recent times, portions of the Rio Grande south of the Isleta and San Acacia Diversion Dams have had large stretches of river (0.8 to 93.5 miles, average 34.7 miles (USBR 2012) routinely dewatered. Silvery minnows in these areas were subjected to poor recruitment conditions (lack of nursery habitats during low flows) or were trapped in drying pools where many perished (USFWS 2010a).

Reports for 2008 indicated high recruitment, at all 20 sampling sites along the Middle Rio Grande, and strong runoff over an extended duration from May to July lead to elevated numbers of this species. Sampling in October 2009, indicated high recruitment, at 19 of the 20 sampling sites. The highest densities were noted to persist in the San Acacia Reach during the population monitoring in October of 2008, 2009, 2010, and 2011. The lack of extensive river drying in 2008 and 2009, and favorable spring peak flows, was likely an important factor in this distribution shift from highest densities in the Angostura Reach in 2007 to the San Acacia Reach in 2008 and 2009 (Dudley and Platania 2008a, 2008b, 2009). During 2010, the silvery minnow was the most common fish species caught in the San Acacia Reach and the least common in the Angostura Reach during monitoring (Dudley and Platania 2010). In late 2010, the Isleta and San Acacia Reaches were stocked with hatchery-raised silvery minnows, and this activity was apparently the primary cause for increased silvery minnow catch rates in those reaches (Dudley and Platania 2011).

Even though densities of silvery minnows have shown a tendency to track hydrological patterns, site occupancy data has determined that there has been about a 2% decline since 2005 in the number of occupied sampling units (Dudley et al. 2011a,b,c). This reduced site occupancy has indicated a cumulative loss of about 10% occupied sites in 5 years (Dudley et al. 2011a,b,c).

Population Estimate

Since 2006, the Middle Rio Grande Endangered Species Collaborative Program (MRGESCP) has funded studies to investigate methods for estimating population size for the Rio Grande silvery minnow (Dudley et al. 2011a,b,c, 2012b). This study was structured to provide estimation for the population of Rio Grande silvery minnow based on data collected from 20 sampling units in the study area. Sampling units were selected randomly using a spatially balanced statistical design to maintain an unbiased probability of sampling at localities that support differing densities of silvery minnow. The 2008 estimate incorporated sampling efficiencies by habitat and is considered the most reliable estimate to date. In 2008, silvery minnow numbers were highest in the Isleta Reach (N = 1,027,489) and lowest in the San Acacia Reach (N = 404,864). In October 2009, population estimates were highest in the Isleta Reach (N = 1,602,348) and lowest in the San Acacia Reach (N = 923,352). The total population estimate

for all three reaches was 3,476,873 (Dudley et al. 2011b). In October 2010, the overall population estimate decreased to 267,272 for all three reaches (Dudley et al. 2011c). The 2011 population estimation data suggested that the silvery minnow population declined as compared with 2010 (Dudley et al. 2012b) and undoubtedly declined further in 2012 as indicated by the lack of detection during population monitoring of silvery minnows in the San Acacia Reach (Dudley et al. 2012a).

Genetics

The ability of a species to persist long term is determined in part by the amount of genetic variation that is retained by a species. As a population declines, genetic variation is lost and can lead to reduced viability and reproductive capability (Falconer 1981, Ralls and Ballou 1983), affect a species' ability to adapt and respond to environmental changes, and can ultimately heighten the risk of extinction (Frankham 1995, Higgins and Lynch 2001). Evaluations of genetic data collected for the Rio Grande silvery minnow indicate that overall, mitochondrial (mt) DNA diversity declined nearly 18 percent between 1987 and 2005. There have been two sharp declines in mt DNA diversity in the "wild" Rio Grande silvery minnow population. The first occurred in 1999, the second in 2001 (Alò and Turner 2005, Turner et al. 2006, Turner and Osborne 2007). The losses of diversity followed a sharp decline in abundance of Rio Grande silvery minnow between 1995 and 1997, and again between 1999 and 2000, as catch rates declined by an order of magnitude (Dudley et al. 2005). These declines in diversity coincided with extensive drying in the San Acacia Reach of the Rio Grande. Mitochondrial DNA diversity has continued to decline between 2004 and 2007 (Turner and Osborne 2007).

Declines in heterozygosity were also recorded for silver minnow from 1987 to 1999 and between 2000 and 2002, but increased between 2002 and 2005. Supplemental stocking with captively reared minnows from wild-caught eggs between 2001 and 2003 is thought to have temporarily alleviated loss of alleles and heterozygosity in the wild during this period (Turner and Osborne 2004). Heterozygosity again declined in 2007 (Turner and Osborne 2007).

Genetic studies have also demonstrated that the effective population size (N_e) for the Rio Grande silvery minnow is a fraction of the census size (Alò and Turner 2005). The effective population size is defined as the number of adult individuals that successfully contribute genes to subsequent generations (Frankham 1995). Alternatively, put into other words, the effective population size is a measure that allows predictions about the rate of loss of genetic variation in a population and is generally equivalent to the number of individuals that contribute genes to subsequent generations. In natural population, N_e is less than the census population size, which is the actual number on individuals that can be counted (Frankham 1995). For the Rio Grande silvery minnow, the presence of diversion dams prevents the recolonization of upstream habitats (Platania 1995) and has reduced the species' effective population size to critically low levels (Alò and Turner 2005). The N_e for the silvery minnow is estimated to be approximately 100 and calculated from measured genetic changes (due to genetic drift) across nine generations. Although the Service does not know the direct impacts of small genetic effect size in silvery minnow, the rate at which genetic diversity is lost is inversely proportional to effective population size. There is ample indication that populations of species that have limited diversity

are at increased extinction risk. In conservation genetics literature, an N_e of 500 has been recommended to conserve neutral genetic variation (Frankel and Soule 1981) and an N_e of 5000 has been recommended to maintain the normal adaptive potential in important traits, such as size, that are determine by multiple genes (Lande 1995). Estimates of genetic effective size for the Rio Grande silvery minnow have consistently fallen well below the lower of these numbers, and the current effective size is not sufficient to rule out genetic consequences of small N_e for the species.

Reasons for Listing and Threats to Survival

The silvery minnow was federally listed as endangered for the following reasons:

1. regulation of stream waters, which has led to severe flow reductions, often to the point of dewatering extended lengths of stream channel;
2. alteration of the natural hydrograph, which impacts the species by disrupting the environmental cues the fish receives for a variety of life functions, including spawning as well as food availability during larval fish development;
3. both the stream flow reductions and other alterations of the natural hydrograph throughout the year can severely impact habitat availability and quality, including the temporal availability of habitats;
4. actions such as channelization, bank stabilization, levee construction, and dredging result in both direct and indirect impacts to the silvery minnow and its habitat by severely disrupting natural fluvial processes throughout the floodplain;
5. construction of diversion dams fragment the habitat and prevent upstream migration;
6. introduction of nonnative fishes that directly compete with, and can totally replace the silvery minnow, as was the case in the Pecos River, where the species was totally replaced in a time frame of 10 years by its congener the plains minnow (*H. placitus*); and,
7. degraded water quality caused by industrial, municipal, or agricultural discharges also affects the species and its habitat (USFWS 1994).

These reasons for listing continue to threaten the species throughout its currently occupied range in the Middle Rio Grande. The decline in abundance of the silvery minnow in association with the much-reduced range of the species is a great concern to its continued existence. Any species, restricted to as small a portion of its natural range is susceptible to a variety of local perturbations that may lead to its extinction (PBS&J 2011).

Recovery Efforts

Recovery efforts are currently guided by the First Revision of the Rio Grande Silvery Minnow Recovery Plan, which was finalized and issued on February 22, 2010 (75 FR 7625, USFWS 2010a). The revised Recovery Plan describes recovery goals for the silvery minnow and actions to complete these (USFWS 2010a). The three goals identified for the recovery and delisting of the silvery minnow are:

1. prevent the extinction of the silvery minnow in the Middle Rio Grande of New Mexico;
2. recover the silvery minnow to an extent sufficient to change its status on the List of Endangered and Threatened Wildlife from endangered to threatened (downlisting); and
3. recover the silvery minnow to an extent sufficient to remove it from the List of Endangered and Threatened Wildlife (delisting).

Downlisting (Goal 2) of the silvery minnow may be considered when the criteria have been met resulting in three populations (including at least two that are self-sustaining) that have been established within the historical range of the species and have been maintained for at least 5 years.

Delisting (Goal 3) of the species may be considered when the criteria have been met resulting in three self-sustaining populations have been established within the historical range of the species and have been maintained for at least 10 years (USFWS 2010a).

Conservation and recovery efforts targeting the silvery minnow are also summarized in the revised Recovery Plan and elsewhere (Tetra Tech EM Inc. 2004; USFWS 2010a). These efforts have included habitat restoration activities; research and monitoring of the status of the silvery minnow, its habitat, and the associated fish community in the Middle Rio Grande; and programs to stabilize and enhance the species, such as tagging fish and egg monitoring studies, salvage operations, captive propagation, fish health monitoring, and augmentation efforts (for more information see www.middleriogrande.com). In addition, specific water management actions in the Middle Rio Grande valley over the past several years have been used to meet river flow targets and the 2003 BO requirements for silvery minnow (USFWS 2003a).

Propagation and Augmentation

In 2000, the Service identified captive propagation as an appropriate strategy to assist in the recovery of the silvery minnow. Captive propagation is conducted in a manner that will, to the maximum extent possible, preserve the genetic and ecological distinctiveness of the silvery minnow and minimize risks to existing wild populations.

Facilities at Dexter National Fish Hatchery and Technology Center and the City of Albuquerque's BioPark conduct captive propagation of silvery minnows. Silvery minnows are also held at the Service's New Mexico Fish and Wildlife Conservation Office, the Interstate Stream Commission Refugium in Los Lunas, New Mexico, and USGS Columbia Environmental Research Center Laboratory in Yankton, South Dakota.

Since 2002, over 1 million silvery minnows have been propagated and released into the Rio Grande (Remshardt 2010b). Wild gravid adults are successfully spawned in captivity at the City of Albuquerque's propagation facilities. Eggs are raised and released as larval fish. Marked fish have been released into the Middle Rio Grande by the Service's New Mexico Fish and Wildlife Conservation Office, and others, since 2002 under an augmentation effort funded by the Middle

Rio Grande Endangered Species Collaborative Program. Eggs left in the wild have a very low survivorship, and captive propagation ensures that an adequate number of spawning adults are present to repopulate the river each year. Wild eggs are also collected and reared to maximize the genetic diversity of the minnows released (Remshardt 2008b; Osborne et al. 2012).

Silvery Minnow Salvage and Relocation

During river drying, staff from the Service's New Mexico Fish and Wildlife Conservation Office often captures and relocates silvery minnows to nearby perennial water (Remshardt 2010a,b). Through 2009, approximately 800,000 silvery minnows have been rescued and relocated to wet river reaches, the majority of which were released in the Angostura Reach. Studies have been conducted to determine survival rates for salvaged fish. Caldwell et al. (2010) reported on studies that assessed the physiological responses of wild silvery minnows subjected to collection and transport associated with salvage. The authors examined primary (plasma cortisol), secondary (plasma glucose and osmolality), and tertiary indices (parasite and incidence of disease) and concluded that the effects of stressors associated with river intermittency and salvage resulted in a cumulative stress response in wild silvery minnows. They also concluded that fish in isolated pools experienced a greater risk of exposure and vulnerability to pathogens (parasites and bacteria), and that the stress response and subsequent disease effects were reduced through a modified salvage protocol that applied specific criteria to determine which wild fish are to be rescued from pools during river intermittency (Caldwell et al. 2010).

SOUTHWESTERN WILLOW FLYCATCHER

The terms "territory" and "site" are used below to help describe flycatcher population biology and breeding habitat. A territory is an area occupied by a single male or pair of flycatchers throughout the breeding season. Territories are the unit of measurement used by the Service in determining population numbers. A site may include a single territory or a cluster of territories. When used alone, the term "habitat" is used to describe those areas that provide food, shelter, and protection from predators during long-distance migration and short-distance stopover habitat. The term "breeding habitat" is used to describe those habitats that also provide resources for nest support, extra food for raising young, and protection from nest predators.

Species and Subspecies Description

The willow flycatcher is a widespread species that breeds across much of the contiguous United States. There are four commonly recognized subspecies of willow flycatcher; *Empidonax traillii traillii*, *Empidonax traillii brewsteri*, *Empidonax traillii adastus*, and *Empidonax traillii extimus*. Each subspecies occupies a distinct breeding range (Figure 4), though there is an interbreeding or gradation zone in the northern boundary area between *E. t. extimus* and *E. t. adastus*, making the delineation of a precise boundary between these two subspecies difficult (Sedgwick 2001 and Paxton et al. 2008). All subspecies of willow flycatcher are neotropical migrants that breed in the U.S. and migrate to Mexico, Central America, and South America during the wintering season, returning to the U.S. to breed in the spring (Phillips 1948; Stiles and Skutch 1989; Browning 1993; Ridgely and Tudor 1994; Howell and Webb 1995; Paxton et al. 2011a).

The willow flycatcher is a small passerine bird (Family Tyrannidae) measuring approximately 5.75 in (14.6 cm) in height (USFWS 1995). It has drab plumage; often including grayish-green feathers on its back and wings, a pale, white-colored throat, a light gray-olive breast, and a pale yellow-colored belly. Two white wingbars are often visible (juveniles have buff-colored wingbars). The eye ring is faint or absent in many individuals. (Unitt 1987 and Browning 1993). Plumage color can vary on observer bias, and feather wear and fading can affect color and lightness (Paxton et al. 2010a). The upper portion of the flycatcher's beak is often dark, with the lower portion light yellow in color and grading to black at the tip. A flycatcher's song is not particularly melodious, and has been characterized as a sneezy "fitz-bew" and their call is a repeated, but soft, "whitt" (Howell and Webb 1995).

The southwestern subspecies, *E. t. extimus*, was described by Phillips (1948), and its taxonomic status has been accepted by most authors (USFWS 1995, 2002). Morphological differences among the four flycatcher subspecies is mostly based on difference in plumage coloration (Unitt 1987). Generally, the southwestern subspecies has a lighter and more yellowish plumage coloration compared with other flycatcher subspecies. The remainder of this document will focus on the southwestern subspecies of willow flycatcher, *E. t. extimus* (flycatcher).

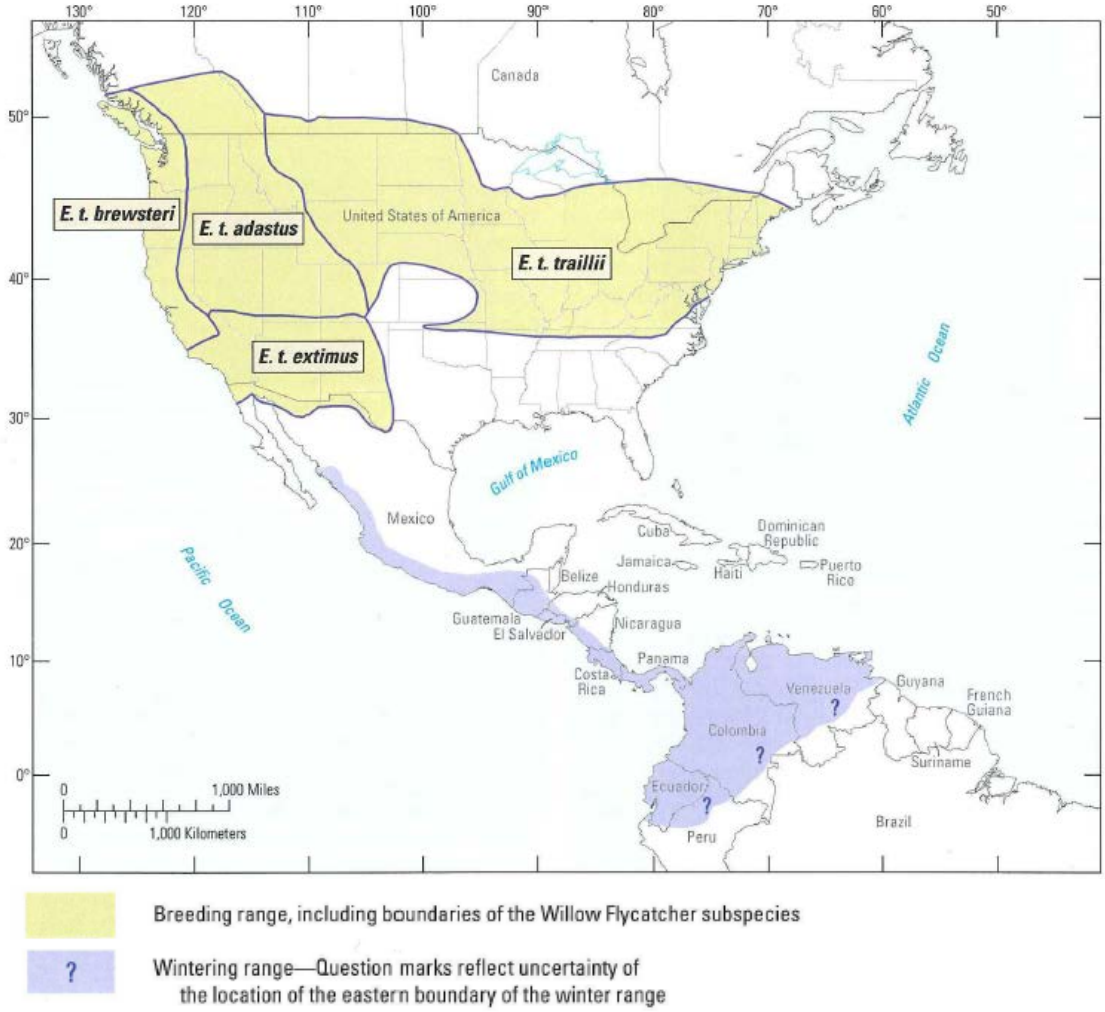

Figure 4. Approximate range distribution of willow flycatcher subspecies (Sogge et al. 2010) adapted from Unitt (1987), Browning (1993), and Paxton et al (2008).

Listing and Critical Habitat

The final rule that listed the flycatcher as an endangered species was published in the Federal Register (FR) on February 27, 1995, without critical habitat designation (USFWS 1995). A 5-year review of the flycatcher was initiated on March 20, 2008 (USFWS 2008c) and did not include a recommendation to the endangered listing status, however, a final decision as to the flycatcher's status has yet to be issued (USFWS 2013). In addition to its federal status, the flycatcher is also listed as an endangered species or species of concern in California (California Department of Fish and Game 1991), New Mexico (NMDGF 1996), Utah (Utah Division of Wildlife Resources 1997), and Arizona (Arizona Game and Fish Department 2006).

Critical habitat was designated for the flycatcher on July 22, 1997 along 599 river miles in Arizona, California, and New Mexico (USFWS 1997a). A correction notice was later published in the Federal Register on August 20, 1997, to clarify the lateral extent of the designation (USFWS 1997b). In May 2001, citing a faulty economic analysis, the 10th Circuit Court of Appeals vacated the designation of critical habitat and instructed the Service to issue a new flycatcher critical habitat designation. On, October 19, 2005, critical habitat was re-designated on approximately 48,896 ha (120,824 acres) or 1,186 km (737 mi) within Arizona, California, Nevada, New Mexico and Utah (USFWS 2005). On July 13, 2010, the Service agreed to revise critical habitat for the flycatcher; while the 2005 critical habitat designation remained in place. On January 3, 2013, a final rule to designate revised critical habitat was published in the Federal Register (USFWS 2013) for the flycatcher on approximately 1,975 stream km (1,227 mi) on a combination of Federal, State, tribal, and private lands in California, Nevada, Utah, Colorado, Arizona, and in New Mexico. In determining which areas within the geographical area are occupied by the flycatcher, the Service considered physical or biological features essential to the conservation of the flycatcher in accordance with sections 3(5)(A)(i) and 4(b)(1)(A) of the ESA and regulations at 50 CFR 424.12. These areas included:

the specific areas within the geographic area occupied by flycatchers on which are found those physical or biological features essential to the conservation of the flycatcher; and,

specific areas outside the geographical area occupied by the flycatcher at the time it is listed in accordance with the provisions of section 4 of this Act, upon a determination by the Secretary that such areas are essential to the conservation of the species.

Proposed critical habitat areas included, but were not limited to:

1. Space for individual and population growth and for normal behavior;
2. Food, water, air, light, minerals, or other nutritional or physiological requirements;
3. Cover or shelter;
4. Sites for breeding, reproduction, or rearing (or development) of offspring; and
5. Habitats that are protected from disturbance or are representative of the historical, geographical, and ecological distributions of a species.

The specific physical or biological features required for the flycatcher from studies of its habitat, ecology, and life history was described by the Service (USFWS 2013). In general, the physical or biological features of critical habitat for nesting flycatchers are found in the riparian areas within the 100-year floodplain or flood-prone areas. Flycatchers use riparian habitat for feeding, sheltering, and cover while breeding, migrating, and dispersing. It is important to recognize that flycatcher habitat is ephemeral in its presence, and its distribution is dynamic in nature because riparian vegetation is prone to periodic disturbance (such as flooding). The PCEs of critical habitat proposed for the flycatcher included:

1. Primary Constituent Element 1— Riparian vegetation. Riparian habitat in a dynamic river or lakeside, natural or manmade successional environment (for nesting, foraging, migration, dispersal, and shelter) that is comprised of trees and shrubs (that can include Gooddings willow (*Salix gooddingii*), coyote willow (*S. exigua*), Geyers willow (*S. geyerana*), arroyo willow (*S. lasiolepis*), red willow (*S. laevigata*), yewleaf willow (*S. taxifolia*), pacific willow (*S. lasiandra*), boxelder (*Acer negundo*), tamarisk (*Tamarix ramosissima*; also known as salt cedar), Russian olive (*Elaeagnus angustifolia*), buttonbush (*Cephalanthus occidentalis*), cottonwood (*Populus fremontii*), stinging nettle (*Urtica dioica*), alder (*Alnus spp.*), velvet ash (*Fraxinus velutina*), poison hemlock (*Conium maculatum*), blackberry (*Rubus ursinus*), seep willow (*Baccharis salicifolia, B. glutinosa*), oak (*Quercus agrifolia, Q. chrysolepis*), rose (*Rosa californica, R. arizonica, R. multiflora*), sycamore (*Platinus wrightii*), false indigo (*Amorpha californica*), Pacific poison ivy (*Toxicodendron diversilobum*), grape (*Vitis arizonica*), Virginia creeper (*Parthenocissus quinquefolia*), Siberian elm (*Ulmus pumila*), and walnut (*Juglans hindsii*)).

2. and some combination of:

   a. Dense riparian vegetation with thickets of trees and shrubs that can range in height from about 2 meters (m) to 30 m (about 6 to 98 feet (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 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); and/or

   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 hectares (ha) (0.25 acres (acres)) or as large as 70 ha (175 acres); and

3. 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 cicada (Homoptera).

The PCEs of flycatcher critical focused on the end result of all the components that culminate in the development of flycatcher breeding habitat. The Service (USFWS 2005) described those components (e.g., broad floodplain, surface water, fine sediments, hydrologic regime, channel-floodplain connectivity, elevated groundwater, etc.) in detail in the supporting text for the PCEs (69 FR 60712–60715). The methodology used for designating critical habitat for the flycatcher was based around nesting territories. Riparian habitat is dependent on the location of river channels, floodplain soils, subsurface water, floodplain shape, and is driven by the wide variety of high, medium, and low flow events. Rivers normally can and do move from one side of the floodplain to the other. Flooding occurs at periodic frequencies that recharge aquifers, deposit, and moisten fine floodplain soils that create seedbeds for riparian vegetation germination and growth within these boundaries. All the PCEs of critical habitat for the flycatcher are found in the riparian ecosystem within the 100-year floodplain or flood prone area. Pre-existing data sources were used by the Service (USFWS 2005) to assist in the process of delineating the lateral extent of the riparian zones for this designation included: (1) National Wetlands Inventory (NWI) digital data from the mid 1980's, 2001, 2002; (2) Federal Emergency Management Agency (FEMA) 1995, Q3 100 year flood data; (3) U.S. Census Bureau Topologically Integrated Geographic Encoding and Referencing; and (4) (TIGER) 2000 digital data. Where pre-existing data may not have been available to readily define riparian zones, visual interpretation of remotely sensed data was used to define the lateral extent.

The flycatcher may be dependent upon habitat components beyond the immediate areas where individuals of the species occur if they are important in maintaining ecological processes such as hydrology; stream flow; hydrologic regimes; plant germination, growth, maintenance, regeneration (succession); sedimentation; groundwater elevations. However, floodplains may be productive environments because flooding makes them so. The location of breeding sites, foraging locations, or areas used for migration or dispersal, can change over time (sometimes within a year or over a few years). Changes can occur due to flooding, drought, fire, or choices in land management. Thus, habitat that is not currently suitable for nesting at a specific time, but useful for foraging and/or migration can be essential to the future conservation of the flycatcher.

Within the State of New Mexico, revised critical habitat was designated along 402 steam km (250 mi) on a combination of Federal, State, Tribal and private lands. The majority of these lands are located within the Rio Grande Recovery Unit, which primarily includes the Rio Grande watershed from its headwaters in southern Colorado downstream to the Pecos River confluence in Texas and is made up of the San Luis Valley Management Unit in Colorado, and the Upper Rio Grande, Middle Rio Grande, and Lower Rio Grande Management Units in New Mexico.

Within the Upper Rio Grande Management Unit, a 46.8km (29.1 mi) segment of the Rio Grande is being proposed that extends from the Taos Junction Bridge (State Route 520) downstream to the northern boundary of the San Juan (Ohkay Ohwingeh) Pueblo, plus a 1.1 k, (0.4 mi) portion of the Rio Grande between San Juan Pueblo and Santa Clara Pueblo, an 11.9 km (7.4-mi) segment of the Rio Grande del Rancho is being proposed from Sarco Canyon downstream to the Arroyo Miranda confluence, and a 10.7 km (6.6-mi) segment of Coyote Creek is being proposed from above Coyote Creek State Park downstream to the second bridge on State Route 518, upstream from Los Cocas. Additionally, a 0.4 km (0.2 mi) segment of the Rio Fernando is designated upstream of Rio Lucero confluence.

Within the Middle Rio Grande Management Unit, a 180.4 km (112.1 mi) segment of the Rio Grande was designated from below the Isleta Pueblo and the Bernalillo and Valencia County line downstream past Bosque del Apache and Sevilleta National Wildlife Refuges and into the upper portion of Elephant Butte Reservoir in Valencia and Socorro Counties, New Mexico. Within the Lower Rio Grande Management Unit, no critical habitat was designated.

Reasons for Endangerment

The historic breeding range of the flycatcher included southern California, Arizona, New Mexico, western Texas, southwestern Colorado, southern Utah, extreme southern Nevada, and extreme northwestern Mexico (Sonora and Baja) (Unitt 1987). Declining flycatcher numbers have been attributed to loss, modification, and fragmentation of riparian habitat, breeding habitat, loss of wintering habitat, and brood parasitism by the brown-headed cowbird (*Molothrus ater*) (Sogge et al. 1997, McCarthey et al. 1998). Changes to riparian ecosystems such as reductions in water flow, alteration of flood flows, physical modifications to watersheds and streams, and removal of riparian vegetation have occurred because of dams and reservoirs, groundwater pumping, channelization of streams for flood control, livestock overgrazing, agriculture developments, urbanization and other modifications.

Fire is also responsible for changes to riparian ecosystems, and is a threat to willow flycatcher habitat (Paxton et al. 1997), especially in monotypic tamarisk vegetation (DeLoach 1997) and where water diversions and/or groundwater pumping desiccate riparian vegetation (Sogge et al. 1997).

Flycatcher nests are parasitized by brown-headed cowbirds, which lay their eggs in the flycatcher nests. Feeding sites for cowbirds are enhanced by the presence of livestock and range improvements such as waterers and corrals, agriculture, urban areas, golf courses, bird feeders, and trash areas. When these feeding areas are in close proximity to flycatcher breeding habitat, especially coupled with habitat fragmentation, cowbird parasitism of flycatcher nests may increase (Hanna 1928; Mayfield 1977a,b; Tibbitts et al. 1994). An increase in nest parasitism by cowbirds and predation of flycatcher nests affects populations, especially those in smaller numbers and at more isolated locations.

Modification and loss of wintering habitat as well as loss of migratory "stopover" habitat used by flycatchers to replenish energy reserves during their long-distance migration may also contribute to the decline of flycatcher survival and reproduction. The widespread distribution, accumulation, or continued use of agrichemicals and pesticides in North, Central, and South America as well as the legacy of previous chemical use, storage, leaks, spills and atmospheric re-distribution also likely contributed to the decline of the flycatcher.

Recently, a new threat to the flycatcher has been introduced that was not previously identified in the reasons for listing. The U.S. Department of Agriculture facilitated a biological control effort to eradicate nonnative tamarisk vegetation by releasing tamarisk beetles in the southwestern United States. These leaf beetles act by defoliating tamarisk trees during the growing season, with repeated defoliation over multiple years until the tree is killed. The use of tamarisk beetles was predicted to have large net positive benefits and minimal negative effects, however tamarisk beetles have dispersed from original release sites in Colorado and Utah much faster than predicted (Bean et al. 2007), and have the potential to spread widely and defoliate large expanses of tamarisk habitat, which is often utilized by flycatchers. In June 2010, the U.S. Department of Agriculture issued a moratorium on the release of tamarisk beetles in response to concerns over its potential effects on flycatcher critical habitat. Tamarisk beetle has become established in multiple watersheds in the southwest and will likely continue to expand its range (Paxton et al. 2011b).

Recovery Plan

A final recovery plan for the flycatcher was issued by the Service on August 30, 2002 (USFWS 2002). The Recovery Plan describes the reasons for endangerment, current status of the flycatcher, addresses important recovery actions, includes detailed papers on management issues, and provides recovery goals.

Because the breeding range of the flycatcher encompasses a broad geographic area with much site variation, management of its recovery is approached in the Recovery Plan by dividing the flycatcher's range into six Recovery Units, each of which are further subdivided into Management Units (USFWS 2002). This provides an organizational strategy to "characterize flycatcher populations, structure recovery goals, and facilitate effective recovery actions that should closely parallel the physical, biological, and logistical realities on the ground" (USFWS 2002). Recovery goals are recommended for most Management Units. Recovery Units are defined based on large watershed and hydrologic units.

Within each Recovery Unit, Management Units are based on watershed or major drainage boundaries at the Hydrologic Unit Code Cataloging Unit level. The "outer" boundaries of some Recovery Units and Management Units were defined by the flycatcher's range boundaries. Flycatcher habitat within Recovery and Management Units is expected to expand, contract, or change as a result of flooding, drought, inundation, and changes in floodplains and river channels (USFWS 2002) that result from natural occurrences and water or land management choices. The Recovery Plan (USFWS 2002) provides recommendations to recover the flycatcher and provides two alternatives, either of which can be met, in order to consider downlisting the

species to threatened. The first alternative for downlisting requires reaching a total population of 1,500 flycatcher territories geographically distributed among all Recovery Units and maintained for 3 years with habitat protections. Habitat protections include a variety of options such as conservation plans, conservation easements, or safe harbor agreements. The second alternative approach for downlisting calls for reaching a population of 1,950 territories also strategically distributed among all Recovery and Management Units for 5 years without additional habitat protection. In order to delist this flycatcher subspecies (to remove it from the List of Endangered and Threatened Wildlife and Plants), a minimum of 1,950 territories are geographically distributed among all Recovery and Management Units, and that twice the amount of habitat is provided to maintain these territories over time. Twice the amount of suitable habitat is needed to support the numerical territory goals, because the long-term persistence of flycatcher populations cannot be assured by protecting only those habitats in which flycatchers currently breed. Second, these habitats must be protected from threats to assure maintenance of these populations and habitat for the foreseeable future through development and implementation of conservation management agreements. Third, all of these delisting criteria must be accomplished and their effectiveness demonstrated for a period of 5 years.

The amount of additional habitat needed may vary in each Management Unit, based on local and regional factors that could affect the rate of occupied habitat loss and change. Until these factors can be better quantified, the Service believes that conserving, within each Management Unit, double the amount of breeding habitat needed to support the target number of flycatchers assures that displaced flycatchers will have habitats in which to settle, given even a catastrophic level of local habitat loss.

Based on a range-wide review of riparian patch sizes and flycatcher population sizes presented in published and unpublished literature, a patch has an average of 1.1 ha (2.7 acres) (± 0.1 acres Standard Error) of dense, riparian vegetation for each flycatcher territory found within the patch. Therefore, delisting would require that twice this amount of breeding habitat (i.e., 5.4 acres) be protected for each flycatcher territory that is part of the recovery goal within a Management Unit. For example, a Management Unit with a recovery goal of 100 territories would need to assure the protection of 540 acres (220 ha) (i.e., 100 territories x /5.4 acres for each territory) of suitable breeding habitat. This total amount of available and protected breeding habitat includes: (a) habitat occupied by flycatchers meeting the population target (100 territories), (b) flycatchers in excess of the population target, and (c) suitable but unoccupied habitat. The factor of 5.4 acres/2.2 ha of breeding habitat per flycatcher territory can be modified based on more local data on patch sizes and population numbers. For example, if the average amount of dense, riparian vegetation per flycatcher territory were higher or lower for a given Management Unit, the amount of breeding habitat required, within that unit, to meet delisting criteria would change accordingly. Suitable breeding habitat conditions may be maintained over time through natural processes and active human manipulation.

The Service (USFWS 2002) identified several key strategies tied to flycatcher conservation in the Recovery Plan such as: 1) populations should be distributed close enough to each other to allow for movement; 2) maintaining/augmenting existing populations is a greater priority than establishing new populations; and, 3) a population's increase improves the potential to disperse and colonize. Breeding habitat objectives are incorporated into the delisting criteria because of the importance of providing replacement habitat for dispersing flycatchers after natural stochastic destruction of existing breeding habitat, and suitable breeding habitat for future population growth.

Essential to the survival and recovery of the flycatcher is a minimum size, distribution and spatial proximity of habitat patches that promotes metapopulation stability. The current size of occupied breeding habitat patches is skewed heavily toward small patches and small population sizes; this situation inhibits recovery. Recovery will be enhanced by increasing the number of larger populations and by having populations distributed close enough to increase the probability of successful immigration by dispersing flycatchers. For example, decreasing the proportion of small breeding groups can be achieved by striving for a minimum patch size that supports 10 or more territories. Available data indicate that current populations with 10 or more territories occupy patches with a mean size of 24.9 ha/61.5 acres. Alternatively, along the lower San Pedro River and nearby Gila River confluence in Arizona, smaller, occupied habitat patches show substantial between-patch movement by flycatchers and function effectively as a single site. Thus, to promote recovery, land managers and other conservation entities should strive to protect larger breeding habitat patches (about 25 ha/62 acres or more) within Management Units to minimize the distance between smaller occupied patches so that they function ecologically as a larger patch.

Breeding Biology

Throughout their range, the generalized breeding chronology of flycatchers begins with the arrival at breeding grounds in late April and May (Sogge and Tibbitts 1992; Sogge et al. 1993; Muiznieks et al. 1994; Sogge and Tibbitts 1994; Maynard 1995; Sferra et al. 1995, 1997; USFWS 2002; Sogge et al. 2010), though extreme or record dates for any given stage of the flycatcher breeding cycle may occur slightly earlier or later than the dates presented. Nesting and egg laying may begin as early as late May, but more often starts in early to mid-June. Flycatchers typically lay three to four eggs per clutch (range = 1 to 5). Eggs are laid at one-day intervals and are incubated by the female for approximately 12 days (Bent 1960, Walkinshaw 1966, McCabe 1991). Chicks can be present in nests from mid-June through early August and will typically fledge approximately 12 to 13 days after hatching (King 1955, Harrison 1979), from late June through mid-August. Young will remain in the natal area for up to 15 days (Brown 1988a,b; Sogge and Tibbitts 1992; Muiznieks et al. 1994; Maynard 1995). Adults depart from breeding territories as early as mid-August, but may stay until mid-September in later nesting efforts. Fledglings likely leave the breeding areas a week or two after adults. Most flycatchers only live one or two years as adults, but there have been rare occurrences of flycatchers living at least 9 years of age (Paxton et. al 2007a). Typically, one brood is raised per year, but birds have been documented raising two broods during one season and re-nesting after a failure (Whitfield 1990, Sogge and Tibbitts 1992, Sogge et al. 1993, Sogge and Tibbitts 1994,

Muiznieks et al. 1994, Whitfield 1994, Whitfield and Strong 1995). The entire breeding cycle, from egg laying to fledging, is approximately 28 days. 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 quickly abandon if the conditions in the selected breeding habitat become adverse, decadent, or result in nest failure.

Flycatcher nests are small (3.2 inches tall and wide) and are commonly placed in a shrub or tree. Nests are open cup structures, and are typically placed in the fork of a branch. Nests have been found against the trunk of a shrub or tree (in monotypic tamarisk and mixed native broadleaf/tamarisk vegetation) and on limbs as far away from the trunk as 10.8 feet (Spencer et al. 1996). Typical nest placement is in the fork of small-diameter (e.g., 0.4 in), vertical or nearly vertical branches (USFWS 2002). Occasionally, nests are placed in down-curving branches. Nest height varies considerably, from 1.6 to 60 feet, and may be related to height of nest plant, overall canopy height, and/or the height of the vegetation strata that contain small twigs and live growth. Most typically, nests are relatively low, 6.5 to 23 feet above ground. Flycatcher nests in box elder dominated habitats are highest at almost 60 feet (USFWS 2002).

A breeding site is simply an area along the river that has been described while surveying for flycatcher territories (USFWS 2002; Sogge et al. 2010). A breeding site can contain none, only one, or many territories, however breeding sites are areas where flycatcher territories were detected. A territory is defined as a discrete area defended by a resident single flycatcher or pair of flycatchers within a single breeding season (Sogge et al. 2010). This is usually evidenced by the presence of a singing male, and possibly one or more mates (Sogge et al. 2010). Flycatchers have been recorded nesting in riparian habitat patches as small as 0.1 ha (0.25 acres) along the Rio Grande, and as large as 70 ha (175 acres) in the upper Gila River, New Mexico (USFWS 2002). The mean reported size of flycatcher breeding patches was 8.6 ha (21.2 acres), with the majority of sites toward the smaller end, as evidenced by a median patch size of 1.8 ha (4.4 acres) (USFWS 2002). Mean patch size of breeding sites supporting 10 or more flycatcher territories was 25 ha (62 acres). Aggregations of occupied breeding patches within a breeding site may create a riparian mosaic as large as 200 ha (494 acres), such as areas like the Kern River, Alamo Lake, Roosevelt Lake (Paradzick et al. 1999), and Lake Mead (McKernan 1997).

Flycatcher territory size likely fluctuates with population density, habitat quality, and nesting stage. Territories are established within a larger patch of appropriate habitat sufficient to contain several nesting pairs of flycatchers; flycatchers appear to be semi-colonial nesters. Estimated territory sizes are 0.59 to 3.21 acres for monogamous males and 2.7 to 5.7 acres for polygynous males at the Kern River (Whitfield and Enos 1996), 0.15 to 0.49 acres for birds in a 1.5 to 2.2 acre patch of habitat on the Colorado River (Sogge et al. 1995a), and 0.5 to 1.2 acres in a 3.7 acre patch on the Verde River (Sogge 1995b).

Flycatchers can cluster their territories into small portions of riparian sites (Whitfield and Enos 1996; Sogge et al. 2010), and major portions of the site may only be used briefly or not at all in any given year. Habitat modeling based on remote sensing and GIS data has found that breeding site occupancy at reservoir sites in Arizona is influenced by vegetation characteristics of habitat adjacent to the actual nesting areas (Hatten and Paradzick 2003); therefore, areas adjacent to nest

sites can be an important component of a breeding site. The continued exploration into the use of satellite imagery combined with associated predictive modeling techniques, whether it is suitability of flycatcher nesting habitat (Hatten and Paradzick 2003, Hatten and Sogge 2007) or to evaluate possible habitat changes associated with the tamarisk beetle (Dennison et al. 2009), may become an even more important tool in future management and recovery. How size and shape of riparian patches relate to factors such as flycatcher nest-site selection and fidelity, reproductive success, predation, and brood parasitism remains as areas for further research (USFWS 2002).

Reproductive Success

Using the information derived from tracking banded flycatchers over multiple years, Paxton et al. (2007a) estimated the average minimum lifetime productivity (the total number of young fledged per individual over their estimated lifetime) at 3.3 offspring per female, but it varied by site and year. Over a third of nesting birds did not fledge young that were detected, and over 50 percent of the young fledged were contributed by just 16 percent of the breeding adults (Paxton et al. 2007a). Average seasonal fecundity for females ranged from 1.6 at Roosevelt Lake to 2.0 at the San Pedro and Gila River confluence area. Older females had higher seasonal productivity than second-year females (Paxton et al. 2007a).

In New Mexico, breeding success has been studied in the Gila River sites, and along the Rio Grande. In 2001, 133 nests were monitored in the Gila River near Gila-Cliff Valley, New Mexico. Data indicated that 34.4 percent of the nesting attempts were successful (Broadhead et al. 2002). Along the Rio Grande, in 2000, the nest success along the Rio Grande was 65 percent of 26 monitored nests (Ahlers et al. 2001). In 2001, 45 nesting attempts were documented, and 73 percent of these were successful (Ahlers et al. 2002). In 2002, 80 nests were monitored and success was 55 percent (Ahlers et al. 2003). Since 1999, the overall nest success rate along the Middle Rio Grande has been 50 percent, with a brood parasitism rate of 14 percent, nest predation rate of 33 percent, and a nest abandonment rate of 8 percent (Moore and Ahlers 2012). Nest success has greatly decreased since 2009 and has been below 50 percent since, with 2010 being the lowest success rate observed in 12 years. This is believed to be attributed to a large increase in predation rates (Moore and Ahlers 2012). Nest success decreased to 31% in 2012 and was below the 10-year average and the parasitism rate was the highest observed in the past 13 years. The San Marcial Reach was similarly less productive in 2012, with 223 nests detected and only 65 nests successful with young fledged (i.e., 65/223=29 percent successful) (Moore 2012).

In 2001, 426 nesting attempts were documented in Arizona at 40 sites (Smith et al. 2002). The outcome from 329 nesting attempts was determined (not every nesting attempt was monitored). Of the 329 nests monitored, 58 percent (n=191) were successful, 35 percent failed (n=114), and 7 percent (n=24) had an outcome which could not be determined. Causes of nest failure were predation (n=82), nest desertion (n=10), brood parasitism (n=6), infertile clutches (n=12), weather (n=2), and unknown causes (n=2). Cowbirds may have contributed to other abandoned nests, but no direct evidence was detected. Three parasitized nests fledged flycatchers along with cowbird young.

Intensive nest monitoring efforts in California, Arizona, and New Mexico have shown that cowbird parasitism and/or predation can result in failure of the nest, reduced fecundity in subsequent nesting attempts, delayed fledging, and reduced survivorship of late-fledged young. Cowbirds have been documented at more than 90 percent of sites surveyed (Sogge and Tibbitts 1992, Sogge et al. 1993, Muiznieks et al. 1994, Sogge and Tibbitts 1994, Whitfield 1994, Tomlinson 1997, Griffith and Griffith 1995, Holmgren and Collins 1995, Kus 1995, Maynard 1995, McDonald et al. 1995, Sferra et al. 1995, Sogge 1995b, c, San Diego Natural History Museum 1995, Stransky 1995, Whitfield and Strong 1995, Griffith and Griffith 1996, Skaggs 1996, Spencer et al. 1996, Whitfield and Enos 1996, Sferra et al. 1997, McCarthey et al.1998). The probability of a flycatcher successfully fledging its own young from a cowbird parasitized nest is low (< 5 percent). In addition, nest loss due to predation appears consistent from year to year and across sites, generally in the range of 30 to 50 percent.

Cowbird trapping has been demonstrated to be an effective management strategy for increasing reproductive success for the flycatcher in certain areas as well as for other endangered passerines (e.g., least Bell's vireo [*Vireo bellii pusillus*], black-capped vireo [*V. atricapillus*], golden-cheeked warbler [*Dendroica chrysoparia*]). It may also benefit juvenile survivorship by increasing the probability that parents fledge birds early in the season. Expansion of cowbird management programs may have the potential to not only increase reproductive output and juvenile survivorship at source populations, but also to potentially convert small, sink populations into breeding groups that contribute to population growth and expansion.

Flycatcher Habitat

Flycatchers utilize riparian habitats that are generally dense, shrubby, moist, and that have abundant flying insects. Flycatchers use riparian corridors throughout their range as stopover habitat during their long-distance migration. Historical species' descriptions often describe the flycatcher's widespread use of native willow (*Salix* spp.) for habitat and nesting (Phillips 1948, Phillips et al. 1964, Hubbard 1987, Unitt 1987, San Diego Natural History Museum 1995).

Flycatcher Breeding Habitat

The flycatcher currently breeds in areas from near sea level to over 2,600 m (8,500 ft) (Durst et al. 2008b) in vegetation alongside rivers, streams, or other wetlands (riparian habitat). It establishes nesting territories, builds nests, and forages where mosaics of relatively dense and expansive growths of trees and shrubs are established, near, adjacent to surface water, or underlain by saturated soil (Sogge et al. 2010). Vegetation characteristics of flycatcher breeding habitat generally include dense tree or shrub cover that is greater than 3 meters high, with dense twig structure and abundant live, green foliage (Allison et al. 2003). Riparian habitat characteristics such as dominant plant species, size and shape of habitat patches, tree canopy structure, vegetation height and density, hydrology, and insects are important parameters of flycatcher breeding habitat, although they may vary widely at different sites (USFWS 2002).

The accumulating knowledge of flycatcher breeding sites reveals important areas of similarity, which constitute the basic concept of what is suitable breeding habitat (USFWS 2002). These features are generally discussed below. Flycatchers nest in thickets of trees and shrubs ranging in height from 2 m to 30 m (6 to 98 ft) (USFWS 2002). Lower-stature thickets (2 to 4 m (6 to 13 ft) tall) tend to be found at higher elevation sites, with tall-stature habitats at middle- and lower-elevation riparian forests (USFWS 2002). Nest sites typically have dense foliage (greater than 1000 stem density) greater than at least from the ground level up to approximately 4 m (13 ft) above ground, although dense foliage may exist only at the shrub level, or as a low, dense tree canopy (USFWS 2002). Breeding habitat is often associated with dense, riparian scrub-shrub wetlands.

Regardless of the plant species' composition or height, breeding sites usually consist of dense vegetation in the patch interior, or an aggregate of dense patches interspersed with openings creating a mosaic that is not uniformly dense (USFWS 2002). Canopy density (the amount of cover provided by tree and shrub branches measured from the ground) at various nest sites ranges from 50 to 100 percent (USFWS 2002). Flycatchers primarily use Geyer willow (*Salix geyeriana*), Goodding's willow (*Salix gooddingii*), coyote willow (*Salix exigua*), boxelder (*Acer negundo*), tamarisk (*Tamarix* spp.), Russian olive (Elaeagnus *angustifolio*), cottonwood (*Populus* spp.), and live oak (*Quercus agrifolia*) for nesting. Other plant species less commonly used for nesting include buttonbush (*Cephalanthus sp*.), black twinberry (*Lonicera involucrata*), white alder (*Alnus rhombifolia*), blackberry (*Rubus ursinus*), and stinging nettle (*Urtica* spp.). Other plant species used for nesting may become known over time as more studies and surveys occur.

Most flycatcher breeding sites are comprised of spatially complex habitat mosaics, often including both exotic (mostly tamarisk) and native vegetation. Within a site, territories are frequently clumped or distributed near the patch edge. Thus, the vegetative composition of individual territories may differ from the overall composition of the patch. Flycatchers may move extensively within a breeding patch, travel between patches, or exploit resources outside of a patch (Cardinal and Paxton 2005; Cardinal et al. 2006). Therefore, an area much larger than a territory or even a patch may be important to flycatcher breeding success and persistence at a particular site (Hatten and Paradzick 2003).

The habitat at flycatcher breeding sites can be broadly characterized by proportion of native and exotic habitats into four broad categories (Sogge et al. 2010). Most commonly, tamarisk is the exotic plant species (Russian olive has also been used). Those categories are based on species composition of the tree/shrub layer(s) of the site:

1. Native = >90% native vegetation.
2. Mixed (>50% native) = 50 to 90% native vegetation.
3. Mixed (>50% exotic) = 50 to 90% exotic vegetation.
4. Exotic = >90% exotic vegetation.

Though an exotic species, tamarisk is an important component of the flycatchers' nesting and foraging habitat in Arizona and New Mexico. In 2001 in Arizona, 323 of the 404 (80 percent) known flycatcher nests (in 346 territories) were built in a tamarisk tree (Smith et al. 2002). Durst et al (2008b) broadly characterized the use of native and exotic habitats by flycatchers as of the 2007 breeding season, and found that habitat patches comprising mostly of native vegetation accounted for 44% of the known flycatcher territories range wide, 4% of territories occurred within exotic vegetation, and approximately 50% were located within sites where the habitat included a mixture of native and exotic vegetation. In 2010, along the Middle Rio Grande in New Mexico, about 43 percent of nests (n = 110) were found in vegetation dominated by tamarisk (Moore and Ahlers 2011). In 2011, flycatcher nests were physically placed in tamarisk substrate 58 percent of the time, even though 57 percent of the nesting territories were dominated by native vegetation (Moore and Ahlers 2012). Although the quality of tamarisk as nesting habitat for flycatchers has been debated, comparisons of reproductive performance and physiological conditions of flycatchers breeding in native and exotic vegetation has revealed no difference, and tamarisk may be ecologically suitable and equivalent to native vegetation is some areas (Service 2002, Owen and Sogge 2002, Sogge et al 2008, Moore and Ahlers 2012). Paxton et al. (2011b) suggests that species with restricted distributions, such as the flycatcher, that utilize habitat dominated by tamarisk may be negatively affected both in the short and long term by defoliation by tamarisk beetles. There are currently no large, monotypic stands of tamarisk in the Middle Rio Grande that are occupied by flycatchers, however flycatchers in the Middle Rio Grande do nest in exotic substrate and establish territories in exotic dominated vegetation (14 percent in 2011) which would be adversely impacted by beetle defoliation (Moore and Ahlers 2012).

Hydrology and Breeding Habitat

Flycatchers are closely associated with water. An affinity for moist or wet, shrubby areas, often with standing or running water, has been noted throughout the West (Sedgwick 2004). The riparian vegetation that constitutes breeding habitat requires substantial water (USFWS 2002). Because breeding habitat is associated, where there is slow moving or still water, these slow and still water conditions may be important in influencing production of an insect prey base for flycatcher food (USFWS 2002). Flycatcher breeding habitat is largely associated with persistent water during breeding and water flow that supports dense vegetation and insect prey needed by breeding flycatchers, nesting conditions, and flycatcher fledglings. Productivity of successful flycatcher nests appeared greater near water or saturated soils (Moore and Ahlers 2012).

Over 13 studies have identified a positive association with water or saturated soils and flycatcher breeding habitat use, sites, territories, and nesting (ERO Resources Corporation 2009). Of 33 sites with breeding flycatchers along the lower Colorado River from 2003 to 2007, 80% had surface water or saturated soils nearby (McLeod et al. 2008). At Elephant Butte, 95% of all nests were within 100 m and 91% were within 50 m of water or saturated soil (Moore and Ahlers 2008). Other hydrologic conditions that flycatchers have selected include sites with large floodplains (Hatten and Paradzick 2003, Paxton et al. 2007a) and patches with a high percentage of riparian forest (Brodhead 2005). The range and variety of stream flow conditions (frequency, magnitude, duration, and timing) (Poff et al. 1997) that will establish and maintain breeding

habitat can arise in different types of both regulated and unregulated flow regimes throughout its range (USFWS 2002). In addition, flow conditions that will establish and maintain breeding habitat can be achieved in regulated streams, depending on scale of operation and the interaction of the physical characteristics of the landscape (USFWS 2002).

Flowing streams with a wide range of discharge conditions that create and support expansive riparian vegetation and insect prey are essential physical and biological features of flycatcher habitat (USFWS 2011c). The most common stream flow conditions are largely perennial (persistent) stream flow with a natural hydrologic regime (frequency, magnitude, duration, and timing). However, in the Southwest, hydrological conditions can vary; causing some flows to be intermittent, but the floodplain can retain surface moisture conditions favorable to expansive and flourishing riparian vegetation. These appropriate conditions can be supported by managed water sources and hydrological cycles that mimic components of the natural hydrologic cycle.

Low water availability and earlier drying of soils, such as during dry years, may affect the number of breeding SWFLs (McLeod et al. 2008, 2009), demographics (ERO Corporation 2009) and reproductive success (Johnson et al. 1999, Brodhead et al. 2002, Paxton et al. 2007a, Ellis et al. 2008). Flycatcher nesting habitat can persist on intermittent (ephemeral) streams that retain local hydrologic conditions favorable to riparian vegetation and insect prey (USFWS 2002). In the Southwest, hydrological conditions at a flycatcher-breeding site can vary remarkably within a season and between years (USFWS 2002). At some locations, particularly during drier years, water or saturated soil may only be present early in the breeding season (May and part of June) (USFWS 2002). In the MRGV, few nest attempts were made by flycatchers during the dry year of 1996 and birds migrated south between mid-June and early July (Johnson et al. 1999). In 2006, flycatchers established territories in areas previously occupied, even though the areas were dry, but then birds moved to wetter areas later in season (Smith and Johnson 2008).

In some areas, natural or managed hydrologic cycles can create temporary breeding habitat, but may not be able to support it for an extended amount of time, or may support varying amounts of breeding habitat at different points during its maturation and succession phases. Some dam operations create varied situations that allow different plant species to thrive when water is released below a dam, held in a lake, or removed from a lakebed, and consequently, varying degrees of breeding habitat are available because of dam operations (USFWS 2002). Slow-moving water situations can also be managed or mimicked through manipulated supplemental water originating from sources such as agricultural returns or irrigation canals (USFWS 2002).

Habitat Dynamics and Restored Habitat

The hydrologic regime (stream flow pattern) and supply of (and interaction between) surface and subsurface water is a driving factor in the long-term maintenance, growth, recycling, and regeneration of flycatcher habitat (USFWS 2002). As streams reach the lowlands, their gradients typically flatten and surrounding terrain opens into broader floodplains (USFWS 2002). In these geographic settings, the stream-flow patterns (frequency, magnitude, duration, and timing) will provide the necessary stream-channel conditions (wide configuration, high sediment deposition, periodic inundation, recharged aquifers, lateral channel movement, and elevated groundwater

tables throughout the floodplain) that result in the development of flycatcher habitat (Poff et al. 1997; USFWS 2002). Allowing the river to flow over the width of the floodplain, when overbank flooding occurs, is integral to allow deposition of fine moist soils, water, nutrients, and seeds that provide the essential material for plant germination and growth. An abundance and distribution of fine sediments extending farther laterally across the floodplain and deeper underneath the surface retains much more subsurface water, which in turn supplies water for the development of the vegetation that provides flycatcher habitat and micro-habitat conditions (USFWS 2002). The interaction between groundwater and surface water contributes to the quality of riparian vegetation community (structure and plant species) and will influence the germination, density, vigor, composition, and the ability of vegetation to regenerate and maintain itself (Arizona Department of Water Resources 1994).

Flycatcher habitat can quickly change and vary in suitability, location, and occupancy over time (Finch and Stoleson 2000). Flycatcher nesting habitat comprised of willows can grow out of suitability; tamarisk habitat can develop from seeds to suitability in five years; heavy runoff can remove or reduce habitat suitability in a day; and river channels, floodplain width, location, and vegetation density may change over time. The development of flycatcher habitat is a dynamic process involving, maintenance, recycling, and regeneration of habitat. Due to its dynamic and cyclic nature, flycatcher "habitat" is often defined as either suitable or potential (Service 2002). Thus, areas other than occupied locations can be considered flycatcher "habitat" and are essential to the survival and recovery of the flycatcher (USFWS 2002).

It is important to recognize that most flycatcher breeding habitats are susceptible to future changes in site hydrology (natural or human-related), impacts from development activities or fire, and natural catastrophic events such as flood or drought (USFWS 2002). Flycatcher habitat can quickly change and vary in suitability, location, use, and occupancy over time (Finch and Stoleson 2000). For example, suitable habitat dominated by tamarisk can develop in five years, heavy runoff can create velocities or sediment deposition that may reduce or remove habitat within in a day, or river flow and channel topology may also change quickly. Flycatcher breeding habitat can mature beyond that suitable for nesting. Flycatcher use of breeding habitat in different successional stages may also be dynamic. For example, over-mature or young riparian vegetation may not be suitable for breeding habitat and instead can be used for foraging and shelter by migrating, dispersing, or non-territorial individuals (McLeod et al. 2005). Similarly, early successional riparian habitat may subsequently mature over time and later become suitable for breeding habitat. These and other factors can destroy or degrade breeding habitat, such that one cannot expect any given breeding site to remain suitable in perpetuity (USFWS 2002). Thus, in order to manage flycatcher-breeding habitat over time, it is necessary to have additional suitable habitat available to which flycatchers, displaced by such habitat loss or change, can readily move into and breed (USFWS 2002).

In many instances, flycatcher-breeding sites occur along streams where human impacts are minimized enough to allow more natural processes to create, recycle, and maintain flycatcher habitat. However, there are also breeding sites that are supported by various types of supplemental water including agricultural and urban run-off, treated water outflow, irrigation or diversion ditches, reservoirs, and dam outflows (USFWS 2002). Although the waters provided to these habitats might be considered "artificial," they are often important for maintaining the habitat in appropriate condition for breeding flycatchers within the existing environment.

Sites for Germination or Seed Dispersal of Riparian Vegetation

Subsurface hydrologic conditions may be equally important to surface water conditions in determining riparian vegetation vigor and landscape patterns (Lichivar and Wakely 2004). Where groundwater levels are elevated to the point that riparian forest plants can directly access those waters, it can be an area for breeding, non-breeding, territorial, dispersing, foraging, or migrating flycatchers. Elevated groundwater helps create moist soil conditions believed to be important for nesting conditions and prey populations (USFWS 2002).

Depth to groundwater plays an important part in the distribution of riparian vegetation (Arizona Department of Water Resources 1994; USFWS 2012b) and consequently, flycatcher habitat. The greater the depth to groundwater below the land surface, the less abundant the riparian vegetation (Arizona Department of Water Resources 1994). Flow regulation also affects the integrity of riparian zones by lowering water tables, reducing lateral fluxes of water and materials, accelerating and modifying the processes of plant succession, and stopping the formation of new riparian habitats (Ward and Stanford 1995; Decamps et al. 2008). The vertical accumulation of sediment in a floodplain, exacerbated by the lateral confinement of flooding, can also result in a physical separation of riparian vegetation from groundwater necessary for flycatcher habitat (Dufour et al 2007; USFWS 2012b). During this process of "terrestrialization," productive pioneer species such as willows or poplars tend to be replaced by either invasive or upland plant species that invade the floodplain under artificially enhanced conditions of environmental stability (Friedman and Auble 2000; Decamps et al 2008). Localized, perched aquifers (a saturated area that sits above the main water table) can and do support some riparian habitat, but these systems are not extensive (Arizona Department of Water Resources 1994).

The abundance and distribution of fine sediment deposited on floodplains is critical for the development, abundance, distribution, maintenance, and germination of the plants that grow into flycatcher habitat (USFWS 2002). Fine sediments provide seed beds to facilitate the growth of riparian vegetation for flycatcher habitat. In almost all cases, moist or saturated soil is present at or near breeding sites during wet and non-drought years (USFWS 2002). The saturated soil and adjacent surface water may be present early in the breeding season, but only damp soil is present by late June or early July (USFWS 2002). Microclimate features (temperature and humidity) facilitated by moist or saturated soil, are believed to play an important role where flycatchers are detected and nest, their breeding success, and availability and abundance of food resources (USFWS 2002).

Riparian vegetation also provides the flycatcher cover and shelter while migrating and nesting. Placing nests in dense vegetation provides cover and shelter from predators or nest parasites that would seek out flycatcher adults, nestlings, or eggs. Similarly, using riparian vegetation for cover and shelter during migration provides food-rich stopover areas, a place to rest, and shelter or cover along migratory flights (USFWS 2002). Riparian vegetation used by migrating flycatchers can sometimes be less dense and abundant than areas used for nesting (USFWS 2002). However, migration stopover areas, even though not used for breeding, may be critically important resources affecting local and regional flycatcher productivity and survival (USFWS 2002, 2011c).

Nutritional and Physiological Requirements

The flycatcher is somewhat of an insect generalist (USFWS 2002), taking a wide range of invertebrate prey including flying, and ground- and vegetation-dwelling species of terrestrial and aquatic origins (Drost et al. 2003). Wasps and bees (Hymenoptera) are common food items, as are flies (Diptera), beetles (Coleoptera), butterflies, moths and caterpillars (Lepidoptera), and spittlebugs (Homoptera) (Beal 1912; McCabe 1991). Plant foods such as small fruits have also been reported (Beal 1912; Roberts 1932; Imhof 1962), but are not a significant food during the breeding season (McCabe 1991). Diet studies of adult flycatchers (Drost et al. 1998; DeLay et al. 1999) found that major prey items ranged from small (flying ants) (Hymenoptera) to large (dragonflies) (Odonata) flying insects, with Diptera and Hemiptera (true bugs) comprising half of the prey items. From an analysis of the flycatcher diet along the South Fork of the Kern River, California (Drost et al. 2003), flycatchers consumed a variety of prey from 12 different insect groups. Flycatchers have been identified targeting seasonal hatchings of aquatic insects along the Salt River arm of Roosevelt Lake, Arizona (Paxton et al. 2007a).

Flycatcher food availability may be largely influenced by the density and species of vegetation, proximity to and presence of water, saturated soil levels, and microclimate features such as temperature and humidity (USFWS 2002). Flycatchers forage within and above the tree canopy, along the patch edge, in openings within the territory, over water, and from tall trees as well as herbaceous ground cover (Bent 1960; McCabe 1991). Flycatchers employ a “sit and wait” foraging tactic, with foraging bouts interspersed with longer periods of perching (Prescott and Middleton 1988).

Parasitism and Predation

Brown-headed cowbird parasitism of flycatcher broods has been documented throughout its range (Brown 1988a,b; Whitfield 1990; Muiznieks et al. 1994; Whitfield 1994; Hull and Parker 1995; Maynard 1995; Sferra et al. 1995; Sogge 1995a). Where studied, high rates of cowbird parasitism have coincided with flycatcher population declines (Whitfield 1994; Sogge 1995a,c; Whitfield and Strong 1995) or, at a minimum, resulted in reduced or complete nesting failure at a site for a particular year (Muiznieks et al. 1994; Whitfield 1994; Maynard 1995; Sferra et al. 1995; Sogge 1995a,c; Whitfield and Strong 1995). Cowbird eggs hatch earlier than those of many passerine hosts, thus giving cowbird nestlings a competitive advantage (Bent 1960; McGeen 1972; Mayfield 1977a,b; Brittingham and Temple 1983). Flycatchers can attempt to

renest, but this often results in reduced clutch sizes, delayed fledging, and reduced nest success (Whitfield 1994). Whitfield and Strong (1995) found that flycatcher nestlings fledged after July 20 had a significantly lower recruitment rate; cowbird parasitism was often the cause of delayed fledging. In the Middle Rio Grande in recent years, parasitism of nests appears to be a non-factor in the growth of the Middle Rio Grande population (Moore and Ahlers 2011).

Predation of flycatcher eggs and nestlings has been documented for the common king snake (*Lampropeltis getulus*), gopher snake (*Pituophis melanoleucus affinis*), Cooper's hawk (*Accipiter cooperii*), red-tailed hawk (*buteo jamaicensis*), great horned owl (*Bubo virginianus*), western screech owl (*Otus kennicottiii*), yellow-breasted chat (*Icteria virens*), and Argentine ants (*Linepithema humili*) (Paxton et al. 1997a, McKernan and Braden 2001, Whitfield and Lynn 2001, Stoleson and Finch 1999, Smith et al. 2002, Paradzick et al. 2000, Famolaro 1998, USFWS 2002). Other potential predators include various snakes, lizards, chipmunks, weasels, raccoons, ringtailed cats, foxes, and domestic cats (McCabe 1991, Sogge 1995c, Langridge and Sogge 1997, Paxton et al. 1997a, Sferra et al. 1997, McCarthey et al. 1998, Paradzick et al. 2000, USFWS 2002). There are wide varieties of flycatcher nest predators. Flycatcher nest success can be greatly affected by predation, and may often be the single largest cause of nest failure in some years (Whitfield and Enos 1996, Paradzick et al. 1999). In 2010, the predation rate on nests in the Middle Rio Grande increased to 49% (125 out of 257 nests), compared to an average of approximately 30% for the previous eight years (Moore and Ahlers 2011). These high predation rates may be explained by a drier hydrologic regime, leading to reduced foliage density, reduced nest concealment and/or easier access by a wider range of potential predators (Moore and Ahlers 2011).

Movements, Long-Distance Migration, and Stopover Flight Distance

Flycatchers have higher site fidelity (to a local area) than nest fidelity (to a specific nest location) and can move among sites within stream drainages and between drainages (Kenwood and Paxton 2001). Within-drainage movements are more common than between-drainage movements (Kenwood and Paxton 2001). Evidence gathered during studies of banded populations shows that although most male willow flycatchers return to former breeding areas, flycatchers regularly move among sites within and between years (Ellis et al. 2008). Juvenile flycatchers were the group of flycatchers that moved (dispersed) the farthest to new and distant breeding sites from the area where they hatched (Paxton et al. 2007a).

The USGS's 10-year flycatcher study in central Arizona (Paxton et al. 2007a) is the key movement study that has generated these conclusions, augmented by other flycatcher banding and re-sighting studies (Sedgwick 2004; McLeod et al. 2008). Between 1997 and 2005, of the 1,012 relocated banded flycatchers, 595 (59%) banded flycatchers in Arizona returned to the breeding site of the previous year, while 398 (39%) moved to other breeding areas within the same major drainage, and 19 (2%) moved to a completely different drainage (Paxton et al. 2007a). Overall distance moved amongst adults and returning nestlings ranged from 0.03 to 444 km with mean distance moved by adults (9.5 km) being much less than the mean natal dispersal distance (20.5 km). Movement patterns are strongly influenced by reproductive success, and the age class of habitat patches may also be of consideration (Paxton et al. 2007a).

Flycatchers showed a high degree of movement, with movements common among breeding sites that were 30 to 40 km (18 to 25 mi) apart and within the same drainage (Paxton et al. 2007a). Therefore, the idea of a biologically meaningful breeding site has shifted from considering every habitat patch as a distinct site, to a network of patches within the same drainage as a site. At a larger geographic scale, infrequent movements that connect different drainages allow for metapopulation-scale processes to occur. Along the Lower Colorado River and its major drainages, flycatchers demonstrated similar patterns of movement (MacLeod et al. 2008). Thus, consideration of drainage and regional breeding habitat connectivity when planning flycatcher recovery and management will be more effective.

The USGS concluded that rapid colonization and increased metapopulation stability could be accomplished by establishing breeding sites within 30 to 40 km (18 to 25 mi) of each other (Paxton et al. 2007a). Flycatchers at breeding sites configured in this way would be able to regularly disperse or move between new or known breeding sites within the same year or from year-to-year. This proximity of sites would increase the connectivity and stability of the metapopulation, as well as support migratory stopover activity. Therefore, distances between patches for flycatcher breeding (30 to 40 km or 18 to 25 mi) in a stable metapopulation within an area may need to occur more closely than the proximity of riparian habitats used for stopovers during their long-distance migration (35 to 46 mi or 56 to 74 km, see migration section above).

Flycatchers migrate through the Rio Grande and arrive in breeding habitat between early May and early June; whereas autumn migration can occur anywhere from late July to mid September (Finch et al. 2000). Additionally, autumn flycatcher migration may vary from year to year, from site to site, and especially, in response to environmental conditions that affect nesting success or fledgling survival, such as drying events, fire, weather patterns or a combination of factors (Finch et al. 2000).

Flycatchers that breed in the Rio Grande Valley likely stopover along the Rio Grande during long-distance migration to Central America (Paxton et al. 2011a). During migration, flycatchers use a greater variety and distribution of habitats, including non-riparian vegetation than during breeding (Finch et al. 2000). Stopover habitats may lack some of the components important for breeding birds such as the presence of standing water or moist soils and suitable riparian patch size and structure. However, Yong and Finch (1997) and Finch et al. (2000) reported that capture rates and body mass of flycatchers were often highest in flycatchers captured in willow than in cottonwood, tamarisk, agricultural edge, or mowed willow.

Flycatchers do not deposit large amounts of fat in their bodies in order to prepare them for the high energy demands of long-distance migration as do migratory waterfowl (Finch et al. 2000). Alerstam and Lindstrom (1990) proposed that flycatchers may maintain low fat stores to minimize the energetic costs of flying with unnecessary weight. Owing to low fat stores, flycatchers may be constrained to feed at stopover habitats in order to make progress toward their breeding or wintering destination. Yong and Finch (1997) reported that the average body mass of migrant flycatchers on the middle Rio Grande was 12.7 grams (g) and ranged from 10.3 to 15.9 g. About 70% of the spring and fall migrant flycatchers captured along the Middle Rio Grande were captured between the hours of 0700 and 0900 (Yong and Finch 2002). After that

period, migrant flycatchers had apparently stopped for an average of one day and were then recaptured. Yong and Finch (1997) reported an average increase of 1.6 percent body mass per day after their recapture, generally increasing with time of day. DeLay et al. (1999) found a positive association between the relative abundance of migrant willow flycatchers and the relative abundance of aerial insects, suggesting that flycatchers migrate briefly in the morning, and stopover in habitats containing abundant insects sufficient to gain body mass and fat reserves before their next segment of their long-distance migratory journey.

Alerstam et al. (2007) suggested that maximum potential flight distance is the product of the potential hours of flight based on available flight energy from fat multiplied by flight speed. Therefore, based on the average flycatcher weight, and using the Alerstam et al. (2007) estimator, the average flight speed of a flycatcher is likely 18 to 23 mph (8 to 10 meters per second (mps)). If 70 percent of flycatchers migrate 2 hours per day, then the distance travelled would range from 35 to 46 mi per day (56 to 74 km per day). Since flycatcher wintering habitat is approximately 1,700 to 1,800 mi (2,736 to 2,897 km), and flycatchers spend approximately 12 percent of the year migrating (or 44 days; based on Yong and Finch 2002), then the average migration distance per day would be approximately 40 mi (64 km). Based on flight speeds, and distance travelled by flycatchers during 2 hours of flight, flycatchers would be able to reach their wintering grounds in fall or breeding grounds in spring, if adequate stopover habitats occurred at no less than every 40 miles. Since the average sized flycatcher likely flies approximately 9 mps (20 mph) for approximately 2 hours per day, migratory flycatcher habitats at distances greater than 65 km (40 mi) apart would likely stress flycatchers by reducing their fat and protein reserves necessary for survival and their long-distance migration. While the maximum average distance flycatchers could potentially fly in a day is larger, perhaps as far as 140 mi (225 km; see Finch et al. 2000), such distances may come at high energetic cost, as indicated by the lack of fat reserves in nearly 50 percent of migrant flycatchers captured, and potentially resulting in protein metabolism, reduced flight performance, and an inability to overcome obstacles.

Migrant flycatchers face a variety of obstacles and threats during migration including inclement weather, landscape barriers, predators, limited food and water, and discontinuity of stopover habitat (Finch et al. 2000, citing Moore 2000). If migrating flycatchers cannot periodically replenish their fat stores and do so quickly, the probability of a successful migration is reduced. If food supply varies among habitats during migration periods, fat stores, and body mass may depend on how successfully migrant flycatchers select foraging habitats with plentiful food during stopover (Finch et al. 2000). During flights, birds metabolize not only fat but also protein. Because there is no storage form of protein, protein metabolism may entail a structural or functional loss in flight performance, particularly if breast muscle is lost. Therefore, the probability of a successful migration is likely to be increased when stopover habitats are managed with distances between stopovers minimized as well as having stopover habit contain willow vegetation and abundant insects (Finch et al. 2000; Yong and Finch 2002). Whenever stopover habitats become degraded, diminished, or fragmented, migrating flycatchers will likely experience stress, a reduction of fitness, reduced mating or nesting success, increased time and energy expenditures, or an impaired ability to defend nesting or wintering sites, which could ultimately result in a population reduction. However, specific features associated with riparian habitats that support migratory flycatchers require further study (Yong and Finch 2002).

Range Wide Distribution and Abundance

Overall, the flycatcher's current range is similar to the historical range, but the quantity of suitable habitat within that range has been significantly reduced from historical levels (USFWS 2002, 2011c). The flycatcher's current range includes distribution over six Southwestern states (Arizona, New Mexico, southern California, extreme southern Nevada, southern Utah, and southwestern Colorado). Though part of its historical range, Texas is not included is the flycatcher's current distribution as there is no survey data or other records to determine its current status within the state. Durst et al. (2008a) reported that since 1993, extensive survey efforts in the states of Arizona, California, Colorado, Nevada, New Mexico, and Utah have greatly increased the number of known flycatcher breeding sites and territories. Between 1993 and 2007, the number of known flycatcher breeding sites grew from less than 50 to 288 sites. This increase was also reflected in the number of estimated flycatcher territories, growing from less than 200 territories in the 1990s to 1,299 in 2007. However, from 2005 to 2007, Durst et al. (2008a) estimated that the number of territories range wide increased only modestly from 1,214 to 1,299, and breeding sites from 275 to 288.

Across the flycatcher's range, certain river drainages have more territories than others do. More flycatcher territories are found along the Gila River Basin in New Mexico and Arizona than any other major drainage. Elsewhere in New Mexico and in southwest Colorado, territories are mostly found along the Rio Grande. The primary drainages in California with territories are the Kern, Owens, San Luis Rey, Santa Ana, and Santa Margarita Rivers. In Arizona, most flycatchers are found along the Gila, San Pedro, and Salt Rivers (particularly, at Roosevelt Lake). The Gunnison River drainage supports the majority of flycatchers in Colorado, while the Virgin and Pahranagat Rivers support the most territories in Nevada (Durst et al 2008a).

There are four general locations across the flycatcher's breeding range that has the most number of territories. Breeding locations along the Middle Rio Grande and Cliff-Gila Valley in New Mexico, and Roosevelt Lake (Salt River/Tonto Creek confluence) and the lower Gila River/San Pedro river confluence in Arizona fluctuate in numbers, but each can have about 200 territories in a single season (sometimes increasing to over 300 along the Middle Rio Grande). As a result, those four locations, can account for about 60 percent (approximately 800 out of 1,299 range wide territories) of all known territories. These sites create great colonization potential and opportunities to accomplish the Recovery Plan's goal of developing many breeding sites spread across the landscape (USFWS 2002). However, having that high of a proportion of territories in few locations increases concern for the subspecies from catastrophic events. Additionally, two of these locations (Roosevelt Lake in Arizona and Elephant Butte Reservoir in New Mexico) are associated with water storage. Therefore, while these locations are anticipated to maintain the dynamic nature of habitat, those cycles could be altered by water demand and climate change.

Tracking the distribution and abundance of the flycatcher has become increasingly challenging as the compilation of flycatcher survey data forms, database entry, and reporting is becoming more difficult to coordinate and accomplish across six states without dedicated funding (USFWS 2011c). Synthesizing the information of these sites and territories is also difficult due to the lack of standardized of data collection and survey reporting range wide (Durst et al 2008a). There

have been annual statewide reports from Arizona and range wide reports completed between the mid-1990s to 2007, but none since. Because of current limitations in database management, the ability to estimate populations and detect changes is becoming more difficult. Recently, Reclamation has compiled flycatcher data for New Mexico (Carstensen et al. 2012).

Due to the variety of habitat and breeding site characteristics, potential threats, and management responsibilities across the broad geographic area utilized by the flycatcher, its range is divided into 6 Recovery Units, with each Recovery Unit further divided into Management Units.

Coastal California Recovery Unit

The Coastal California Recovery Unit extends along the coast of southern California from north of Point Conception south to the Mexico Border and encompasses the Santa Ynez, Santa Clara, Santa Ana, and San Diego Management Units. The most recent range wide assessment of this Recovery unit in 2007 estimated that the number of territories had declined to 120, representing 9 percent of the range wide total (Durst et al. 2008a, USFWS 2011c).

Basin and Mohave Recovery Unit

The Basin and Mohave Recovery Unit represents a broad geographic area, which includes the arid interior of southern California and a small portion of extreme southwestern Nevada. This area encompasses the Owens, Kern, Mohave, Salton, and Amargosa Management Units. Since 2002, the number of known territories has decline from 69 to 51(Durst et al. 2008a), and with the exception of breeding sites on the Owens and Kern Rivers, all other known sites have fewer than five territories (USFWS 2002, 2011c).

Lower Colorado Recovery Unit

The Lower Colorado Recovery Unit is a geographically large and ecologically diverse unit, and includes the Colorado River and its major tributaries from the high elevation streams of East-Central Arizona and Central Western New Mexico to the main stem Colorado River through the Grand Canyon and downstream along the lower Colorado River to the Mexico Border (USFWS 2002, 2011c). The Lower Colorado Recovery Unit encompasses the Little Colorado, Middle Colorado, Virgin, Pahranagat, Bill Williams, Hoover to Parker Dam, and Parker Dam to Southerly International Border Management Units. Durst et al. (2008) estimated that as of 2007, 150 territories occurred in this Recovery Unit, representing 11 percent of the range wide total, with most sites containing fewer than five territories.

Upper Colorado Recovery Unit

The Upper Colorado Recovery Unit comprises another broad geographic area including much of the Four Corners area of southeastern Utah and southwestern Colorado, and smaller portions of northwestern Arizona and northeastern New Mexico, and encompasses the Powell and San Juan Management Units (USFWS 2002, 2011c). Only five breeding sites are known to occur in this Recovery Unit, representing an estimated high of 10 territories as of 2007 and less than 1 percent

of the range wide total (Durst et al. 2008a). These low numbers however may be due to a relatively low survey effort rather than an accurate reflection the flycatcher numbers and distribution (USFWS 2002, 2011c).

Gila Recovery Unit

The Gila Recovery Unit includes the Gila River watershed from its headwaters in southwestern New Mexico and downstream across Arizona toward the confluence with the Colorado River, and encompasses the Verde, Hassayampa and Agua Fria, Roosevelt, San Francisco, Upper Gila, Middle Gila and San Pedro, and Santa Cruz Management Units (USFWS 2002, 2011c). The latest range wide estimates from 2007 indicate the number of known territories to have increased to 659, representing 50 percent of the range wide total (Durst et al. 2008a).

Rio Grande Recovery Unit

The Rio Grande Recovery Unit includes the Rio Grande watershed from its headwaters in southern Colorado downstream to the Pecos River confluence in Texas and to a lesser extent the Rio Grande in Texas and the Pecos watershed in New Mexico and Texas. This Recovery Unit encompasses the San Luis Valley, Upper Rio Grande, Middle Rio Grande, and Lower Rio Grande Management Units (USFWS 2002, 2013). Large increases in the number of estimated and known territories have occurred within this Recovery Unit, primarily due to increasing numbers with the Middle Rio Grande Management Unit. In 2002, a total of 197 territories were known to occur within the Recovery Unit, mostly along the main stem Rio Grande (Sogge et al. 2003), representing 17 percent of the range wide total. By 2007, this number had increased to an estimated 230 territories (Durst et al. 2008a).

Reclamation (e.g., Moore and Ahlers 2011) has conducted presence/absence surveys within the Middle Rio Grande Management Unit since 1995 and there are currently eight distinct reaches that are surveyed along 300 km of the Rio Grande between Bandelier National Monument and Elephant Butte Reservoir (Figure 5). In 2011, the Middle Rio Grande Management Unit had approximately 399 territories detected (Moore and Ahlers 2012). In 2012, Moore (2012; Appendix B) reported 581 flycatchers observed, 348 flycatcher territories, 283 nests found, and 88 successful nesting attempts by flycatchers in the Middle Rio Grande Management Unit. Since 1999, most territories within the Middle Rio Grande Management Unit (~72 percent in 2012) have been located within the San Marcial Reach near and within Elephant Butte Reservoir (Moore and Ahlers 2012; Moore 2012). In the Middle Rio Grande Management Unit, the numerical territory goal is 100 territories, which has been far surpassed in the most recent years (Moore and Ahlers 2010).

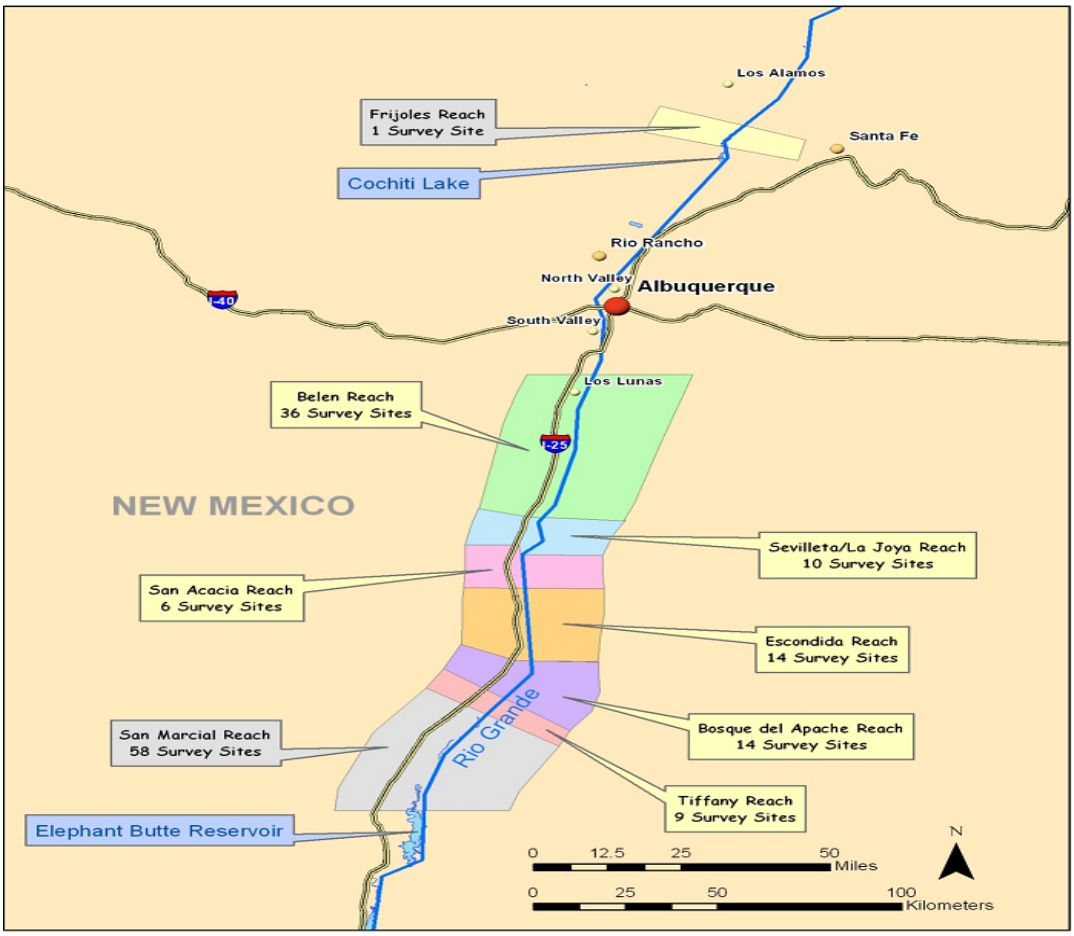

Figure 5. General locations of flycatcher survey sites conducted by the U.S. Bureau of Reclamation (Moore and Ahlers 2011, 2012)

New Mexico Distribution and Abundance

In New Mexico, surveys and monitoring since 1993 have documented approximately 173 to 400 flycatcher territories in 8 drainages and have been observed at 34 sites along the Rio Grande, Chama, Canadian, Gila, San Francisco, San Juan, and Zuni drainages. Unitt (1987) considered New Mexico as the state with the greatest number of flycatchers remaining. After reviewing the historical status of the flycatcher and its riparian habitat in New Mexico, Hubbard (1987) concluded, "[it] is virtually inescapable that a decrease has occurred in the population of breeding flycatchers in New Mexico over historical time. This is based on the fact that wooded sloughs and similar habitats have been widely eliminated along streams in New Mexico, largely as a result of the activities of man in the area." Unitt (1987), Hubbard (1987), and more recent survey efforts have documented very small numbers and/or extirpation in New Mexico on the San Juan River (San Juan County), near Zuni (McKinley County), and Blue Water Creek (Cibola County).

There are varying reasons why there have been changes in the number of territories in specific Management or Recovery units since completion of the Recovery Plan. In general, riparian habitat is dynamic due to it being subjected to river flooding, water storage, dam releases, river diversion, fire, agricultural return flow, drought, and so on. As a result, breeding habitat quality and distribution can rapidly change in quality and quantity (Paxton et al. 2007a), which will be reflected by the number of breeding territories observed. For example, nesting habitat can grow out of suitability; vegetation can develop from seeds to nesting suitability within five years; heavy river flow can remove or reduce habitat suitability in a day; and water storage can inundate habitat within conservation pools of lakes, and recede during or after the breeding season (USFWS 2002). Flycatcher's use of breeding habitat in different successional stages can also be dynamic. There is little doubt that changes to breeding habitat quality and quantity, and possibly increased survey efforts, have led to increases in flycatcher territories detected in the Middle Rio Grande (Moore and Ahlers 2010), Middle Gila and San Pedro River (Ellis et al. 2008, Graber and Koronkiewicz 2009), and Upper Gila Management Unit (Dockens et al. 2006), and decreased territories in Roosevelt Lake after reservoir elevation changes (Ellis et al. 2008).

Recent flycatcher breeding site reports show increases and maintenance of some of the largest populations in New Mexico. Along the Middle Rio Grande Management Unit, the number of known flycatcher territories has increased from 51 territories in 2002 (USFWS 2002) to 319 in 2009 (Moore and Ahlers 2010) and to 348 in 2012 (Moore 2012; Appendix B). During the 2010 breeding season, a total of approximately 400 flycatcher territories were found within the entire Rio Grande Basin in New Mexico (USBR 2012) and 617 were detected range wide in New Mexico (D. Carstensen, Reclamation, written comm., Jan 30, 2012), though numbers declined in 2012 (Moore 2012).

Throughout the San Acacia Levee Project area, there have been as many as 550 flycatchers or flycatcher territories detected from 1994 through 2012. Nearly all flycatcher pairs, or pairs with nests occur between River Mile 72 to River Mile 83 along the Rio Grande near the Refuge. However, in 2012, 4 pairs with nests were detected near Escondida, New Mexico.

Approximately 75% of the total known territories found within the Rio Grande Basin during the 2010 season were within the conservation pool of Elephant Butte Reservoir. The distribution of flycatcher territories within Elephant Butte Reservoir has shifted with the development of younger riparian habitats at lower elevations within the conservation pool as its elevation has receded over time. Fluctuating reservoir levels, reminiscent of the once-frequent scouring peak flood events of major rivers in pre-dam times, can create large swaths of dense riparian shrub habitat at relatively young successional stages suitable as flycatcher breeding habitat. When this occurs, the riparian habitat is quickly colonized by wildlife, particularly by vagile species such as birds, and can become important for the period that it exists (Hatten et al. 2010). However, although flycatchers are utilizing breeding habitat at elevations associated with the changing conservation pool, some of the greatest densities remain in those areas supported by groundwater seepage and some of the outflows from the LFCC. Breeding habitat availability in this area appears to have been a key component to the increasing population trend in the Middle Rio Grande Management Unit. .

III. ENVIRONMENTAL BASELINE

Under section 7(a)(2) of the ESA, when considering the effects of the action on federally listed species, the Service is required to take into consideration the environmental baseline. Regulations implementing the ESA (50 CFR 402.02) define 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 already undergone formal or early section 7 consultation; and the impact of State and private actions that are contemporaneous with the consultation in process. Given that the scale of environmental baseline information available on silvery minnows is generally associated with the four reaches of Middle Rio Grande (Figure 3), in this case, San Acacia Reach, the Service will evaluate the environmental baseline of the silvery minnow in the San Acacia Reach as part of the action area, which does not include the historical floodplain (Figure 2). However, the action area for the flycatcher does include the historical floodplain, as well as all areas of effect associated with the San Acacia Levee Project area including within the MRGV and along the west side of the Rio Grande Floodway from just upstream of SADD downstream to San Marcial, New Mexico. Therefore, the Service will refer to the action area for the flycatcher as the San Acacia Levee Project area versus the action area for the silvery minnow, which the Service will refer to as the San Acacia Reach. The Service will include environmental baseline information on the silvery minnow in the San Acacia Reach and on the flycatcher within the current 1% flow event floodplain and the floodway of the San Acacia Levee Project area. These species environmental baselines will help define the effects of the proposed action and other activities in the action area on the status of the species and its habitat to provide a platform to assess the effects of the action now under consultation.

To make this determination, the Service considered the regulations at 50 CFR 402.02 and 402.14(h)(2) which define "effects of the action" as including both direct and indirect effects of an action, and the “environmental baseline” as including "the past and present impacts of all Federal, State or private actions and other human activities in the action area" and "the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation."

Status of the Silvery Minnow in the Action Area

<u>Status of the Silvery Minnow in the San Acacia Reach of the Middle Rio Grande</u>

Several activities have contributed to the status of the silvery minnow and its habitat in the action area, and are believed to affect the survival and recovery of silvery minnows in the wild. These include the current weather patterns, changes to the natural hydrology of the Rio Grande, changes to the morphology of the channel and floodplain, water quality, storage of water and release of spike flows, captive propagation and augmentation, silvery minnow salvage and relocation, ongoing research, and past projects in the San Acacia Reach.

From 1993 until 2010, the catch rate of silvery minnows (n=1153) ranged from 0 to 2653 per 100 m^2 in the San Acacia Reach, and averaged 17.8 per 100 m^2. Since the Services 2003 Opinion was issued (USFWS 2003a), that is, since 2003, the catch rate has dropped, averaging 9.8 silvery minnow per 100 m^2 and ranging from 0 to 32.2 per 100 m^2 in the San Acacia Reach. More recently, in June 2012, Dudley et al (2012a) reported the catch rate of silvery minnows from 0 to 2.7 per 100 m^2 in the San Acacia Reach, with an average catch rate of 0.5 per 100 m^2. Based on their lengths, silvery minnows collected in the San Acacia Reach appeared to be primarily Age 1 individuals. Dudley et al. (2012a) sampled an area of 4,080.8 m2 of water in the San Acacia Reach during June 2012. The highest number of silvery minnows was observed at Site 15 (i.e., near the middle of the Refuge; Dudley et al. 2012a).

FACTORS AFFECTING SILVERY MINNOWS IN THE ACTION AREA

Changes in Hydrology

There have been two primary changes in hydrology because of the construction of dams on the Rio Chama and Rio Grande that affect the silvery minnow: 1) loss of water in silvery minnow habitat, and 2) changes to the magnitude and duration of peak flows.

Loss of Water in Silvery Minnow Habitat

Prior to measurable human influence on the system, up to the 14th century, the Rio Grande was a perennially flowing, aggrading river with a shifting sand substrate (Biella and Chapman 1977). There is now strong evidence that the Middle Rio Grande first began drying up periodically after the development of Colorado's San Luis Valley in the mid- to late 1800s (Scurlock 1998). After humans began exerting greater influence on the river, there are two documented occasions when the river became intermittent during prolonged, severe droughts in 1752 and 1861 (Scurlock 1998). The silvery minnow historically survived low-flow periods because such events were infrequent and of lesser magnitude than they are today. There were also no diversion dams to block repopulation of upstream or downstream areas, the fish had a much broader geographical distribution, and there were oxbow lakes, cienegas, lagoons, and sloughs associated with the Rio Grande that supported fish until the river became connected again.

Water use and flood management has resulted in a large reduction of suitable habitat for the silvery minnow. Total water use (surface and groundwater) by agriculture may range from 28 to 37 percent (S. S. Papadopoulos & Associates, Inc. 2000; Bartolino and Cole 2002). However, agriculture accounts for up to 90 percent of surface water consumption historically in the Middle Rio Grande (Bullard and Wells 1992). The average annual diversion of water in the Middle Rio Grande by the Middle Rio Grande Conservancy District (MRGCD) was 0.7×10^7 m^3 (535,280 acre-feet [af]) for the period from 1975 to 1989. Since 2001, improvements to physical and operational components of the irrigation system have contributed to a reduction in the total diversion of water from the Middle Rio Grande by the MRGCD. Total net diversions by the MRGCD have more recently dropped to 292,000 acre-feet (USBR 2012). A portion of the water diverted by the MRGCD returns to the river (through drains) and may be diverted from the river again for other uses, sometimes more than once (Bullard and Wells 1992). MRGCD diversions

from SADD are much lower, approximately 6,000 acre-feet (USBR 2012). In the San Acacia Reach, some lands are also irrigated using a combination of surface and groundwater (Landsford 1993a, 1993b, 1996).

Groundwater withdrawals also affect flow in the Middle Rio Grande. In 1990, total water withdrawal (groundwater and surface water) from the Rio Grande Basin in New Mexico was $2.3x10^9$ m^3 (1,830,628 af), significantly exceeding input (Schmandt 1993). Whipple (1996) identified enormous water losses to infiltration in the San Acacia Reach ranging from 17 to 77% and averaging 55% of surface flow. However, under New Mexico State law, the municipal and industrial users are now required to offset the effects of groundwater pumping on the surface water system (USBR 2003, 2012). Water withdrawals have not only reduced overall flow quantities, but also caused the river to become locally intermittent or dry for extended reaches. Irrigation diversions and drains, riparian evapotranspiration, as well as a declining water table, significantly reduce water volumes in the river.

The state has legally acknowledged the connection between surface flow and groundwater (USBR 2012). Where potential exists for groundwater pumping to deplete a stream system of surface water, the state may prohibit or limit groundwater withdrawals. Thereafter, surface rights must be purchased and "retired" in exchange for what is pumped from the new well. The rule applies only to large wells; domestic wells are considered *de minimus* depletions of groundwater and are exempt from the offset requirement and many groundwater permits are issued annually by the State of New Mexico Office of the State Engineer. However, due to the proximity of the City of Socorro well fields to the MRG, the future expected drawdown of the aquifer by 14.6 feet by 2022 and 17.1 feet by 2042, could potentially result in relatively immediate stream depletions that must be considered (S.S. Papadopulos & Associates 2002). Metering of groundwater use in Socorro County is not compulsory and the cumulative impact of domestic wells on Rio Grande surface flows has not been fully characterized in the San Acacia Reach.

River reaches particularly susceptible to river drying occur at an extended 58-km (36-mi) reach from near Brown Arroyo (downstream of Socorro, New Mexico) to Elephant Butte Reservoir. Extensive fish kills, including tens of thousands of silvery minnows, have occurred in these lower reaches when the river has dried (USFWS 2003a, 2010a). It is assumed that mortalities during river intermittence are likely greater than those documented, for example, due to predation by birds in isolated pools (USFWS 2010a). From 1996 to 2007, an average of 51 km (32 mi) of the Rio Grande dried each year, mostly in the San Acacia Reach. The most extensive drying occurred in 2003 when 70 miles was dewatered. In contrast, 2008 was considered a wet year, with above average runoff and an average monsoon season. As a result, there was no river intermittency (though 0.8 miles were purposely dewatered) and no salvage of silvery minnow that year, which was the first time there has been no river drying since 1996. Intermittent river conditions in 2009, 2010, and 2011 resulted in 20, 28 and 40 miles of dewatered channel (USBR 2012); large sections of the San Acacia Reach are also drying currently in 2012. Dudley et al (2005) reported a strong negative correlation between low flow days less than 100 cfs and mean October catch rate of silvery minnows in the San Acacia Reach.

Changes to Magnitude and Duration of Peak Flows

Water management has resulted in a loss of peak flows that historically triggered the initiation of silvery minnow spawning. The reproductive cycle of the silvery minnow is tied to the natural river hydrograph. A reduction in peak flows or altered timing of flows may inhibit reproduction. Since completion of Elephant Butte Dam in 1916, additional dams have been constructed on the Middle Rio Grande (Scurlock 1998). Construction and operation of these dams, which are either irrigation diversion dams (Angostura, Isleta, San Acacia) or flood control and water storage dams (Elephant Butte, Cochiti, Abiquiu, El Vado), have modified the natural flow of the river. Mainstem dams store spring runoff and summer inflow, which would normally cause flooding, and release this water back into the river channel over a prolonged period.

Surface flows of the Middle Rio Grande are of two general types: snowmelt runoff and stormwater runoff (USACE 2012a). Snowmelt runoff generally occurs from April through June as a result of snowmelt, which may be augmented by general precipitation (Corps et al. 2007). Spring flows are characterized by gradual rises to moderate discharge rates, large runoff volumes, and approximately two-month-long flow durations, with shorter duration peak flows included. Since it was completed in 1975, flow regulation upstream at Cochiti Dam substantially limits potential for spring flooding through the San Acacia Levee Project area (USACE 2012a,b). However, most of the floods producing the greatest damage within the San Acacia Levee Project area have been flows from summer storms entering the Rio Grande through tributary inflows from the Rio Puerco and Rio Salado.

The Corps has consulted with the Service on the variations of releases of water. For example, from November 1995 to March 31, 1996, during which time 0.1×10^7 m^3 (98,000 af) of water was released at a rate of 9.2 m^3/s (325 cfs). Such releases depart significantly from natural, historical winter flow rates, and can substantially alter the habitat for silvery minnows. In spring and summer, artificially low flows may limit the amount of habitat available to silvery minnows (USFWS 2003a). The Corps (USACE 2009) has proposed to implement a temporary deviation from its water control plans for the Cochiti Lake Project to facilitate spawning and recruitment flows for silvery minnows and to provide seasonal overbank flooding opportunities to create flycatcher habitat.

In the spring of 2002, 2003, and 2012, an extended drought raised concerns that silvery minnows would not spawn because of a lack of spring runoff. Except in 2012, river discharge was artificially elevated through short-duration reservoir releases during May to induce silvery minnow spawning (USACE 2009). In response to the releases, significant silvery minnow spawning occurred in all reaches except the Cochiti Reach (USACE 2009).

By contrast, natural spring runoff in 2005 was above average, leading to a peak of over 170 m^3/s (6,000 cfs) at Albuquerque and sustained high flows greater than 85 m^3/s (3,000 cfs) for more than 2 months. These flows improved conditions for both spawning and recruitment (Dudley et al. 2005). The October 2005 monitoring indicated a significant increase in silvery minnow densities in the Middle Rio Grande compared to 2003 and 2004. In 2006, however, October numbers declined again after an extremely low runoff period and channel drying in June and July

(Dudley et al. 2006). October samples that year yielded no age-0 silvery minnows, indicating poor recruitment in the spring. Runoff conditions in 2007 to 2009 were average or above average and maintained a high catch rate (Dudley and Platania 2009). In addition to providing a cue for spawning, flood flows can help maintain a channel morphology to which the silvery minnow is adapted. Despite periodic and sometimes sustained declines in the abundance of silvery minnow, the species can apparently rebound quickly following years with good spawning and recruitment conditions (Dudley et al. 2006). The dramatic increase in the abundance of silvery minnow from 2006 to 2007 (nearly an order of magnitude) is indicative of the ability of the species to rebound following favorable conditions.

Mainstem dams and altered flow regimes can affect aquatic and riparian habitat by preventing overbank flooding, trapping nutrients, altering sediment transport and temperature regimes, reducing and dewatering main channel habitat, modifying or eliminating native riparian vegetation, and creating reservoirs that favor nonnative fish species. Wesche et al (2005) evaluated the hydrologic alterations by compare 33 different hydrologic parameters between gage stations and times in the MRGV. Overall, hydrologic alteration was highest at SADD (0.47). For example, the 1, 3, 7, 30 and 90-day maximum flow parameters at SADD were highly altered, but positive, indicating high flows were occurring more frequently within the RVA target range than would be expected. Likewise, several low flow parameters (e.g. December and January median flows, 3, 7, and 30-day minimums) were found to be highly altered at SADD and negative. These changes may affect the silvery minnows by reducing increasing winter flows and decreasing summer minimum flows, thereby altering its preferred habitat, especially in summer and winter, and affecting the fishes' metabolism, increases stress, and affecting health. Dams and reservoirs also fragment habitat, affect dispersal and provide a continual supply of nonnative fish that may compete with or prey upon silvery minnows. Altered flow regimes may also result in improved conditions for other native fish species that occupy the same habitat, causing those populations to expand at the expense of the silvery minnow (USFWS 1999).

Changes in Channel and Floodplain Morphology, Geomorphology, and Sedimentation

Historically, the Rio Grande was slightly sinuous, braided, and freely migrated across the valley floodplain. Changes in natural flow regimes, narrowing and deepening of the channel, and restraints (levees, jetty jacks) to channel migration adversely affected the silvery minnow. These effects result directly from constraints placed on channel capacity by structures built in the floodplain. These anthropogenic changes have and continue to degrade and eliminate spawning, nursery, feeding, resting, and refugia areas required for species' survival and recovery (USFWS 1993; 2003a). Structural flood control also prevents natural channel avulsions within the MRGV to which silvery minnows (and flycatchers) are adapted and benefit from the dynamic habitat, even at when such avulsions can lead to local mortalities and habitat destruction.

Present water management in the Middle Rio Grande implemented because of the 1948 authorization for the Rio Grande Floodway includes flood risk and sediment management dams and reservoirs, irrigation storage reservoirs, levees, channel maintenance, irrigation diversions, drainage systems, and runoff conveyance systems (USACE et al. 2007). In addition, the river has been laterally stabilized in the floodplain by the installation of jetty jacks in the 1950s and

1960s (Crawford et al. 1993). River sediment loads and debris settled in the jacks, creating stable banks and a riparian zone of cottonwood, Russian olive, willow, and saltcedar (Crawford et al. 1993). All these activities affect channel morphology through alterations in discharge and sediment load. The river discharge influences the size of the channel, whereas the type of material transported influences the character of the channel. The existing spoil bank limits meandering to the historic floodplain and controls the degradation/aggradation process (USACE 2012a). The increased vegetation hastens aggradation in the overbank areas of the floodway through increased roughness and lowered velocities and energy. The status of the channel morphology is a result of these earlier and ongoing activities and water management and is predicted to continue to degrade over time (USBR 2012).

In the San Acacia Levee Project area, stream channel incision has been pronounced from immediately upstream of the SADD extending downstream of the SADD to approximately 4 miles above a point on the river parallel to the intersection between United States Highway 60 and Interstate 25 (USACE 2012a). Localized geologic uplift may be a major contributor to stream channel incision in this reach. Below this point, for a distance of less than 10 miles, the river is neither incising nor aggrading, and below this, the river channel is in a long-term aggradation pattern (Massong et al. 2007). Aggradation has occurred within the floodway, raising it as much as 10 to 12 feet above the adjacent, sediment-starved historical floodplain (Figure 2). With individual years' average sediment concentrations as high as about 200,000 mg/L the Middle Rio Grande is one of the more heavily sediment-laden streams on earth (Baird 1998). The combination of high sediment loading coupled with confinement of the floodway by spoil banks (and soon engineered levees) exacerbate the already-perched channel, whereby the active channel and adjacent overbanks are elevated above the historical floodplain lying outside the floodway. Potential effects on silvery minnow habitat by spoil bank confinement of the active floodplain into the floodway have not been evaluated.

As a result of the lateral confinement of floods within the floodway by the spoil bank, vertical accumulation of sediment deposition along the channel and the floodway has resulted in a raised water and sediment surface elevation, by as much as 11 to 24 feet in some locations, but mostly below Highway 380 (Crawford et al. 1993, USACE 2012b). This process of vertical sediment accumulation within the floodway will continue at a rate of approximately 0.5 ft per year and is predicted to accumulate over 10 to 15 feet into the future (USACE 2012b) for as long as the spoil bank lasts. Corps (2012b, Appendix F, page 126, Tables F-2A, F-2B, F-61) describe the water surface elevation exceeding the height of the spoil bank and causing damages and flow into the historical floodplain (Table 3). Flood protection greater than that provided by the spoil bank is the purpose of San Acacia Levee Project (USACE 2012a,b). Floods that are not contained by the spoil bank will result in sediment accumulation outside the floodway, with various environmental and societal consequences (USACE 2012b).

Corps (USACE 2012b) developed a relationship between the rates of aggradation to the position in the river (as defined by cross section or range lines) that predicted sediment accumulation continuing over the next 50 years (Figure 6). The Corps plotted these aggradation (or degradation) values against range lines to determine where the reach had a general aggradation or degradation trend. The Corps (USACE 2012b,e) analysis showed that the San Acacia Levee

Project area had a general degradation trend upstream of the Escondida Bridge (near range line/cross section 1412) and an aggradation trend 10 miles downstream of the Escondida Bridge at approximately at the Brown Arroyo and Rio Grande confluence, south of Socorro, New Mexico (Figure 6).

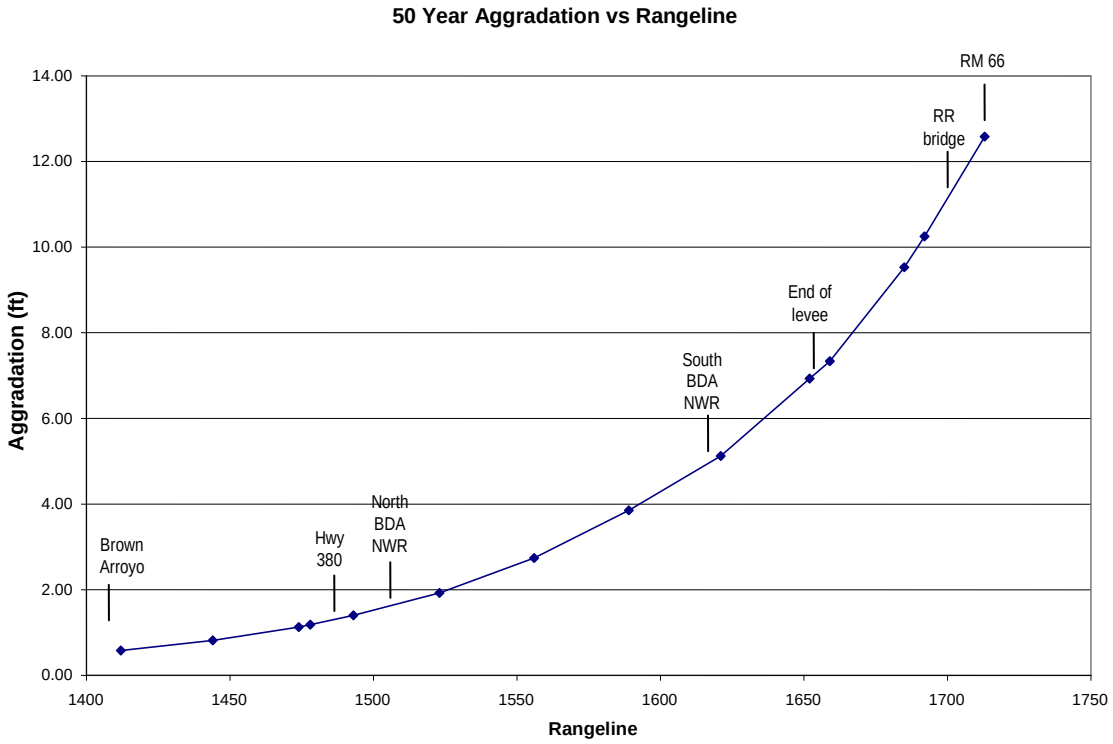

Figure 6. Corps (2012b,e) predicted 50-year sediment accumulation (aggradation) for selected Rangelines (cross sections) along the San Acacia Reach of the Middle Rio Grande.

The active river channel within the floodway is also being narrowed by the encroachment of vegetation, resulting from continued flow reductions and the lack of overbank flooding. The lack of flood flows has allowed nonnative riparian vegetation, such as tamarisk and Russian olive, to encroach on the river channel (USBR 2001; 2012). These nonnative plants are very resistant to erosion, resulting in channel narrowing and a subsequent increase in water velocity. Higher velocities result in fine sediment (e.g., silt and sand) being swept into the water column and redeposit downstream to form sediment plugs or be transported further away, which leaves coarser bed materials such as gravel and cobble as the predominant substrate. Habitat studies (Dudley and Platania 1997), demonstrated that a wide, braided river channel with low velocities resulted in higher catch rates of silvery minnows, and narrower channels with higher velocities resulted in fewer fish captured. The availability of wide, shallow habitats that are important to the silvery minnow is decreasing. Narrow channels have few backwater habitats or frequently flooded overbank areas with low velocities that are important for silvery minnow fry and age-0 fish.

Within the current range of the silvery minnow, human development and use of the floodplain have greatly restricted the width available to the active river channel. A comparison of river area between 1935 and 1989 shows a 52 percent reduction, from 10,764 ha (26,598 acres) to 5,626 ha (13,901 acres) (Crawford et al. 1993). These data refer to the Rio Grande from Cochiti Dam downstream to the "Narrows" in Elephant Butte Reservoir. Analysis of aerial photography taken by Reclamation in February 1992, shows that of the 290 km (180 mi) of river, only 0.6 percent of the floodplain has remained undeveloped. Development in the floodplain also makes it difficult, if not impossible, to send large quantities of water downstream that would create adequate low velocity habitat that the silvery minnow prefers. As a result, reduced releases have decreased available habitat for silvery minnows and allowed encroachment of nonnative vegetation and human development in the floodplain.

Habitat Fragmentation

In addition to altering peak flows, and contributing to reductions of water in silvery minnow habitat and alterations of river morphology, the dams constructed along the MRG have resulted in fragmentation of existing silvery minnow habitat, and are believed to be a significant causal factor for the 90 to 95% reduction of the species range compared to its historical range (USFWS 1994; Platania and Altenbach 1998). By changing the flow of water, sediment, nutrients, energy, and biota, dams interrupt and alter most of a river's important ecological processes (Ligon et al 1995). In the San Acacia Levee Project area, dams have fragmented silvery minnow habitat. For the silvery minnow, two of the major deleterious effects from the presence of dams in the Middle Rio Grande include the inability of fish to move to upstream reaches and repopulate those portions of the Middle Rio Grande without human intervention, and effects on the genetics of the existing silvery minnow population (USFWS 2010).

Water Quality

Many natural and anthropogenic factors affect water quality in the Middle Rio Grande. 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 deliveries to the river (Ellis et al. 1993). Factors that are known to contribute to degraded fish habitat include temperature changes, sedimentation, runoff, erosion, organic loading, reduced oxygen content, pesticides, and an array of other toxic or hazardous substances (USFWS 2003; NMED 2009; Lusk et al 2012). Both point source pollution (pollution discharges from a pipe or other discreet conveyances) and nonpoint source pollution (from diffuse sources such as urban stormwater runoff) affect the MRGV (NMED 2007, 2009, 2010). Major point sources include discharges from wastewater treatment plants (WWTPs) and potentially from confined animal feeding operations (i.e., feedlots). Major nonpoint sources include agricultural activities, such as, fertilizer and pesticide application, excessive grazing; urban stormwater; atmospheric deposition; and mining activities (Ellis et al. 1993).

Effluents from WWTPs contain pollutants such as ammonia that may affect the water quality of the Rio Grande and adversely affect silvery minnows (Passell et al. 2007). Since 1989, ammonia and chlorine have been discharged unintentionally at concentrations that exceed protective levels for silvery minnows (Passell et al. 2007) as recently as 2011 (Chwirka 2011; Lusk 2011a). In addition to ammonia and chlorine, WWTP effluents may also include cyanide, chloroform, pesticides, semivolatile compounds and hydrocarbons, volatile compounds, heavy metals, and pharmaceuticals and their derivatives, which can pose a health risk to silvery minnows when discharged in concentrations that exceed the water quality criteria or guidelines (Lusk 2003; NMED 2010). Additionally, even if the concentration of a single chemical compound is not harmful by itself, chemical mixtures can be additive in their toxicity to silvery minnows (Buhl 2002). Marcus et al. (2010) described the concentrations of chemicals in the Middle Rio Grande that may affect fish health or produce localized mortalities. However, the long-term effects and population-level impacts of toxic chemical discharges or other degraded water quality conditions in the Middle Rio Grande on silvery minnow over time have not been fully evaluated and often fail to address uncertainties.

Dissolved Oxygen and Oxygen Demanding Substances

DO is the amount of oxygen as measured dissolved in the water column (Benson and Krause 1980). The amount of DO in water depends upon the water temperature, atmospheric pressure, the surface area of water exposed to the atmosphere, and the oxygen byproduct of photosynthesis by aquatic plants (Odum 1956; Bott 1996). The capacity of water to hold oxygen in solution is inversely proportional to the water temperature (Benson and Krause 1980). DO is critical to the aquatic community and for the breakdown of organic matter in the Rio Grande. DO, at appropriate saturation, is essential to keeping fish and other aquatic organisms alive, and for sustaining their reproduction, development, vigor, immune capacity, behavior, movement, and predator response actions (Hughes 1973; Kramer 1987; Breitburg 1992; Pörtner and Peck 2010). DO can be lost from the water column because of aquatic life respiration and the oxygen demand created by substances oxidizing in the water or sediment (Odum 1956; Bott 1996). Diurnal fluctuations in DO concentrations result from photosynthesis as a source of oxygen in excess of saturation during the day, and at night, when photosynthesis ceases and respiration consumes oxygen and reduces the DO concentrations in the water column (Ignjatovic 1968; Bott 1996). Hypoxia occurs when DO concentrations are below those expected at 100 percent saturation of oxygen between the air and water. Critically low DO levels (below 2 mg/L), are often termed anoxic. DO can be reduced from its maximum saturation within the water column because of aquatic life respiration and the oxygen demand of substances oxidizing in the water or in sediment (Odum 1956; Bott 1996).

Fish can attempt to compensate for low DO conditions by their behavioral responses, such as increased use of ventilation of oxygenating water at the aquatic surface, by changing their activity level or habitat use, and by avoidance behaviors; though these activities are known to come at a higher energy cost for fish (Kramer 1987; BCME 1997). Below some threshold oxygen saturation, fish will be expending excess energy to maintain homeostasis and some degree of physiological stress will occur (Heath 1995). For example, ventilation rates are often increased, reduced feeding and movement activity are decreased and increased glycolysis and

cortisol release can be induced even by short-term low DO conditions (Kramer 1987; Heath 1995; BCME 1997). Eventually fish suffocate at critically low DO concentrations and may begin to die. Additionally, hypoxic conditions may also cause a wide range of chronic effects and behavior responses in fish (Downing and Merkens 1957; Davis 1975; Kramer 1987; Breitburg 1992).

The depletion of oxygen from the water overlying the bottom sediment is primarily caused by the decomposition of organic matter in sediments. For example, Bexfield (2010) reported that the groundwater at shallow depths below and near the Rio Grande channel tends to have low concentrations of dissolved oxygen, which probably reflects a greater organic-carbon content for sediments within the Rio Grande inner valley and, therefore, greater oxygen reduction. Sediment oxygen demand (SOD) has been defined as the rate of oxygen consumption, biologically or chemically, on or in the sediment at the bottom of a water body (Veenstra and Nolen 1991). The primary sources of SOD are often reduced or recalcitrant compounds (e.g., iron, manganese, ammonia, sulfides, anoxic groundwater, etc.) in the sediments as well as algae, bacteria, and other sources of organic matter that settle out of the water column, or are resuspended with increased flow (Fillos and Molof 1972; Kreutzberger et al. 1980; Wang 1980; Walker and Snodgrass 1986, Caldwell and Doyle 1995).

The sources of these oxygen demanding compounds includes erosion from stream banks, from bed sediment and as attached to suspended sediment, attached particulate organic matter, or associated with anoxic, alluvial groundwater, and from the addition of chemicals added from point and nonpoint sources, including biotic deposits (e.g., debris, feces), or as the result biotic activity (e.g., colonies of bacterial growth). Kreutzberger et al. (1980) reported that low DO in the Milwaukee River was due to sediment oxygen demanding substances that were churned up by stormwater discharges scouring sediment into the water column. Several researchers have reported low oxygen events in the Middle Rio Grande associated with storm water runoff events from urban areas, natural tributaries, and fire burn scar areas (Van Horn and Dahm 2008, USFWS 2011a, Lusk et al. 2012, Dahm and Candelaria-Ley 2012). Another important consequence of low DO conditions is that organic matter and sediments can then also release ammonia, which can affect fish and their prey, thereby reducing the quality of suitable habitat (Merkens and Downing 1957; Fillos and Molof 1972; Thurston et al. 1981; Caldwell and Doyle 1995).

Precipitation events of sufficient intensity can result in increased turbidity, increased or decreased water temperatures, and increased input of oxygen demanding substances (Huggins and Anderson 2005). Conditions in the Rio Grande that have led to increased erosion and sedimentation including natural or anthropogenic-induced variation in water and sediment discharge due to high and low flows, poor land management, flooding, catastrophic wildfires, or other activities (Graf 1994; Scurlock 1998; Julien et al. 2005; Massong et al. 2007). When tributaries and riverbeds are scoured by stormwater runoff or other events of sufficient velocity, and sediments are redistributed, the actions of sedimentation and elevated SSC likely creates mixing zones that may scour or smother sessile organisms (algae, bacteria, some invertebrates), and turbidity that shades light levels and reduces algae production, and creates stressful or suffocating conditions for fish at least temporarily until the sediment-water interface is stabilized

and DO again increases (Huggins and Anderson 2005: Bixby and Burdett 2009). Moderate to large changes in any one of these factors because of a single or multiple events that can affect the level of DO in the Rio Grande and potentially adversely affect silvery minnows.

Infrequent Overbank Flooding and Hypoxic Water Return

Flooding of the overbank areas during spring runoff is beneficial to the development and recruitment of silvery minnows as the flooded habitats provide cover, food, and low velocity nursery habitat. However, in the Middle Rio Grande, Valett et al. (2005) found that flooding of the riparian forest soils (Rio Grande floodplain or "bosque") increased the rates of respiration during the flood pulse. Ellis et al. (1999) suggested that a decade of annual flooding of riparian forest may be used to return forest floor organic debris levels to pre-disturbance levels. In floodplains that were *infrequently* flooded, inundation of the forest resulted in widespread low DO in the floodwaters capable of affecting fish. For example, Abeyta and Lusk (2004b) reported a fish kill due to low DO in a large stagnant floodplain pool after flooding along the Middle Rio Grande. Contributions from the stagnant floodwaters into the main channel would also be expected to decrease the DO content within the Rio Grande downstream. Depending on how the annual cycle of the flood pulse influences primary productivity, plant respiration, decomposition of woody and other vegetation, and water residence time, floodplains may produce and retain enough organic matter to reduce the DO of floodwaters on an annual basis (Valett et al. 2005; DBS&A 2009). However, these flood events are not necessarily a "natural phenomena" as the flood frequency and depositional character of the Rio Grande floodplain has been substantially changed, and frequently flooded areas did not experience low DO conditions to the same extent as did infrequently flooded areas (Ellis et al. 1998; Valett et al. 2005).

Petroleum, Hydrocarbons, and Spills

There are concerns about the potential petroleum spills (and other chemicals) from pipelines or during transportation in vehicles or by rail along and across the Rio Grande. Based on information reported in the National Response Center database (http://www.nrc.uscg.mil Accessed April 27, 2011). PAHs are known to occur during petroleum spills and may persist in contaminated sediments. These may be transported to fish tissues through foraging on contaminated sediments or prey where they can be toxic to fish (Eisler 1987; Schein et al. 2009). A petroleum pipeline break, if it were to spill into the Rio Grande, has the potential to reduce DO in the water column as well as contaminate the water, sediment and habitats of fish and wildlife, and could contribute to adverse effects on downstream water quality and silvery minnow habitat (Lusk 2010). However, the lack of available information on past spill events does not allow the estimation of these effects to silvery minnow or to forecast future frequency of spill events. In the action area, high potential risk may include rail spills near San Marcial Railroad Bridge.

PAHs can be associated with petroleum spills, parking lot runoff, but wet and dry atmospheric deposition from combustion activities is often a predominant source in the environment (Eisler 1987). To understand the potential effects of polycyclic aromatic hydrocarbons (PAHs) on sediment, the data on PAHs in Rio Grande sediments can be compared to numerical sediment quality criteria (such as Threshold Effect Concentrations or Probable Effect Concentrations

[PECs]) such as those proposed by MacDonald et al. (2000). Using sediment PAH concentrations in the Middle Rio Grande compared with guidelines similar to PECs, Marcus et al. (2010) identified heavy metal- and PAH-contaminated sediment as posing the greatest toxicity threat to silvery minnow. PAH compounds have been detected in sediment for decades, and are widespread in the Rio Grande (Levings et al. 1998; NMED 2009; Marcus et al. 2010). PAHs in sediment are often toxic to aquatic life and may reduce prey populations, and when incorporated into prey or through sediment ingestion can become carcinogenic to fish and other predators (Eisler 1987). Concentrations of naphthalene, an indicator PAH, ranged up to 17 µg/kg wet weight were found in silvery minnows collected from the Middle Rio Grande (Lusk 2012). Except for evaluating the PAH concentrations in sediment using quality criteria (e.g., PECs), there are few diagnostic criteria for the evaluation of PAHs in silvery minnows or methods of evaluation for potential effects to their prey, and how specifically silvery minnow behaviors, habitat, feeding, or health may be affected by their widespread exposure to PAHs in the Middle Rio Grande.

Sediment Quality

Sediment is an important component of silvery minnow habitat in the Rio Grande (USFWS 1999, 2003a). Sediment suspended in the water column, from erosion and other processes, can be described in terms of suspended sediment concentration (SSC) or as total suspended solids (TSS), but these measurements are not identical (Gray et al. 2000). Sediment concentrations and suspended sediment loads are important sources of sediment contamination often conveyed by stormwater (Harwood 1995; USEPA 2002). USEPA (2002) identified a number of pollutants that are more likely to partition into sediment than remain dissolved in the water column, such as heavy metals, certain semivolatile organic compounds such as PAHs, PCBs, and organochlorine pesticides. Large precipitation events wash sediment and pollutants that adhere to sediment into the river from surrounding lands through storm drains and intermittent tributaries. Stormwater produces high levels of SSC and TSS, and consequently high levels of contaminants for those constituents that commonly bound to sediment particles, for example, metals, radionuclides, and PCBs (NMED 2009, 2010).

Heavy Metals

The USEPA (USEPA 2010a) reported lead and zinc in urban stormwater exceeded applicable water quality standards. In their Biological Evaluation, the USEPA (2010a) reviewed the accumulation of lead and zinc in fish tissue and sediment. Numerous researchers (Roy et al. 1992; Schmitt et al. 2004; Buhl 2011b; Lusk 2012) have reported high zinc concentrations in fish collected from the Rio Grande. However, zinc in silvery minnows rarely exceed concentrations associated with adverse effects in those fish used in laboratory studies, but additional study on elevated zinc burdens in silvery minnows may be warranted (Buhl 2011b; Lusk 2012).

PCBs

The chemicals known as PCBs are mixtures of synthetic organic chemicals with the same basic chemical structure and similar physical properties that range from oily liquids to waxy solids (USEPA 2011). There are no known natural sources of PCBs in the San Acacia Reach. While the production of PCBs was banned in 1979, there are many PCB containing applications still in use, which can become sources for PCBs in the environment (USEPA 2011). PCBs enter aquatic environments from wet and dry atmospheric deposition, river inflows, groundwater flow, and discharges from industrial facilities. Deposition may be the most important source to water bodies such as large lakes, reservoirs and rivers (Wenning et al. 2010).

PCBs have been detected in suspended sediments (0.09 µg/g) in urban stormwater entering the Rio Grande (NMED 2010). The NMED (2010) noted a correlation between the concentrations of PCBs in suspended sediment and stormwater discharges, suggesting that management techniques that reduce suspended sediment in stormwater may reduce sediment contamination loads to the Rio Grande. Lusk (2012) reported that silvery minnows collected from the Middle Rio Grande contained detectable concentrations ranging from 4.7 to 38.2 ng/g wet weight. Olsson et al. (1999) reported skeletal deformities associated with fish injected with 360 ng/g PCBs on a lipid basis. Lusk (2012) reported that silvery minnows had PCBs concentrations lower than 36 ng/g on a per lipid basis. This suggests that PCB-induced deformity would be unlikely in silvery minnows unless they were more sensitive to PCBs than were the test fish and that concentrations detected do not exceed current known toxic effect levels (Wenning et al. 2011) within the silvery minnow.

Pesticides and Pesticide Use

Pesticide contamination can occur from agricultural activities, as well as from the cumulative impact of residential and commercial landscaping and other activities (Anderholm et al. 1995). Stormwater runoff, irrigation return, and riverside drain return flows and windblown dust and drift likely contribute a portion of pesticides to the Rio Grande. The presence of pesticides in surface water can depend on the amount applied, timing, location, and method of application. Water quality standards have not been established for many pesticides, and existing standards do not consider cumulative effects of several pesticides in the water at the same time or as part of the food chain. Ong et al. (1991) recorded the concentrations organochlorine pesticides in water, suspended sediment and bed sediment samples between 1978 and 1988. Several researchers (Roy et al. 1992; Anderholm et al. 1995; Abeyta and Lusk 2004a; Langman and Nolan 2005; NMED 2009; Marcus et al. 2010) have all reported various pesticide residues detected in water, fish tissues, or sediment samples in the Middle Rio Grande, including in the San Acacia Reach.

Roy et al. (1992) reported that DDE, a degradation product of DDT, was detected in whole body fish collected throughout the Rio Grande. They suggested that fish in the lower Rio Grande were accumulating DDE in concentrations that may be harmful to fish and their predators. Lusk (2012) analyzed silvery minnows collected in the Rio Grande for DDT residues and found that the sum of DDT residues and metabolites ranged from 8.8 to 30.7 micrograms per kilogram (µg/kg) wet weight. The concentrations of DDT residues in silvery minnows, while elevated,

were not above concentrations of concern for lethality (890 µg/kg wet weight), but may be associated with sublethal effects (greater than 5 µg/kg wet weight) particularly if similar DDT residues are found in silvery minnow eggs (Beckvar and Lotufo 2011).

Pesticide use may occur throughout Socorro County, New Mexico (USEPA 1991). For example, a number of Federal and non-Federal agencies use herbicide applications in association with nonnative vegetation removal and riparian restoration projects in or near the floodway (NMSLO 2010, USFWS 2011b). A variety of herbicides (e.g., Arsenal, Roundup, Garlon 4) have been used to control salt cedar and Russian olive along roadways, dikes, and in areas undergoing riparian vegetation restoration; particularly on new sprouts in previously treated areas using a backpack sprayer application methods to foliage or onto cut-stumps. Some herbicides have been used to control Eurasian water milfoil (*Myriophyllum spicatum*) or pepperweed (*Lepidium latifolium*) and other weeds in or along irrigation return drains and roadways. The Service (White 2004) identified a number of conservation measures that prescribe pesticide use applications, timing and formulations in or near flycatchers or silvery minnows that seek to reduce the potential for adverse effects on flycatchers or silvery minnows and their habitat that have been implemented by Federal agencies to reduce effects (NMSLO 2010, USFWS 2011b).

Salinity and Other Chemical Stressors

In addition to the compounds and conditions discussed above, several other constituents are present and may affect the water quality of the Rio Grande. These include nutrients such as forms of nitrates and phosphorus, total dissolved solids (salinity), and radionuclides. Salinity levels in the MRGV are elevated in the San Acacia Reach (Cowley et al. 2009), but are not known to be levels likely to adversely affect silvery minnow (<4400 mg/L as total dissolved solids; Hoagstrom (2009)). However, information on toxicity of salinity on silvery minnow is generally lacking, or difficult to quantify (Cowley et al. 2009), presenting a substantial gap in predicting effects without additional information on ion composition and additional study is warranted. Pollutants and physical stressors have the potential to affect the aquatic ecosystem as well as silvery minnow health, silvery minnow prey and prey quality (Lusk et al 2012). Other physical stressors can also affect silvery minnows, particularly during river drying events. As the river dries, pollutants and temperatures tend increase in isolated pools (Caldwell et al. 2010). Toxic pollutants have been documented within the Middle Rio Grande and likely associated with localized mortalities of silvery minnows was suggested by Marcus et al. (2010). Papoulias et al. (2009) suggested the amount and variety of stressors in the Middle Rio Grande, combined, may nonetheless be affecting the health of silvery minnows as observed in their tissues.

Climate Change

“Climate” refers to an area's long-term average weather statistics (typically for at least 20- or 30-year periods), including the mean and variation of surface variables such as temperature, precipitation, and wind. “Climate change” refers to a change in the mean and variability of climate properties that persists for an extended period (typically decades or longer), whether due to natural processes or human activity (Intergovernmental Panel on Climate Change [IPCC] 2007a). Although changes in climate occur continuously over geological time, changes are now

occurring at an accelerated rate. For example, at continental, regional, and ocean basin scales, recent observed changes in long-term trends include: a substantial increase in precipitation in eastern parts of North American and South America, northern Europe, and northern and central Asia, and an increase in intense tropical cyclone activity in the North Atlantic since about 1970 (IPCC 2007a); and an increase in annual average temperature of more than 1.1 °C (2 °F) across U.S. since 1960 (Karl et al. 2009). Examples of observed changes in the physical environment include: an increase average sea level, declines in mountain glaciers and declines in average snow cover in both hemispheres (IPCC 2007a); substantial and accelerating reductions in Arctic sea-ice (e.g., Comiso et al. 2008), and a variety of changes in ecosystem processes, the distribution of species, and the timing of seasonal events (e.g., Karl et al. 2009).

The IPCC used Atmosphere-Ocean General Circulation Models and various greenhouse gas emissions scenarios to make projections of climate change globally and for broad regions through the 21st century (Meehl et al. 2007; Randall et al. 2007), and reported these projections using a framework for characterizing certainty (Solomon et al. 2007). Examples include: 1) it is virtually certain there will be warmer and more frequent hot days and nights over most of the earth's land areas; 2) it is very likely there will be increased frequency of warm spells and heat waves over most land areas, and the frequency of heavy precipitation events will increase over most areas; and 3) it is likely that increases will occur in the incidence of extreme high sea level (excluding tsunamis), intense tropical cyclone activity, and the area affected by droughts (IPCC 2007b, Table SPM.2). More recent analyses using a different global model and comparing other emissions scenarios resulted in similar projections of global temperature change across the different approaches (Prinn et al. 2011).

All models (not just those involving climate change) have some uncertainty associated with projections due to assumptions used, data available, and features of the models; with regard to climate change this includes factors such as assumptions related to emissions scenarios, internal climate variability and differences among models. Despite this, however, under all global models and emissions scenarios, the overall projected trajectory of surface air temperature is one of increased warming compared to current conditions (Meehl et al. 2007; Prinn et al. 2011). Climate models, emissions scenarios, and associated assumptions, data, and analytical techniques will continue to be refined, as will interpretations of projections, as more information becomes available. For instance, some changes in conditions are occurring more rapidly than initially projected, such as melting of Arctic sea ice (Comiso et al. 2008; Polyak et al. 2010), and since 2000 the observed emissions of greenhouse gases, which are a key influence on climate change, have been occurring at the mid- to higher levels of the various emissions scenarios developed in the late 1990's and used by the IPCC for making projections (Raupach et al. 2007, Figure 1; Pielke et al. 2008; Manning et al. 2010, Figure 1). The best scientific and commercial data available indicates that average global surface air temperature is increasing and several climate-related changes are occurring and will continue for many decades even if emissions are stabilized soon (Meehl et al. 2007; Church et al. 2010; Gillett et al. 2011).

Changes in climate can have a variety of direct and indirect impacts on species, and can exacerbate the effects of other threats. Rather than assessing "climate change" as a single threat in and of itself, the Service examined the potential consequences to species and their habitats that arise from changes in environmental conditions associated with various aspects of climate change. For example, climate-related changes to habitats, the quality, availability, and timing of prey to developing fish and wildlife, predator-prey relationships, disease and disease vectors, or conditions that exceed the physiological tolerances of a species, or that alter the rate of metabolic and biochemical processes within organisms, the occurring individually or in combination, may affect the status of a species. Vulnerability to climate change impacts is a function of sensitivity to those changes, exposure to those changes, and adaptive capacity (IPCC 2007a; Glick et al. 2011). As described above, in evaluating the status of a species, the Service uses the best scientific and commercial data available, and this includes consideration of direct and indirect effects of climate change. If a species is listed as threatened or endangered, knowledge regarding its vulnerability to, and impacts from, climate-associated changes in environmental conditions can be used to help evaluate expected effects of the action for this BO, as well as to help devise appropriate strategies for species recovery.

While projections from global climate model simulations are informative and in some cases are the only or the best scientific information available, various downscaling methods are being used to provide higher-resolution projections that are more relevant to the spatial scales used to assess impacts to a given species (see Glick et al. 2011). With regard to the area of analysis for the silvery minnow, the following downscaled projections are available.

The New Mexico Office of the State Engineer report (NMOSE 2006) made the following observations about the impact of climate change in New Mexico:

1. warming trends in the Southwest exceed global averages by about 50 percent;
2. modeling suggests that even moderate increases in precipitation would not offset the negative impacts to the water supply caused by increased temperature;
3. temperature increases in the Southwest are predicted to continue to be greater than the global average;
4. there will be a delay in the arrival of snow and acceleration of spring snow melt, leading to a rapid and earlier seasonal runoff; and
5. the intensity, frequency, and duration of drought may increase.

Most of the upper Rio Grande basin is arid or semiarid, generally receiving less than 25 cm (10 in) of precipitation per year (USBR 2011). In contrast, some of the high mountain headwater areas receive on average over 100 cm (40 in) of precipitation per year. Most of the total annual flow in the Rio Grande basin results, ultimately, from runoff from mountain snowmelt (BOR 2011b). In the Middle Rio Grande, there is expected earlier peak streamflow, reduced total streamflow, and more water lost to evaporation (Hurd and Coonrod 2007).

Climate change is predicted to affect silvery minnow habitat in four areas: 1) increased water temperature; 2) decreased streamflow; 3) a change in the hydrograph; and 4) an increased occurrence of extreme events (fire, drought, and floods). These impacts may affect the amount and qualities of silvery minnow habitat, silvery minnow physiology, phrenology (the timing and availability of resources necessary for silvery minnow growth to maturity), and biological interactions with other aquatic and terrestrial species.

Increased water temperature

Kundzewicz et al. (2007) found that of all ecosystems, freshwater ecosystems will have the highest proportion of species threatened with extinction due to climate change. Small changes in water temperature are known to have considerable effects on freshwater fishes by affecting a variety of life history, behavioral, and physiological aspects (Morgan et al. 2001; Carveth et al. 2006). Alterations in the temperature regime from natural background conditions negatively affect population viability, when considered at the scale of the watershed or individual stream (McCullough 1999). Both silvery minnow hatching and larval development are affected by high temperatures (Platania 2000). The density, type and seasonal availability of prey available to developing larvae and maturing silvery minnow, the amount of primary productivity and oxygen saturation are also affected by higher temperatures. As such, the slivery minnow may be adversely affected by increased water temperature due to climate change.

Decreased streamflow

Consistent with the outlook presented for New Mexico, Hoerling and Eischeid (2007) states that, relative to 1990 through 2005, simulations indicate that a 45 percent decline in streamflow will occur from 2035 through 2060 in the Southwest. Current models suggest a decrease in precipitation in the Southwest (Kundzewicz et al. 2007; Seager et al. 2007) that would lead to reduced streamflow and a reduced amount of habitat for silvery minnows. Streamflow is predicted to decrease in the Southwest even if precipitation were to increase moderately (NMOSE 2005; Hoerling and Eischeid 2007). Winter and spring warming causes an increased fraction of precipitation to fall as rain, resulting in a reduced snow pack, an earlier snowmelt, and decreased summer base flow (Regonda et al. 2005; Stewart et al. 2005). Earlier snowmelt and warmer air temperatures can lead to a longer dry season. Warmer air temperatures lead to increased evaporation, increased evapotranspiration, and decreased soil moisture. These factors could lead to decreased streamflow even if precipitation increased moderately.

The effects of decreased streamflow on the Rio Grande include smaller wetted area; more frequent intermittent or dry conditions; and greater conflicts among water users (Hurd and Coonrod 2007). As such, there will be reduced habitat available for aquatic species. As the river becomes more intermittent, fish isolated in pools may be subject to increased stress and predation.

Change in the hydrograph

Another documented effect of climate change is that warming in the Southwest has resulted in a shift of the timing of spring snowmelt (BOR 2011b). Stewart et al. (2005) show that timing of spring streamflow in the Southwest during the last 5 decades has shifted so that the major peak now arrives 1 to 4 weeks earlier, resulting in less flow in the spring and summer. They conclude that almost everywhere in North America, a 10 to 50 percent decrease in spring-summer streamflow fractions will accentuate the seasonal summer dry period with important consequences for water supplies, ecosystems, and wildfire risks (Stewart et al. 2005). Enquist et al. (2008) found that 93 percent of New Mexico's watersheds have become relatively drier from 1970 to 2006 and that snowpack in New Mexico's major mountain ranges has declined over the past 2 decades. The timing of peak streamflow from snowmelt in New Mexico is an average of 1 week earlier than in the mid-20th century (Enquist et al. 2008). Watersheds with the greatest declines in snowpack are those that have experienced the greatest drying from 1970 to 2006. Dust storms, associated with drought-stricken or poorly managed land can also influence snow albedo (reflectance), which can affect snowpack and the timing of snowmelt (Breed and Reheis 1999; Yasunari et al. 2011). Increased winter temperatures can cause more precipitation to fall as rain instead of snow resulting in earlier spring peak streamflow (Regonda et al. 2005). Rauscher et al. (2008) suggest that with air temperature increases of 3 to 5 ºC (37 to 41 ºF), snowmelt runoff in the Southwest could occur as much as 2 months earlier than present. Changes in the hydrograph could potentially alter the native fish assemblages, prey availability, and affect the reproductive success of the silvery minnow that is dependent on river flow pulses to spawn (Platania and Hoagstrom 1996).

Increased occurrence of extreme events

It is anticipated that an increase in extreme events (droughts, floods, fires) will most likely affect populations living at the edge of their physiological tolerances. The predicted increases in extreme temperature and precipitation events may lead to dramatic changes in the distribution of species or to their extirpation or extinction (Parmesan and Matthews 2006). Of these extreme events, drought intensity may be most important to the silvery minnow. The formation of an ice dam in 2011, in the San Acacia Reach, may have been an extreme event, and the ice dam resulted in blockage of the river and overbank flooding for several days until it thawed.

Overall, the predicted effects of climate change are expected to result in degradation of the remaining silvery minnow habitat, with potential adverse consequences on species viability.

Ongoing and Past Projects in the Middle Rio Grande including those in the San Acacia Reach

The Service has issued permits authorizing take for scientific research and enhancement purposes under ESA section 10(a)(1)(A), and for incidental take under section 7 for Federal actions. Applicants for ESA section 10(a)(1)(A) permits must also acquire a permit from the State of New Mexico to "take" or collect silvery minnows. Many of the section 10 permits issued by the Service allow take for the purpose of collection and salvage of silvery minnows and their eggs for captive propagation. Eggs, larvae, and adults are also collected for scientific studies to further our knowledge about the species and how best to conserve the silvery minnow.

Low Flow Conveyance Channel (LFCC)

Federal agencies have conducted numerous ESA section 7 consultations on flood control activities, water operations, LFCC and other projects in the Middle Rio Grande that inform the environmental baseline of the San Acacia Reach.

Floods in the early 1940s and the drought of the 1950s created a condition where the Rio Grande river channel below the Refuge had become a series of disconnected segments separated by sediment plugs and delta deposits (USBR 2012). To reduce provide more effective sediment and water transport to meet water obligations downstream, Reclamation constructed a 54-mile long artificial channel, the LFCC, running alongside the Rio Grande between San Acacia, New Mexico and Elephant Butte Reservoir. Operation and maintenance of the LFCC are ongoing Reclamation responsibilities.

The LFCC was designed to reduce depletion of water by diverting some or all of the river's flow into a narrower, deeper, and more hydraulically efficient channel. The LFCC exposes relatively less water surface area to evaporation and is less prone to loss of water by seepage than the natural river channel. The higher flow velocities in the low flow channel can also move more sediment than the river, especially at lower discharges. Currently, at its upper end, the LFCC behaves as a canal conveying water downstream, but downstream from Escondida, New Mexico, the LFCC transitions in function to that of a drain. The LFCC can discharge to the Rio Grande, under certain conditions at the 9-mile outfall near Escondida; however, there is typically little or no flow in the LFCC at that point. The MRGCD returns surface water from its canals directly to the LFCC at four wasteway points. The MRGCD then may re-divert this LFCC water into its canal system at three locations. There is a single, small MRGCD wasteway that can return water directly to the Rio Grande by discharging to the Brown Arroyo, which crosses over the LFCC to enter the Rio Grande. The LFCC is protected by spoil banks, and is the subject of complex hydrologic interactions between the Rio Grande and irrigated lands (USBR 2012). The LFCC has a nominal capacity of 2,000 cfs, and the maximum-recorded mean daily discharge of the LFCC at San Acacia is 1,950 cfs.

In the 1990s and early 2000s, the Service consulted with Reclamation on the diversion of water from the Rio Grande into the LFCC and vice versa, including studying the effects of channel gradient and sedimentation on water delivery (USBR 2001, 2003, 2012; USFWS 2003a). Experimental diversions into the LFCC resulted in the entrainment of silvery minnow eggs and

subsequent detections of silvery minnows in the LFCC. Reclamation may perform some operations associated with the LFCC in conjunction with its supplemental water management program including pumping activities (USBR 2012). Reclamation also uses LFCC water in response to requests by the MRGCD or the Refuge to check up flows in the channel at existing check structures, thus increasing the head on the water so that diversions by the MRGCD and the Refuge from the LFCC are more easily made. Occasionally, the entrainment of silvery minnow eggs and adults may become entrained in the LFCC (USBR 2012), however, long-term occupancy by silvery minnows in the LFCC is not anticipated as flow velocities (> 7 fps; USACE 2012a,b) would create unfavorable conditions for silvery minnows.

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 (LFCC) and the associated levee on flycatcher and silvery minnow and their designated critical habitat. The project would allow the Rio Grande more freedom to move within its historical 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 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 river mile (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.

Flood Control Activities and Water Operations

In 2001 and 2003, the Service issued jeopardy biological opinions resulting from programmatic section 7 consultations with Reclamation (USBR 2001, 2003; USFWS 2003a) and Corps (USBR 2003; USFWS 2003a), which addressed water operations and management on the Middle Rio Grande and the effects on the silvery minnow and flycatchers (USFWS 2001, 2003a). Incidental take of listed species was authorized associated with the 2001 programmatic BO (USFWS 2001), as well as consultations that were tiered off of that BO.

In the 2003 ESA consultation, a jeopardy Opinion was issued on March 17, 2003 (USFWS 2003a), and is the current programmatic Opinion on water operations for the Middle Rio Grande, and contains one RPA with multiple elements (USFWS 2003a). These elements set forth a flow regime in the Middle Rio Grande and describe habitat improvements necessary to alleviate jeopardy to both the silvery minnow and flycatcher. In 2005, the Service revised the incidental take statement (ITS) for the 2003 Opinion using a formula that incorporates October monitoring data, habitat conditions during silvery minnow spawn (spring runoff), and augmentation. Incidental take of silvery minnows is authorized with the 2005 BO revised ITS, and now fluctuates on an annual basis relative to the total number of silvery minnows found in October across the 20 population monitoring locations. Incidental take is authorized through consultations tiered off of the programmatic Opinion and on projects in the Middle Rio Grande.

In 2007, the Corps and others (USACE et al. 2007) evaluated the effects of a number of alternative water operations in the Middle Rio Grande. In particular, the "no action" alternative described in the Final Environmental Impact Statement (FEIS) helps inform the environmental baseline of silvery minnow habitat in the San Acacia Reach. Changes in magnitude and duration of peak flows by water operations and flood control activities were the most pronounced in the San Acacia Reach. Silvery minnow habitat in the San Acacia Reach was characterized as intermediate (USACE et al 2007, Table L-3.20, page L-161), as operations result in velocities surpassing the threshold velocity 62% of the time resulting in only 511,468 square feet (11.7 acres). San Acacia Reach peak flows of 3,578 cfs, and peak flow durations of up to 39 days per year, were expected to inundating 201 acres of overbank areas within the floodway during as many as 33 days per year. Additionally, flows less than 100 cfs were expected to occur for over 98 days per year (USACE et al 2007, Table L-3.20, page L-161). Discharges of less than 100 cfs and zero discharge are currently experienced in the San Acacia Reach and are detrimental to silvery minnow. Drought, diversions, and seepage into the LFCC contribute to low-flow conditions. Operations and flood control may not provide low-flow augmentation during the spring and summer months due to storage and release conditions and limitations at Abiquiu, Cochiti and other reservoirs (USACE et al. 2007). Storage of the spring runoff in upstream reservoirs is characterized as locked until late fall, when release of reservoir storage is least beneficial biologically. The Corps (USACE 2012c) and Reclamation (USBR 2012) have more recently been preparing BAs to reinitiate ESA consultation effects of flood control activities, reservoir and water operation and associated actions on Federally listed species and designated critical habitat within the MRGV of New Mexico. These activities include discretionary flood control operation of reservoirs, delivery of "carryover" floodwater, San Juan Chama water storage at Abiquiu Reservoir, delivery of Cochiti recreation pool water, maintenance actions at Corps-managed reservoirs, and temporary deviation for spawning and recruitment flows, to name a few. It is expected that formal consultation would begin sometime in 2012, and therefore, no more formal evaluation of those activities are conducted in this San Acacia Levee Project Opinion than is described above.

Bosque del Apache National Wildlife Refuge (Refuge) Water Management Plan

The Refuge completed an intra-Service section 7 consultation in May 2001, for the use of 8,691 acre feet of consumptive water use from the Rio Grande for the years 2001 through 2004, with 869 acre feet being used to aid in maintenance of habitat for the silvery minnow if: (1) data indicating that the addition of the water will foster survival of the silvery minnow or flycatcher; (2) an equal or greater percentage of water by other water users in the MRGV is also contributed; and (3) legal permitting from the Office of the State Engineer is obtained prior to the emergency transfer request. The Refuge maintains a consumptive water right of 12,417 acre feet and has initiated ESA consultation with the Service for its future use. Consumptive use of water at the Refuge may also affect flow, duration, and during drying events as well as silvery minnow and flycatcher habitat conditions in the San Acacia Reach.

Sediment Plug Removal Project at the 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 BDANWR during spring runoff 2008, on silvery minnow and its designated critical habitat and on the flycatcher. Reclamation's environmental commitments for the Sediment Plug Removal Project include: 1) construction of at least four embayment habitats (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 BDANWR 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; and 4) in-depth analysis of alternatives to pilot channel construction within the aforementioned reach of river to be initiated within six months of completion of Phase I(b) of the project. This included: at least three strategies to address sediment transport through the reach; maintenance of connected unvegetated 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 was conducted and a report titled Channel Conditions and Dynamics on the MRG was issued (Makar and AuBuchon 2012). Based on the study, Reclamation adopted river maintenance goals described in Middle Rio Grande Maintenance Program Comprehensive Plan and Guide (USBR 2012). Reclamation's strategy and goals seek to address trends in channel narrowing, vegetation encroachment, aggradation, channel plugging with sediment, and perched channel conditions.

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; re-vegetating the site; and performing construction outside minnow spawning periods (construction exclusion period of April 15 through July 1).

Vegetation and Sand Bar Removal Project Upstream of San Acacia Diversion Dam (SADD)

The Vegetation and Sand Bar Removal Project consisted of removing vegetation from approximately 11 acres of an in-channel sand bar in order to encourage mobilization of the sediment. Immediately upstream of the SADD, in the small reservoir pool, an 11-acre sand bar has developed, filling the channel with sand and narrowing the channel width. The presence of this sand bar has reduced the pool volume upstream of the Dam to less than 35 percent of the intended design, and channel width above the SADD is about 25 percent of original. This reduced capacity and physical narrowing of the channel has caused significant negative impact to Dam operations and has increased risk to the SADD structure itself. Over time, vegetation has established on the sand bar and has further contributed to stabilization of the sand bar. The Middle Rio Grande Conservancy District planned to implement the Vegetation and Sand Bar Removal Project as part of its operation and maintenance responsibilities at the SADD, and Reclamation undertook ESA Section 7 consultation on its behalf because it owns the SADD. In this area, approximately 6.5 acres of suitable flycatcher habitat would be destroyed. The Vegetation and Sand Bar Removal Project was mostly conducted in the dry and expected to indirectly benefit the silvery minnow by increasing available aquatic habitat above SADD, when inundated. Along with timing restrictions, habitat restoration to create 6.5 acres of suitable flycatcher habitat was proposed as a conservation measure by Reclamation. Construction of the habitat restoration project will be completed by Apri1 15, 2014.

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 this Opinion. The following is considered a non-exhaustive list of non-Federal actions.

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 acre-feet, while New Mexico has accrued debit to Texas is limited to 200,000 acre-feet. 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 acre-feet in addition to tributary inflows. In an average year, when 1,100,000 acre-feet of water passes the gage, approximately 393,000 acre-feet 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 acre-feet in addition to tributary inflows. No Indian water rights may be impaired by the State's Compact management activities.

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 New Mexico Office of the State Engineer (NMOSE) 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 (NMISC) 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, similar work at the state refuges, and temporary pilot channels into Elephant Butte Reservoir. The NMISC, along with the New Mexico Office of the Attorney General, the New Mexico Department of Agriculture, and the New Mexico Department of Game and Fish, represents the State of New Mexico as part of the Middle Rio Grande Endangered Species Collaborative Program.

Summary of the Silvery Minnow Environmental Baseline

The remaining population of the silvery minnow in the Middle Rio Grande is restricted to approximately 7 percent of its historical range. With the exception of 2008, every year since 1996 has exhibited at least one drying event that has negatively affected silvery minnows. The species is unable to expand its distribution because of poor habitat quality and Cochiti Dam prevents upstream movement and Elephant Butte Reservoir blocks downstream movement (USFWS 1999; 2010a). Silvery minnow habitat is limited by reduced peak flow magnitude and duration, water diversions, diversion dams, and climate change that contributing to river drying. Increasing demands for water have altered the normal hydrologic and ecological processes in the San Acacia Levee Project area.

The consumption of surface water and shallow groundwater for municipal, industrial, and agricultural uses continues to reduce the flow in the Rio Grande and degrade habitat for the silvery minnow (USBR 2003, 2012). Stormwater discharges and high velocities appear to contribute to low DO conditions in the Rio Grande that can harm the feeding and sheltering activities of silvery minnows. In addition, a variety of organic chemicals, heavy metals, and pesticides have been documented in the Rio Grande and that cumulatively contribute to the overall degradation of water and sediment quality in silvery minnow habitat.

Population monitoring indicates that densities of this species are the lowest on record (Figure 4; Dudley et al 2012a), lower than catch rates at the time of the silvery minnow listing as an endangered species (USFWS 1994). Norris et al (2008) reported that the fifty-year projections for simulated populations of silvery minnows occupying the Middle Rio Grande were associated with decreased water availability, increased reliance on captive propagation, and the degraded, fragmented, and isolated nature of occupied habitat, and the absence of the silvery minnow throughout most of its historical range. Various conservation efforts have been undertaken in the past and others are currently being carried out in the Middle Rio Grande for the benefit of the silvery minnow. Augmentation of silvery minnows with captive-reared fish has been ongoing, and monitoring and evaluation of these fish provide information regarding the survival and movement of individuals (USFWS 2010a). However, the threat of extinction for the silvery minnow continues because of decreased water availability, increased reliance on captive propagation, the degraded, fragmented, and isolated nature of occupied habitat, and the absence of the silvery minnow throughout most of its historical range.

FACTORS AFFECTING FLYCATCHERS IN THE ACTION AREA

Physical Modification of the Channel, Floodplain, Riparian Vegetation, and Watershed

The watersheds and rivers of the southwestern United States (Southwest) are the physical foundation of habitat for the willow flycatcher (Graf et al. 2002). Hatten et al. (2010) also described the importance of riparian habitats in the Southwest for wildlife. For example, over 50 percent of southwestern bird species are directly dependent on riparian habitat even though it only covers about 1 percent of the landscape (Knopf et al. 1988; Skagen et al. 1998). According to Hatten et al. (2010), riparian habitat has declined by as much as 90 percent as in historical times, and is generally considered a habitat of great conservation and management concern. Many stressors have contributed to the decline of riparian habitat, but one of the most wide-scale stressors to riparian systems is due to dams, diversions, and other modifications of rivers in the Southwest (Graf et al. 2002, Graf 2006). Dams disrupt the natural flood cycle that riparian systems have adapted to, creating rivers that flood infrequently, lose their meanders, and generally become more channelized (Graf 2006; Webb and Leake 2006).

Dams, Operations, and Diversions

The headwaters of the Rio Grande are fed by far away mountain snowpack or tropical monsoon rains and provide water important to people living in a climate is that semi-arid in the Lower Rio Grande (Scurlock 1998; Stotz 2000; Schmandt 2010). Upstream river water is captured in

reservoirs by dams, thus making human settlements possible, with irrigated agriculture providing the local economy with food and jobs (Schmandt 2010). Eventually villages and cities were built or expanded, and their communities increasingly relied on the Rio Grande for drinking water and other demands (USBR 2012).

While dams and reservoirs provide societal benefits including urban water supply, irrigation, hydroelectric power, flood control, and recreation, they also cause changes in river riparian environments that include adjustments in potential habitat for the willow flycatcher (Graf et al. 2002). Dams are the most pervasive and significant changes to flycatcher habitat because they are the primary cause of altered flows of water, energy, and sediment throughout the Rio Grande (Graf et al. 2002). Dams have stored an amount of water equal to almost four times the mean annual runoff in the Rio Grande, which has reduced floods, and the amount and timing of flow in the Middle Rio Grande (Graf et al. 2002, USACE et al. 2007).

In the Rio Grande, "operations" of the river have included the engineering tasks of water management, construction and maintenance of dams, diversions, channeling water to irrigation districts and bringing return flow back to the mainstem, leveling and clearing of flood plains, alterations of the stream and watershed, and allocation of water between New Mexico, Texas, and Mexico. The Middle Rio Grande also experiences periodic droughts during which water allocations are reduced. The specific hydrologic changes downstream from dams depend on the inflows to the reservoir, the engineering characteristics of the dam, and its operating rules (Graf et al. 2002). Dam operating rules often involve the release of water from a reservoir or through the dam according to a variety of agreements by various entities and maintenance conditions. River flows and diversions to irrigation systems, municipal water supplies, or other facilities and levels of water within a reservoir can be increased or decreased depending on how the dam is operated and to meet societal needs.

However, the operating rules of dams can often modify, reduce, destroy, or increase riparian habitat both downstream and upstream of the dam (Graf et al. 2002). Below dams, natural hydrological cycles are modified. Peak and low flow events both can be altered in time, duration and magnitude. Peak flows are reduced in size and frequency below many dams (Graf 2006). The cycle of base flow punctuated by short duration floods is often lost. In so doing, dams inhibit the natural cycles of flood-induced sediment deposition, floodplain hydration and flushing, and timing of seed dispersal necessary for establishment and maintenance of native riparian habitats (USFWS 2002).

Upstream of dams, previous river channels and near-channel surfaces that are in the reservoir area are often inundated, either permanently or periodically, so that the riparian habitat associated with them is lost (Graf et al. 2002). However, the shoreline of the newly formed reservoir may create new riparian habitats where the stream enters the lake, is a dynamic zone where deposition of sediment creates a delta because the lake reduces the energy gradient of flow (Graf et al. 2002). These areas typically support flycatchers when the riparian vegetation becomes suitable at the edges of the reservoir pool (Behle and Higgins 1959; Graf et al. 2002; USFWS 2002).

Historically, the Middle Rio Grande has been used for agriculture (Scurlock 1998; Stotz 2000). Pueblo people were utilizing small diversions and ditch irrigation on a limited scale at the time of Spanish exploration in 1591. The Spanish expanded irrigation greatly, including diverting the main stem at low flow, and the area of irrigated farming steadily increased in New Mexico until it reached a peak of 127,800 acres (50,500 ha) in 1880 (Scurlock, 1998). Stotz (2000) estimated that more than half the summer stream flow from the Rio Grande between 1890 and 1893 was consumed by irrigation or was lost to seepage and evapotranspiration. Water loss due to agriculture was also associated with irrigation in the San Luis Valley (SLV) of Colorado (Scurlock 1998; Stotz 2000). Between 1936 and 1953, the average annual depletion in the SLV was approximately 802,600 acres ft (9.9×10^8 m^3) and annual depletions ranged from about 502,600 acres ft (6.2×10^8 m^3) in dry years to more than 997,200 acres ft(12.3×10^8 m^3) in wet years. The effect of these SLV depletions was primarily reflected in the shorter duration of the median snowmelt flood as far down as El Paso (Stotz 2000).

Peak flow or floods are the primary natural disturbance in riparian ecosystems (Poff et al. 1997). The components of flow, including its amplitude, magnitude, frequency, duration, timing, and rate of change of hydrologic conditions, strongly influenced the structure and function of riparian habitat below dams (Poff et al. 1997; USFWS 2002; USACE et al. 2007). Many of the riparian plant species in the southwest such as Goodding willow are pioneer species that depend on periodic winter and spring flood disturbance for regeneration. Cottonwoods and willows release small, windborne seeds timed to the distributional patterns of flows common to the Rio Grande (Moss 1938; McBride and Strahan 1984; Graf 1994). For example, cottonwood seeds are released coinciding with higher flows, while willow seeds are released during lower flows when sandier substrates are exposed and are wet enough to allow for germination (McBride and Strahan 1984). Other plant species regenerate in response to periodic flooding in the Lower Rio Grande (Stotz 2000).

Infrequent but very large floods reset riparian habitat succession and can rejuvenate large stands of the riparian habitat upon which flycatchers depend (Graf et al 2002). Smaller floods that inundate, but do not destroy riparian vegetation, help to maintain a diversity of herbaceous plant species that may also play important roles in maintaining the food base of the flycatcher. Floods exert important physical and biological controls on riparian habitats, because they inundate and moisten floodplain soils, raise water tables, and recharge aquifers, mobilize and deposit sediment on flood plains creating seed beds for riparian plants, flush salts and redistribute nutrients, cause river channels to relocate or meander, create abandoned channels and backwaters, disperse and scarify plant propagules, scour and relocate vegetation, and deposit organic materials that have higher water-holding capacity than the inorganic materials in the substrate (USFWS 2002).

Scurlock (1998) determined that there were at least 50 major floods exceeding 280 cms in New Mexico between 1849 and 1942. Twice as many of these floods occurred in the 1800's than in the 1600's or 1700's, although the record of large floods improves with time. Scurlock (1998) and Stotz (2000) suggested that environmental degradation may have contributed to the increase in flood frequency in the 1800's. The largest flood occurred in 1828 and had an estimated discharge of about 2830 cms. The entire Rio Grande valley was inundated from Albuquerque to El Paso, Texas. Natural floods large enough to destroy riparian vegetation and flycatcher habitat

operate at regional and local scales in the Rio Grande (USFWS 2002). Extensive flooding can result in widespread loss of riparian habitat. In the intervening years, the riparian habitat recovers and matures. On the time scale of decades, therefore, it is reasonable to expect regional changes in the amount of available riparian habitat for flycatchers due to natural flooding (Graf et al. 2002). The existing hydrology and flood control operations created by dams, diversions, and provisions for safe channel capacity now make flood events large enough to destabilize the current vegetation and change the channel pattern extremely unlikely in the Rio Grande.

Reduced annual flow shrinks both peak and low flows, which increases channel stability, and decreases water tables that can reduce riparian habitat (Graf et al. 2002). Construction of Cochiti Dam significantly reduced the floods and high flow pulses in the action area (USACE 2012b). The width of riparian habitat and biomass decreases with decreased mean and median annual flow volume and drainage size in alluvial river channels (Stromberg 1993). Reduced peak flow shrinks the high flow channel from braided to single thread and thereby reduces riparian habitat dynamics (Stotz 2000). With reduced low flows, or during drought or extended loss of surface flow during drying events, the alluvial groundwater levels also decline often resulting in mortality of riparian vegetation.

Operations of dams have decreased annual fluctuations in flow, which contributed to the simplification of the channel system, reduced the size and amount of beaches, sand bars, or floodplains, and reduced or simplified riparian vegetation, thereby reducing river function and processes, and increasing conditions that favored tamarisk replacement of native vegetation in the action area (Everitt 1993; Graf et al. 2002). These flood-driven fluvial processes maintain high species diversity, productivity, and habitat complexity in riparian ecosystems, all of which benefit habitat for the willow flycatcher. Loss and alteration of surface flows reduced vegetation and insect productivity, reduce the flooding, inundation, or saturation of breeding habitat soils, reduced native riparian habitat quality, as well as affected the production and biomass of insects important to flycatcher breeding habitat in the action area.

Flood Control Activities and Water Operations

(See discussion of flycatcher baseline associated with Flood Control Activities and Water Operations in the “Factors Affecting Silvery Minnows in the Action Area” environmental baseline section).

Changes to the Floodplain, Floodway and Riparian Habitat

Spoil banks currently extend through the project area on the west side of the Rio Grande demarking the edge of the floodway. The spoil banks effectively reduced the historical floodplain area to the floodway. High ground, (naturally elevated bluffs and canyon walls contain flood flows along portions west side of the floodway that does not have spoil banks or levees. Roadways are atop the spoil banks and are generally unpaved gravel roads designed for passage of personnel and equipment.

Pre-canalization channel conditions were characterized by Stotz (2000) as wide and shallow with some meanders in the stream configuration. Once channel capacity was reduced, floods from tributaries created flows that affected communities nearby, and accumulated sediment and vegetation. Changes to the flow and channel described previously have resulted in a current channel pattern that is a narrower, single channel that supports less native riparian vegetation than historically (Stotz 2000; Everitt 1993; USBR 2001). Bank heights have increased in the upper and lower portions of the San Acacia Levee Project area due to channel incision and/or channel bed degradation in reaches below Escondida Bridge, aggradation begins below Socorro, although a recent incision has occurred near San Marcial and traveled northward.

As a result of the lateral confinement of floods within the floodway by the spoil bank, vertical accumulation of sediment deposition along the channel and in the floodway has resulted in a raised sediment surface elevation compared to the historical floodplain. In the San Acacia Reach, below Highway 380, floodway elevation relative to the historical floodplain elevation has been raised by as much as 11 to 24 feet in some locations (Crawford et al. 1993, USACE 2012b). On average, lateral floodplain confinement results in approximately 0.5 ft per year of vertical sediment accumulation within the floodway (USACE 2012b). The USACE (2012b) predicted sediment accumulation within the floodway for as long as the spoil bank lasts. However, Corps (2012b, Appendix F, page 126, Tables F-2A, F-2B, F-61) described the water surface elevation rapidly exceeding the height of the spoil bank or breaching it and causing damages and flow into the historical floodplain (Table 3). Sediment accumulation due to the lateral confinement of the floodplain may increase the depth to groundwater that plays an important part in the health and distribution of riparian vegetation (Arizona Department of Water Resources 1994; USFWS 2012b) and consequently, flycatcher habitat. The greater the depth to groundwater below the land surface, the less abundant the riparian vegetation (Arizona Department of Water Resources 1994, USFWS 2012b). Vertical accumulation of sediment in a floodplain, exacerbated by the lateral confinement of the floodplain, results in a physical separation of riparian vegetation from groundwater necessary for flycatcher habitat (Dufour et al 2007; USFWS 2012b). Accumulation of sediment within a floodway which increases the depth to water results in productive pioneer species such as willows or poplars being replaced by either non-native (e.g., tamarisk) or upland plant species (Friedman and Auble 2000; Dufour et al. 2007; Decamps et al 2008).

As the Rio Grande Valley began to be developed by settlers and the agricultural lands were expanded, water was taken from the river for irrigation, resulting in a slowing of the river flow rate. As river water slows, silt begins to drop and increases the height of the river channel. More than half the Rio Grande silt comes from stormwater tributaries below the mouths of the Rio Puerco and the Rio Salado. These tributaries bring 55% of the total sediment into this portion of the Rio Grande and only 4 to 6% of the surface water yield (USACE 1972). In addition, they run during the summer storm season when the Rio Grande flow is at its lowest. Water is being taken out of the river upstream, and a considerable source of silt is being added just before the San Marcial area. This silt is being added at a time of low flow, which encourages silt to drop out of the flow and accumulate. Sediment can accumulate, the channel aggrades, and vegetation encroachment, mainly by salt cedar, will tend to armor the channel banks thereby simplifying the channel. Reclamation operates and maintains the channel in the floodway within the action area (USACE 2012). Maintenance includes dredging sediment out of the river channel in order to maintain hydraulic efficiency for floodwater conveyance and water distribution (USBR 2012).

As a river channel narrows or incises, it deepens and the adjoining overbank is inundated less frequently, which fosters conditions favoring vegetation growth on or near the banks, and thereby reducing the width of the active channel. This vegetation encroachment is likely the result of decreased peak flows and increased low flow duration. Increased low flow duration provides water more consistently and encourages vegetation growth near the channel. Since riparian vegetation has been shown to provide geotechnical strength to the soil (Simon and Collison 2002; Pollen and Simon 2005; Pollen 2007; Pollen-Bankhead et al, 2009), it can effectively at stabilize channel banks and bars (Thorne 1990; Abernethy and Rutherford, 2001; Gran and Paola 2001; Simon and Collison 2002; Griffin and Smith 2004), and reduce channel-margin flow velocities and shear stresses (Carollo et al. 2002, Tal et al. 2004; Griffin et al. 2005; Tal and Paola 2007), and induce sedimentation (Tooth and Nanson 2000; Schultz et al. 2003). As a result, channel width is often decreased. The San Acacia Section suffers the highest infestation of exotic plant species of MRG. Thus, riparian vegetation can exacerbate processes of channel narrowing during low flow periods by promoting sediment deposition within the channel and on the condition of the floodplain.

In New Mexico, floodplain riparian vegetation has probably been impacted more by human activities than any other type of riparian vegetation (Dick-Peddie 1993). Current Rio Grande floodplain vegetation greatly differs in both composition and extent from that described by Van Cleave (1935; cited in Finch et al. 1995). Cottonwood and willow were, and remain, primarily restricted to the floodway. The bosque, though much reduced in extent, is still represented by some individual cottonwood trees of extremely large size. With some notable exceptions, the historic cottonwood and willow forests have been reduced to a narrow band of mid- to old-age forest stands between levees in the floodway. Many cottonwood/willow communities were lost to expanding agriculture, the demand for fuel and wood products, channelization and flood control projects, urbanization, transportation systems, inundation by large impoundments, and the introduction and escape of exotic plants (Finch et al. 1995).

The specific role of tamarisk in floodplain aggradation and channel narrowing is a matter of debate. Tamarisk was not common on the floodplain until the 1930's, after channel narrowing had begun in the Lower Rio Grande (Everitt 1998). The spread of tamarisk throughout the Rio Grande may have taken place due to the decreased flows, aggradation, and channel narrowing. Nevertheless, tamarisk may play a role in limiting the ability to reconnect the river channel with its overbank. Under stress, dense tamarisk patches can be prone to fire that can directly affect flycatcher habitat (Paxton et al. 2008a).

The Middle Rio Grande and associated riparian habitat has historically been a very dynamic system in constant change and without this change, the diversity and productivity 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 river channel, floodplain, and riparian vegetation in the action area. Flycatcher habitat has historically developed in conjunction with this dynamic system where habitat was created and destroyed at various time scales and locations. It was this type of dynamic, successional system that flycatchers depended upon for the establishment and development of breeding habitat. Through the development of dams, reduced flow, channelization, water withdrawal, and development, the

dynamics of the river system have been eliminated except for localized areas such as the reservoirs where water storage levels frequently change with releases and inflows, where the river is wide and connects to the floodplain, or where riparian vegetation and flycatcher prey is maintained by seepage and high water tables.

Still Waters, Water Table, and Groundwater Interactions

The Middle Rio Grande interacts with groundwater in its alluvial sediment. Additionally, the timing, location, and rate of these exchanges between groundwater and surface water are constantly changing and are often unmeasured making specific observations limited. These alluvial groundwater aquifers are often much wider than the stream channel and can be shaped by aquifer geology. Precipitation on the uplands can infiltrate soils, and depending on elevation and surface geology, it can contribute to the alluvial groundwater. It can also be affected by drought. Recharge to the groundwater aquifer below the Middle Rio Grande can occur from mountain-front seepage, tributary seepage, community wastewater and septic return flow, urban stormwater seepage, or irrigation seepage. Deeper groundwater levels, below, near and associated with the spoil banks have been observed (Parametrix 2008).

The elevation of the water table in riparian areas within the floodway correlates with the surface water elevation in the channel and the drawdown effects of the LFCC functioning as a drain (USACE et al. 2007). The duration of high flows is an indicator of inundation frequency of riparian areas located on islands and in the overbank areas. The reduction in the frequency and magnitude of flow at Cochiti is likely to reduce the frequency, duration, or extent of inundation in wetlands within the floodway below SADD. The duration of high flows also contributes to groundwater recharge and the stability of groundwater elevations. Groundwater elevation maps along the action area show less stable groundwater elevations and decreases in the areal extent of high water table conditions generally during the April to September period (USACE et al. 2007). Water table elevations below the ground surface vary from 4 to 5 feet at Escondida, and from 5 to 10 feet near San Antonio, New Mexico (USACE et al. 2007). Groundwater pumping for agricultural, mining, industrial, and municipal uses has resulted in water table declines along many rivers and is a major factor in the quality of flycatcher habitat (Briggs 1996; USFWS 2002). The net result of lowered water tables has been declines in river flow, with stress, injury and loss of riparian vegetation. Topography, drainage patterns, soil types, depth to groundwater, groundwater flow direction and gradient, and other factors can affect the transport of water on and beneath the ground surface. Locally, manufactured conduits such as sewers, water lines, drains, trenches, or wells can divert subsurface transport. These impacts are expected to be exacerbated as the river aggrades up to 12 ft, over time in the action area (USACE et al. 2007; USACE 2012b).

The effect of activities that alter groundwater can lead to the reduction of water tables in or below riparian habitats that may support flycatchers (USFWS 2002). The floodplain of the Middle Rio Grande historically contained numerous marshes, swamps, meanders, oxbows and pools (Stotz 2000). In addition to providing evidence of channel shifting and flooding, such features also suggest a high water table within the floodplain (Graf et al. 2002). High water tables in floodplains and near river channels sustain extensive growth of riparian vegetation that

provide breeding habitat for flycatchers. These waters and high water tables associated with alluvial aquifers are essential for flycatchers as they foster abundant insects necessary for breeding habitat and are associated with productive nesting (Moore and Ahlers 2012).

Agricultural Development

The availability of relatively flat land, rich soils, high water tables, and water for flood irrigation has fostered agricultural development in the Middle Rio Grande. Conversion of floodplains to agricultural fields reduced the areas covered by native vegetation and certain types of vegetation were more susceptible to conversion than others. These areas often contained extensive grassland, riparian, and wetland vegetation (Stotz 2000). Agricultural development sometimes cleared riparian vegetation, or drained and protected floodplains using spoil banks and other engineering techniques. Agricultural development can also increase the likelihood or severity of cowbird parasitism, by creating foraging sites (e.g., short-grass fields, grain storage, livestock concentrations) in proximity to breeding habitat. However, riparian vegetation that supports flycatcher habitat can also be sustained by agricultural seepage and return flows.

Urbanization, Recreation, and Human Disturbance

Urban development can results in many impacts to riparian ecosystems and flycatcher habitat. Urbanization near flycatcher habitat provides the catalyst for a variety of indirect effects, which can adversely affect flycatchers or contribute to habitat loss. Urban development fosters demand for domestic, municipal, and industrial water use. These demands are satisfied by diverting water from streams and groundwater pumping, which can reduce flow and groundwater aquifers. Urbanization can favor domestic cat predation as well as other predators or competitors of flycatchers (e.g., cowbirds, blackbirds). Urban areas have transportation systems that include bridges, roads, and vehicles that can be detrimental to riparian habitat (Marshall and Stoleson 2000). Some communities may desire to remove riparian vegetation to reduce fire risk or control insect populations. Stormwater management can involve construction of settling basins, reservoirs, and other structures necessary to control floods, alter flow velocity, native riparian habitat, and groundwater infiltration patterns. Urban development can also concentrate pollutants and non-native species in riparian habitats. Riparian vegetation that supports flycatcher habitat can also be sustained by urban stormwater and wastewater. Streams where flow is desiccated that receive some wastewater can increase water tables and water in channels to support riparian vegetation suitable for flycatcher habitat (Stromberg 1993, USFWS 2002). However, the chemical quality of riparian habitat and insects associated with urban water may affect breeding habitat and may need further research. Continued use of chemicals and certain pesticides as well as a legacy of previous chemical use, spills, and atmospheric re-deposition may also affect flycatchers.

Urban development also tends to increase recreational use of riparian habitat. Recreation can occur in riparian habitat because of the shade, water, aesthetic values, as well as its association with opportunities for fishing, boating, swimming, and other activities in surface waters. As developed areas and human populations grow, the magnitude and cumulative effects of these activities often increases. Effects may include: reduction in vegetation through trampling,

clearing, woodcutting and prevention of seedling germination due to soil compaction; bank erosion; increased incidence of fire; promoting invasion by exotic plant species; promoting increases in predators and scavengers due to discarded food and solid waste (e.g., ravens, jays, grackles, skunks, squirrels, domestic cats, etc.); promoting increases in brood parasitism by cowbirds; and noise disturbance. Recreational development also tends to promote an increased need for foot and vehicle access, roads, pavement, trails, boating, and structures that fragment habitat. Effects of these activities on flycatchers may vary with frequency, intensity, and management actions. Reductions in density and diversity of bird communities, including flycatchers, have been associated with recreational activities (USFWS 2002).

Human disturbance in the action area may include flycatcher science and research as well as flycatcher surveys affect flycatchers (USFWS 2002). Temporary, short-term impacts to wildlife from noise, dust, and the presence of workers and machinery during project construction where activities occur near flycatchers or within flycatcher breeding season. Accidental spills of fuels, lubricants, hydraulic fluids and other petrochemicals, although unlikely, could be harmful to aquatic insect prey or riparian habitat vigor.

Livestock Grazing

Overgrazing by domestic livestock has been a significant factor in the modification and loss of riparian habitats in Southwest (USFWS 2002). If not properly managed, livestock grazing can significantly alter plant community structure, species composition, relative abundance of species, and alter stream channel morphology. The primary mechanism of effect is by livestock feeding in and on riparian vegetation. Overutilization of riparian vegetation by livestock also can reduce the overall density of vegetation that provides flycatcher-breeding habitat. Palatable broadleaf plants like willows and cottonwood saplings may also be preferred by livestock, as are grasses and forbs comprising the understory, depending on season and the availability of upland forage. Though rare, livestock may also physically contact and destroy nests (USFWS 2002). Livestock also physically degrade nesting habitat by trampling and seeking shade and by creating trails that nest predators and people may also use for recreation. Furthermore, improper livestock grazing in watershed uplands above riparian systems can cause bank destabilization, increased runoff, increased sedimentation, increased erosion, and reduced capacity of soils to hold water. Because the impact of grazing can be highly variable both geographically and temporally, proper management strategies must be developed locally (USFWS 2002).

Feral Hogs

Feral hogs (*Sus scrofa*) also have potential to degrade riparian habitat and native animal populations through soil disturbance, uprooting of native plants, competition for foraging resources, particularly acorns, predation on small animals, and disease transmission. Feral hogs degrade wildlife habitat and compete directly with native wildlife for food. Hogs are omnivorous, primarily consuming vegetation, mast, roots and tubers, and to a lesser degree a wide range of animal species including invertebrates, reptiles, amphibians, small mammals and birds (Davis and Schmidley 1994, Ditchkoff and Mayer 2009). Their rooting habits create severely disturbed areas, which may lead to a localized shift in plant succession and increase the

potential for soil erosion (Davis and Schmidley 1994). Feral hogs also destabilize wetland areas, springs, creeks and other riparian areas through excessive rooting and wallowing. They also pose a threat to humans and livestock through the spread of disease (USDA 2010).

Fire

Fire is an imminent threat to flycatcher breeding habitat (USFWS 2002). Although fires occurred to some extent in riparian habitats historically, many native riparian plants are neither fire-adapted nor fire-regenerated. Thus, fires in riparian habitats are typically catastrophic, causing immediate and drastic changes in plant density and species composition. Busch (1995) documented that the current frequency and size of fires in riparian habitats is greater than historical levels because reduced floods have allowed buildup of fuels, and because of the expansion and dominance of the highly flammable tamarisk. Tamarisk and arrowweed tend to recover more rapidly from fire than do cottonwood and willow. Riparian fires have destroyed nesting flycatcher sites along the Middle Rio Grande and elsewhere in New Mexico (USFWS 2002).

The Refuge maintains fuel breaks at strategic locations on the Rio Grande floodway on Refuge lands, due to the high recurrence interval and risk of wildfires in the Middle Rio Grande. Most wildfires in this reach of the Middle Rio Grande are human caused (USFWS 2010b). The most recent wildfire on the Refuge floodplain was the Marcial Fire of 2006. The largest wildfire (most acres burned) in recent history that affected the Refuge (and other landowners) was the San Pedro Wildfire of 1996. The San Pedro Wildfire of 1996 burned approximately 4,000 acres on the Refuge floodplain including 2,000 acres of gallery cottonwood forest. This Refuge has installed and widened “fuel breaks” along the floodway. Fires in the floodway have shown that riparian wildfires can "jump" long distances and access to the floodway in this area to utilize heavy equipment to fight these fires is very limited (USFWS 2010b). As a result, the Refuge has created large fuel breaks (approximately 0.25 river miles on average and encompassing the width of the floodway). The Refuge has removed of approximately 43.6 acres of non native woody plant species on the east side of the Rio Grande. This reduced vegetated area is maintained yearly to assure that dense woody vegetation does not become reestablished in the fuel break to the point of creating a fire hazard.

Predators, Predation, Parasites, and Disease

Flycatcher nesting success may be influenced by predation, but predation rates are within the range typical for other open-cup nesting passerine birds (Newton 1998). However, for an endangered species “normal” predation rates may exert disproportionately greater effects on the populations. Predation has been reported as the single largest cause of nest failure in some years (Whitfield and Enos 1996, Paradzick et al. 1999). In a New Mexico, Stoleson and Finch (1999) attributed 37 percent of nest failures to predation. Predation of flycatcher eggs and nestlings has been documented by the common king snake (*Lampropeltis getulus*) (Paxton et al. 1997; McKernan and Braden 2001; Smith et al. 2003), gopher snake (*Pituophis* spp.) (Paradzick et al. 2000, McKernan and Braden 2001), Cooper’s hawk (*Accipiter cooperii*) (Paxton et al. 1997), red-tailed hawk (*Buteo jamaicensis*), great horned owl (*Bubo virginianus*) (Stoleson and Finch

1999), western screech owl (*Megascops kennicottiii*) (Smith et al. 2003), yellow-breasted chat (*Icteria virens*) (Paradzick et al. 2000), and Argentine ants (*Linepithema humili*) (Famolaro 1998). Other potential predators of flycatcher nests include other snakes, lizards, chipmunks, weasels, raccoons, ringtailed cats, foxes, and domestic cats (McCabe 1991; Paxton et al. 1997; Sferra et al. 1997; Langridge and Sogge 1998; McCarthey et al. 1998; Paradzick et al. 2000). Predatory birds such as crows, ravens, hawks, roadrunners, or owls may hunt in flycatcher habitat.

Brown-headed cowbirds (*Molothrus ater*), and to a lesser extent, bronzed cowbirds (*M. aeneus*) effectively function as predators if they remove flycatcher eggs during their parasitism. The cowbird lays its eggs in the nests of several bird species. The "host" bird species will then incubate the cowbirds eggs and raise the young. Because cowbird eggs hatch after relatively short incubation and hatchlings develop quickly, they often outcompete the hosts' own young for parental care. Cowbirds may also remove eggs and nestlings of host species from nests (or injure nestlings in nests), thereby acting as nest predators (Beane and Alford 1990; Scott and McKinney 1994; USFWS 2002). Cowbirds can therefore have negative effects on reproductive success of flycatcher females and populations.

Several factors influence the degree to which cowbird parasitism is a problem to nesting flycatchers, including: parasitism rate; flycatcher response to parasitism (e.g., nest abandonment); and net reproductive success per female flycatcher. Various factors have increased the range and numbers of the brown-headed cowbird, and potentially its impacts on hosts, including expansion of suburban and agricultural areas into and near riparian habitats, and increases in cowbird access into riparian habitats through narrowed riparian habitat and increased fragmentation. Stumpf et al. (2011) examined whether temporal and habitat characteristics were associated with risk of predation and probability of brood parasitism by cowbirds on flycatcher nests. They found that date of parasitism and an interaction between parasitism status and nesting stage affected the overall nestling survival rates. Additionally, of the variables modeled, distance to habitat edge decreased the odds of parasitism 1 percent for every 1 m from the habitat edge. Nests greater than 100 m from an edge were 50 percent less likely to be parasitized as those on an edge, however, only 22 percent of nests were found at that distance. Stumpf et al. (2011) found that where management and conservation goals include reducing nest losses due to parasitism, restoration of habitat patches that minimize edge and maximize breeding habitat further from edges was recommended. At sites where cowbirds have been documented as important nest predators, controlling cowbirds may be one option, but further study of the link between parasitism and nest predation and the identification of major nest predators at specific sites was warranted (Stumpf et al. 2011). Similarly, the USFWS (2002) recommended that cowbird impacts on some (but not all) populations may be sufficiently large to warrant management efforts. However, rates of cowbird removal efficiencies and nest predation have often not declined significantly in response to cowbird control efforts (Ahlers et al. 2009).

Although all wild birds are exposed to disease and various internal and external parasites, little is known of the role of disease and parasites on most species or populations. Disease and parasites may be significant factors in periods of environmental or physiological stress, during certain portions of a life cycle, or when introduced into a new or naive host (Karstad 1971, Atkinson and

van Riper 1991, van Riper 1991). Flycatcher subspecies are known to be a host to a variety of internal and external parasites. These include blood parasites such as Leucocytozoon, Microfilaria, Tyrpanosoma and Plasmodium (Bennett et al. 1982, USFWS 2002); blow fly (*Protocalliphora* sp.) (Boland et al. 1989, Sabrosky et al. 1989, McCabe 1991); and nasal mites (Pence 1975). Most bird species, flycatchers, are susceptible to viral pox (Karstad 1971) and may be susceptible West Nile virus (Flaviviridae) and avian influenzas (Orthomyxoviridae). Although these parasites likely occur in flycatchers, there is no information on what impact they have on infected birds or populations.

Tamarisk Leaf beetles

Threats to flycatchers and flycatcher breeding habitat now include introduced tamarisk leaf beetles (tamarisk beetles; *Diorahbda* spp.). The tamarisk beetles have been and continue to be released in Texas to eradicate tamarisk in the Rio Grande (Knutson 2010). Tamarisk beetles have the potential to spread widely and defoliate large expanses of tamarisk-dominated flycatcher breeding habitat, but the effects of such a widespread loss of riparian vegetation on flycatcher remains unknown. Tamarisk is widely used as breeding habitat by flycatchers without negative consequences to their physiology, immunology, site fidelity, productivity, and survivorship (Sogge et al. 2005). Tamarisk-dominated habitats also vary with respect to breeding habitat quality as do cottonwood and willow dominated habitat (Sogge et al. 2005).

Release of tamarisk beetles within 200 mi (322 km) of the occupied flycatcher breeding range is currently prohibited (USFWS 2002). Initial presumptions that tamarisk beetles would only move “tens of feet per year” and could not survive in the range of flycatcher breeding habitat have proven specious (USFWS 1999, 2011c). In addition to tamarisk beetles moving on their own, they may also be transported accidentally or deliberately by people. Due to the variety of tamarisk beetles being introduced, transported by people, or introduction through biocontrol programs, it is predicted that tamarisk beetles will spread throughout the western United States and into Mexico (Tracy et al. 2008).

The tamarisk beetle however, has become established in multiple watersheds in the southwest, including the at several locations along the Rio Grande, including along the Jemez River, on the Rio Grande on Pueblo of Santa Ana, along Hwy 313 from Tramway Boulevard to Algodones, New Mexico, and along Interstate 25 from Bernalillo, New Mexico, to the Highway 14 bridge over Galisteo Creek in Cerrillos, New Mexico (ISC 2011), along the Rio Grande below and in the City of Albuquerque, New Mexico (A. White, USDA, written comm., 2012), and will likely continue to expand its range (Paxton et al. 2011b). In 2010, tamarisk beetles were released near Presidio, Texas and they have defoliated approximately 20 mi (32 km) of tamarisk along the Rio Grande (Knutson 2010). Tamarisk beetles have been reported along the 45 river miles of the Pecos River, near Pecos, Texas (Knutson 2010). Additionally, tamarisk beetles have also been reported in the Middle Rio Grande near Santa Ana Pueblo, New Mexico (ISC 2011).

Tamarisk beetles have dispersed approximately 30 to 50 mi (50 to 80 km) per year, based on a 200 mi (322 km) expansion over four years in the Colorado River Basin (Tamarisk Coalition 2011). Given the occurrence of tamarisk beetles to the east, north, and south, all within approximately 150 mi (400 km) of occupied flycatcher breeding habitat in the action area, and the apparent long-distance dispersal ability of released tamarisk beetles, it is likely that tamarisk beetles will spread into the action area within one to five years and begin defoliation of tamarisk-dominated flycatcher habitat. Tamarisk beetles' dispersal speed and distance may also increase due to the activities of people.

Tamarisk beetle invasion of tamarisk that supports flycatcher breeding habitat has high potential to negatively affect flycatcher breeding success by changing food abundance, vegetation structure, nest temperature and site humidity (Paxton et al. 2010b) Breeding flycatchers within areas dominated by tamarisk may be negatively affected both in the short and long term. The rate of regeneration or restoration of native cottonwoods and willows relative to the rate of tamarisk loss will be critical in determining the effects of this large-scale ecological experiment.

Drought and Climate Change

Climate change is a long-term shift in the statistics of the weather (including its averages). In its Fourth Assessment Report, the Intergovernmental Panel on Climate Change (IPCC) defines climate change as, "a change in the state of the climate that can be identified by changes in the mean and/or variability of its properties and that persists for an extended period, typically decades or longer" (Solomon et al. 2007). Changes in climate already are occurring. Examples of observed changes in the physical environment include an increase in global average sea level and declines in mountain glaciers and average snow cover in both the northern and southern hemispheres (IPCC 2007a). At continental, regional and ocean basin scales, observed changes in long-term trends of other aspects of climate include: a substantial increase in precipitation in eastern parts of North American and South America, northern Europe, and northern and central Asia; declines in precipitation in the Mediterranean, southern Africa, and parts of southern Asia; and an increase in intense tropical cyclone activity in the North Atlantic since about 1970 (IPCC 2007a).

Projections of climate change globally and for broad regions through the 21st century are based on the results of modeling efforts using state-of-the-art Atmosphere-Ocean General Circulation Models and various greenhouse gas emissions scenarios (Meehl et al. 2007; Randall et al. 2007). As is the case with all models, there is uncertainty associated with projections due to assumptions used and other features of the models. However, despite differences in assumptions and other parameters used in climate change models, the overall surface air temperature trajectory is one of increased warming in comparison to current conditions (Meehl et al. 2007; Prinn et al. 2011). Among the IPCC's projections for the 21st century are the following:

(1) It is virtually certain there will be warmer and more frequent hot days and nights over most of the earth's land areas;

(2) it is very likely there will be increased frequency of warm spells and heat waves over most land areas, and the frequency of heavy precipitation events will increase over most areas; and

(3) it is likely that increases will occur in the incidence of extreme high sea level (excludes tsunamis), intense tropical cyclone activity, and the area affected by droughts in various regions of the world (IPCC 2007b).

Changes in climate can have a variety of direct and indirect ecological impacts on species, and can exacerbate the effects of other threats. Climate-associated environmental changes to the landscape, such as decreased stream flows, increased water temperatures, reduced snowpack, and increased fire frequency, affect species and their habitats. The vulnerability of a species to climate change impacts is a function of the species' sensitivity to those changes, its exposure to those changes, and its capacity to adapt to those changes. Future climate change may present a particular challenge evaluating habitat conditions for species like the flycatcher because the additional stressors may push species beyond their ability to survive in their present locations.

Streams such as the Rio Grande will likely be damaged by a combination of lower water flows, higher water temperatures, silting from erosion and non-native plant invasions (Schmandt 2010). Riparian habitat will likely contract and will be less tolerant of stress. The combination of increased droughts and floods, land use and land cover change, and human water demand will amplify these impacts and promote sedimentation (U.S. Department of Agriculture 2008). Flow and riparian habitat will also be affected by precipitation and evaporation and their seasonality (CCSP 2008; Seager et al. 2007; U.S. Global Change Research Program 2000b, 2000c, 2001). Compared to years before 1950, the snowpack is melting earlier in the year, rain is replacing some snowstorms, and the April snow pack is containing less water (Schmandt 2010). Quantifiable data for water losses due to changes in snowpack still contain much uncertainty; however, riparian habitat losses due to evaporation and salinity or other stressors can be calculated with more confidence. Observed changes in droughts are influenced by climate variability and, increasingly, climate change (Guido 2008; Hidalgo 2009; Nemec 1982; Nitze 2004).

In the recent past, drought has had both negative and positive effects on breeding flycatchers and their habitat, which can provide insight into how climate change may affect flycatchers and flycatcher habitat. For example, the extreme drought of 2002 caused near complete reproductive failure of the 146 flycatcher territories in central Arizona (Smith et al. 2003), and caused a dramatic rise in the prevalence of non-breeding and unpaired flycatchers (Paxton et al. 2007a). While extreme drought during a single year can generate impacts to breeding success, drought can also have localized short-term benefits in some regulated environments. For instance at some reservoirs, drought led to reduced water storage, which increased the exposure of wet soils at the lake's perimeter (USFWS 2011c). Continued drought in those areas allowed the exposed areas to grow vegetation and become new flycatcher nesting habitat (Ellis et al. 2008). These

short-term and localized habitat increases are not likely sustainable with persistent drought or long-term predictions of a drier environment, because of the overall importance of the presence of surface water and elevated groundwater needed to grow dense riparian forests for flycatcher habitat. As a result, long-term climate trends associated with a drier climate will likely have an overall negative effect on flycatcher habitat range-wide.

The future predictions of impacts associated with climate change are similar, and in some respect, an extension or exacerbation of the effects of drought, diversions, and surface and groundwater withdrawal. The potential habitat impact to river flow is similar to the negative effects associated with the water and land management actions that have altered river surface and subsurface flow. Some of the negative impacts to the abundance and distribution of flycatcher habitat were caused by the alteration of peak flow, or the reduction of surface flow, raising floodplains through aggradation and increasing depth to groundwater, and/or lowering of groundwater tables. These impacts, which were key factors in shaping the distribution and abundance of flycatcher habitat, contributed to its listing as an endangered species.

Therefore, it is reasonable to conclude in the Southwest, based upon past negative effects from drought and water or land management actions that the flycatcher and its habitat will be impacted when future drought or low water conditions, including shortages, continue or re-occur. These conditions can be expected to be exacerbated by climate change or future reductions in water supplies and shortages with continued negative impacts to the flycatcher and its habitat.

Exactly how climate change will affect precipitation in the specific areas with flycatcher habitat is uncertain. However, consistent with recent observations of regional effects of climate change, the projections presented for the Southwest predict warmer, drier, and more drought-like conditions (Hoerling and Eischeid 2007; Seager et al. 2007). For example, climate simulations of the Palmer Drought Severity Index (PSDI) (a calculation of the cumulative effects of precipitation and temperature on surface moisture balance) for the Southwest for the periods of 2006 to 2030 and 2035 to 2060 show an increase in drought severity with surface warming. Additionally, drought still increases even during wetter simulations because of the effect of heat-related moisture loss through evaporation and evapotranspiration (Hoerling and Eischeid 2007). Annual mean precipitation is likely to decrease in the Southwest, as is the length of snow season and snow depth (IPCC 2007b). Most models project a widespread decrease in snow depth in the Rocky Mountains and earlier snowmelt (IPCC 2007b). In summary, climate change will result in a warmer, drier climate, and reduced surface water across the flycatcher's range in the Middle Rio Grande as well as in the action area.

V. EFFECTS OF THE ACTION

Regulations implementing the ESA (50 FR 402.02) define the *effects of the action* as the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action, which will be added to the environmental baseline. Indirect effects are those that are caused by the proposed action and are later in time, but are still reasonably certain to occur. Interrelated actions are those that are part of a larger action and depend on the larger action for their justification. Interdependent actions are those that have no independent utility apart from the proposed action.

The proposed project would remove approximately 43 miles of existing levee (non-engineered spoil bank) adjacent to the Rio Grande Floodway and replace it with engineered levees capable of containing at least the 1%-chance flood event. The current levee plan has been divided into 14 phases and 6 segments that would be constructed over a 20-year period (2012-2032). The functional life of the project is considered 50 years (until 2082). Many aspects of the project are not expected to result in effects on the endangered species and their habitats, and those will not be discussed. The following sections describe the anticipated effects on silvery minnows and silvery minnow designated critical habitat, on flycatchers, on flycatcher designated critical habitat, and on flycatcher proposed critical habitat resulting from the proposed action.

Effects of the Proposed Action on Silvery Minnows and Silvery Minnow Designated Critical Habitat

Summary of the Proposed Action Effects to Silvery Minnows and Designated Critical Habitat

Table 2. Summary of the Proposed Action Effects to Silvery Minnows and Critical Habitat

Corps BA Proposed Activity	Estimated Incidental Take of Individual Silvery Minnows	Temporary Impacts to Silvery Minnow Critical Habitat (Acres)	Long term Impacts to Silvery Minnow Critical Habitat (Acres)
Temporary River Crossing	79	0.2	0
East Side Excavation	0	9.9	0
Floodwall Installation and Soil Cement Embankment	238	0.6	2.3
Riprap Blanket Installation	0	4.4	10.9
Sluice Gates at Brown Arroyo	119	0.3	0.3
Earthen Levee and Vegetation Free Zone	0	42.5	0
Tiffany Basin Fill	0	0	0
Corps Conservation Measures	0	3.1	(3.1)
Column Totals	436	64.0	13.5

Earthen Levee and Vegetation-Free Zone

The proposed activities associated with this aspect of the project will occur in the dry and will remove 58.9 acres of vegetation, converting 29.5 acres to grasslands, and replanting 16.4 acres riparian vegetation (BA, Table 5.1, page 74). Therefore, the Service estimates that there is a loss of (58.9 acres – 16.4 acres) up to 42.5 acres riparian vegetation within the floodway. Modification 42.5 acres of a silvery minnow critical habitat PCEs will occur. Removal of vegetation from the installation of the earthen levee and from the levee toe plus 15 ft into the floodway adversely affects vegetation that contributes to silvery minnow PCE water of sufficient quality. The loss of riparian vegetation will change water temperatures during periods when soil and riparian vegetation cooling should normally occur that help maintain natural, daily, and seasonally variable water temperatures in the approximate range of greater than 1 C and less than 30 C. Such reduced shade effects may be particularly pronounced when the river channel width is much larger than river depth, and/or during periods of low flow during summer months. Additional effects due to lack of shading, reduction or removal of riparian organic matter for food and substrate will be removed, and use of herbicides and pesticides during operation and maintenance of the levee may adversely affect silvery minnow critical habitat PCEs.

Gains in the floodway near River Mile 111 and River Mile 113 are currently not adequately revegetated with native riparian vegetation to provide shading. The area near River Mile 113 is especially degraded by vehicle access that is expected to continue without additional management. Over time, the quality of shade contributed by the revegetated riparian and upland areas should again contribute to this silvery minnow critical habitat PCE wherever the channel moves further to the East Side, or by natural reestablishment or installation of additional riparian vegetation near the channel edge would contribute to this PCE. Thus, it is currently estimated that this PCE (i.e., supporting water of sufficient quality) would be temporarily adversely affect 42.5 acres of designated critical habitat, until channel edges are recolonized by riparian vegetation of sufficient shading to reduce and/or moderate water temperatures.

Temporary River Crossing

To reach the East Side Excavation from the maintenance road on the west bank, Corps proposes to temporarily cross the Rio Grande on the downstream side of the SADD between the eastern and western banks of the river channel. The crossing would be constructed on one-half of the river at a time. The temporary river crossing will consist of an earthen ramp approximately 300 feet long, with a 15-foot top width and 2.5 horizontal to 1 vertical side slopes. The temporary river crossing would require the placement of six, 60-inch-diameter, 30-foot-long, corrugated metal pipes would allow low flows through the crossing area to maintain a wet river channel. Added to top of the pipes will be approximately 1,000 cubic yards of random fill ranging in depth from two to eight feet.

Assuming the final width of the crossing is equivalent to pipe length, and then the area filled would be approximately 9,000 square feet (0.2 acres). Corps standard best management practices (BMPs) would be followed during dewatering, and placement and then removal of temporary fill. Construction activities in or immediately adjacent the river channel would be

scheduled during low-flow conditions and no impoundment of water would occur. The construction and removal of the temporary crossing may create a minor and temporary increase in turbidity and decreases in oxygen content. Construction of the temporary ramps and road with the temporary river crossing will occur in the dry and small amounts of vegetation will be removed.

Prior to installing the access ramps and temporary river crossing, an estimated 700 linear feet of silt curtains or coffer dam will be installed to exclude silvery minnows from the construction and access areas. The cofferdam will be installed with the bottom secured to the riverbed. Installation of the silt curtain or coffer dam during the temporary crossing and is expected to occur in the river, and will protect against any influx of river water into the project area that could expose silvery minnows to the construction. Corps will coordinate with the Service to ensure that prior to construction activities, any remaining pools of water between the silt curtain or coffer dam and the SADD will be seined or electro-fished by the Service or biologists who have obtained Section 10(a)(1)(A) permits for research to remove silvery minnows captured by the silt curtains or cofferdams.

Short-term adverse effects on silvery minnows may occur due to disturbance during installation of the silt curtains and cofferdams and exclusion of fish species. The Service expects silvery minnows will be present during the closure of the silt curtain area and will be harassed temporarily as a direct effect of the proposed activities (e.g., installation of the silt fences and cofferdams). Silvery minnows are expected to exhibit an avoidance response to these activities and given the operating speed and location of equipment, as well as the small area affected, the Service does not expect fish will be directly injured. Avoidance behavior, or fleeing from the disturbance, represents a disruption in normal behaviors and an expenditure of energy that an individual silvery minnows would not have experienced in the absence of the proposed action. However, this form of harassment is expected to be short in duration, with pre-exposure behaviors to resume after fleeing the disturbance.

The Service estimates that harassment during the temporary river crossing will affect up to the average density of silvery minnows reported in the San Acacia Reach since 2003 (see page 25), or as many as 9.8 silvery minnows per 100 m^2 (equivalent to 9.8 per 0.0247 acres) (or 9.8 RGSM/0.0247acre *0.2 acre = 79) or 79 silvery minnows may be harassed. Silvery minnows that are harassed by construction impacts may also be captured during rescue activities, and those silvery minnows that are intentionally captured by biologists must be authorized by a valid ESA Section 10(a)(1)(A) permit. To ensure that schooling minnows do not continue to access the area, silt curtains (or as necessary, cofferdams) should be inspected daily to verify connection between bottom of the BMP used (i.e., silt curtain, coffer dam) and the river substrate.

The Service expects that up to 0.2 acres of silvery minnow critical habitat will be temporarily lost when the road is in place, but its conservation value will return after the temporary crossing is removed.

East Side Excavation

Approximately 12.4 acres along the east bank of the river will be excavated by Corps to provide a wider corridor for flood flows and decrease the velocity and erosive potential of the design flood. Excavation would be scheduled for four months during fall and winter when river flow is relatively low and reliably stable. Terraces would be excavated and the existing bank would be excavated to slope downward to the existing channel. Construction would be scheduled during low-flow conditions and no impoundment of water would occur. Following excavation, the lowest 3.1 acres would become part of the active Rio Grande channel (that is, would be excavated to an elevation below that of the 50%-chance flow event). Silt curtains and cofferdams are not expected to be installed in the water column, and therefore no silvery minnows are expected to be taken.

Modification 12.4 acres of silvery minnow critical habitat will occur. Approximately 1.1 acres of the bankline will be revegetated with willows, and 3.1 acres of lower terrace overbank area will be created, and revegetation with grasses and terrestrial shrubs will occur, resulting in the loss of 9.9 acres of riparian shrub (11 riparian - 1.1 acres revegetated = 9.9 acres riparian vegetation lost) within silvery minnow critical habitat. Silvery minnow habitat qualities on the 3.1 acre floodable terrace were not quantified, and without routine maintenance silvery minnow habitat are not expected to be maintained over the duration of the project. We expect unquantifiable changes in relative shading by vegetation types, and changes in organic matter contributions. This will temporarily affect the PCE of water of sufficient quality. Thus, 9.9 acres of silvery minnow critical habitat will temporarily lose shading. Over time, perhaps as long as two years, the quality of shade contributed by the revegetated riparian and upland area should again contribute to the silvery minnow critical habitat PCEs of water of sufficient quality.

Floodwall Installation and Soil Cement Embankment

On the west side of SADD, the corridor between the western bank of the river and the railroad track is too narrow to accommodate an earthen levee. Therefore, a cement floodwall would be constructed on top of the bank beginning at a point about 400 feet upstream of the SADD and extending 650 feet downstream (~1,000 feet total, minus 50 feet around SADD). The floodwall would be approximately 4 feet high and would be flanked by a roller-compacted concrete or soil cement apron along the downstream portion. Nearly the entire area encompassing the floodwall and apron is currently disturbed and devoid of vegetation. Riparian vegetation of dense salt cedar does occur along the 1.1 mile area to be constructed as the Soil Cement Embankment.

According to the BA, there is a high potential for bank erosion along the western bank, especially in the large bend area downstream from the SADD. Therefore, a soil-cement embankment would be constructed by the Corps along 5,700 feet of the west bank immediately downstream from the SADD. The soil-cement embankment is not required to prevent flood flows into the floodplain west of the levee, but is required to prevent erosion and undermining of the railroad track (USACE 2012a, page 10). The soil cement embankment will armor the entire slope from levee crest to toe, removing all vegetation and topsoil. The Soil Cement Embankment, together with the soil apron associated with the Floodwall will cover 6,700 feet. The Corps estimates that 0.6 acres of the Soil Cement Embankment will occur in river channel.

During excavation, dewatering, and placement of the soil-cement embankment, conservation measures and construction precautions similar to those described above for the temporary channel crossing would be employed to minimize the potential for water quality degradation or entrapment of fish. Short-term adverse effects on silvery minnows may occur due to disturbance during reconnaissance, and installation of silt curtains and cofferdams. The Service expects silvery minnows will be present during the closure of the silt curtain area and will be harassed temporarily as a direct effect of the proposed activities (e.g., installation of the silt fences and cofferdams) in approximately 0.6 acres below the ordinary high water mark. Silvery minnows are expected to exhibit an avoidance response to these activities and given the operating speed and location of equipment, as well as the small area affected, the Service does not expect fish will be directly injured.

Avoidance behavior, or fleeing from the disturbance, represents a disruption in normal behaviors and an expenditure of energy that an individual silvery minnows would not have experienced in the absence of the proposed action. However, this form of harassment is expected to be short in duration, with pre-exposure behaviors to resume after fleeing the disturbance. The Service estimates that harassment over the project duration will affect up to the average density of silvery minnows reported in the San Acacia Reach since 2003 (page 25), or as many as 9.8 silvery minnows per 100 m^2 (equivalent to 9.8 per 0.0247 acres) (or 9.8 RGSM/0.0247acre *0.6 acre = 238) or 238 silvery minnows may be harassed. Silvery minnows that are harassed by construction impacts may also be captured during rescue activities, and silvery minnows that are intentionally captured by biologists must be authorized by a valid ESA Section 10(a)(1)(A) permit. To ensure that schooling minnows do not continue to access the area, silt curtains or cofferdams should be inspected daily to verify connection with bottom of BMP and substrate.

During construction, up to 0.6 acres of silvery minnow critical habitat will be temporarily disturbed, but its conservation value will return after the construction is complete and silt curtains are removed. However, during the life of the project, flood flows may overbank in the floodway up to the design elevation of the water surface, at approximately 6 feet above the bottom of the river channel, as indicated in the BA (USACE 2012a, Appendix A, Sheet C-142, C). The width of soil cement embankment that is within those 6 feet depth of inundation is approximately 15 feet. Over the project duration, 70 years, the river channel may migrate within the floodway and widen directly onto the soil cement embankment section, though such migration may be limited by ongoing channel degradation and incision occurring near the SADD. The 70-year project duration prevents a complete understanding of any future channel

alignment with respect to the soil cement embankment. Therefore, the Service assumed that the 6,700 feet in length of the soil cement embankment, with a 15 foot width, and 6 foot depth could be part of the river channel or part of the overbank area subject to flood flows at any time. Therefore, the total area that may occur within silvery minnow habitat, even when such habitat occurs only during flood flows, is equal to, or less than, 6 foot deep, and is 2.3 acres (6,700 feet long x 15 feet wide = 100,500 square feet).

Therefore, the Service estimates that 2.3 acres of Soil Cement Embankment could be inundated with water during flood flows, overbank flows, or associated with channel migration. Substrate of the Soil Cement is largely carbonates of lime, clay, gypsum, silica, alumina, and various oxides and alkalis that are mixed stone and sand to form large slabs and is described by the Corps as having coarse textures (min D50 > 2 feet; BA, Appendix A, Sheet C-142). The predominant bed-material size material in the San Acacia Reach is naturally fine to medium sand with gravel found at confluences with eastside tributaries. The bed material has coarsened somewhat since the early 1970s in the reach downstream from the San Acacia Diversion Dam, although the median bed-material size remains in the medium sand range throughout most of the reach. Silvery minnow critical habitat PCE only includes substrates of sand or silt. Unless completely covered for the duration of the project with sand and silt (D50 = 0.01 to 0.1 mm), which is not expected given the water velocities of up to 17 fps, soil cement installation will permanently change substrate PCE of silvery minnow critical habitat for up to2.3 acres. When inundated or exposed, soil cement embankment exceed silvery minnow critical habitat PCE for fine substrate.

Soil Cement Embankment may also adversely affect the quality of river runs, in that the velocities associated with it are fast (up to 17 fps) and will likely be relatively uniform, unlike runs of varying depth and velocity. Silvery minnow critical habitat extends up to the existing spoil bank toe (including soil cement embankment) during higher flows (10% occurrence, ~5500 cfs water velocities during such flows are not well known, but are depicted anywhere from 1 to 17 fps, some of which are not suitable flow velocity values for the minnow (at or less than 30 cm/s). Silvery minnow does have a positive association with channel shorelines and high velocities associated with the Soil Cement Embankment may preclude silvery minnow use of shorelines that are in direct contact for approximately 1.2 miles.

Additionally, potential water quality effects by pH (below), the lack of shading after removal of riparian vegetation, loss of riparian organic matter for food or substrate may also adversely affect silvery minnows in this area. The function of topsoil previously on the slope of the soil banks that helps process wastes, pesticides, or chemicals associated with the railroad tracks and its right-of-way, as well as the quality of its runoff may be substantially altered. The number of minnows that may be affected by these water quality changes cannot be accurately estimated.

The addition of cement can produce elevated changes in the pH of waters that flow over it (Steffes 1999). The soil cement should be allowed to cure at least a month before contact with water is allowed, to reduce these effects (Steffes 1999). However, water that has been in contact with the soil cement feature for sufficient time periods should be monitored sufficiently to determine if elevated pH (compared to pH measurements upstream, at SADD, or is above pH = 9

for any period of time) conditions exist or persist over time along the soil cement embankment. If the soil cement embankment is found to elevate pH, then the area affected would reduce the water of sufficient quality PCE of silvery minnow critical habitat and must be quantified.

Riprap Blankets

Corps will install riprap blankets only in the dry. During construction, up to 4.4 acres of silvery minnow critical habitat will be temporarily disturbed, but its conservation value will return after the construction is complete and silt curtains are removed. However, during the life of the project, flood flows may overbank in the floodway up to the design elevation of the water surface, at approximately 6 feet above the bottom of the river channel up the riprap blanket, as indicated in the BA (USACE 2012a, Appendix A, Sheet C-142, B). The width of riprap blanket that is within those 6 feet depth of inundation is approximately 15 feet. Over the project duration, 70 years, the river channel may migrate within the floodway and widen directly onto the riprap section. The 70-year project duration prevents a complete understanding of any future channel alignment with respect to the riprap blankets. Therefore, the Service assumed that the 31,700 feet in length of the riprap blankets, with a 15 foot width, and 6 foot depth could be part of the river channel or part of the overbank area subject to flood flows at any time. In addition, riprap blankets are often deployed in areas subject to flood flows. Additionally, the launchable portion of riprap is designed to erode during flooding to protect the levee toe. Therefore, the total area that may occur within silvery minnow habitat, even when such habitat occurs only during flood flows, is equal to, or less than, 6 foot deep, and is 10.9 acres (31,700 feet long x 15 feet wide = 475,500 square feet).

Therefore, the Service estimates that 10.9 acres of Riprap Blanket could be inundated with water during flood flows, overbank flows, or associated with channel migration. Substrate of the Riprap blanket is largely dark basalt rocks and is described by the Corps as having coarse textures (min D50 > 2 feet; BA, Appendix A, Sheet C-142). The predominant bed-material size material in the San Acacia Reach is naturally fine to medium sand with gravel found at confluences with eastside tributaries. The bed material has coarsened somewhat since the early 1970s in the reach downstream from the San Acacia Diversion Dam, although the median bed-material size remains in the medium sand range throughout most of the reach. Silvery minnow critical habitat PCE only includes substrates of sand or silt. Corps will place small earthen berms in the vegetation maintenance zone adjacent to the riprap to increase sand and silt in the area and contribute to slack water features when the area is inundated However, unless completely covered for the duration of the project with sand and silt (D50 = 0.01 to 0.1 mm), riprap blankets may permanently change substrate PCE of silvery minnow critical habitat for up to 10.9 acres. When inundated or exposed, riprap blanket construction materials exceed silvery minnow critical habitat PCE for fine substrate. Additionally, when launchable riprap is eroded, it will contribute large sized cobble and boulders to the silvery minnow critical habitat downstream, and levee maintenance operations will require additional installation of launchable riprap to again protect the levee toe.

Additionally, during higher flows, flow velocities along the riprap are depicted from 1 to 3 fps (30 to 90 cm/s) but not all suitable flow velocity values for the minnow (at or less than 30 cm/s). Silvery minnow does have a positive association with channel shorelines. When exposed, the riprap blanket will possibly exceed silvery minnow critical habitat PCE water velocities associated with the riprap materials. The riprap blanket will armor the entire slope from levee crest to toe, removing most vegetation and topsoil and a vegetation free zone will be maintained over the project duration. Additional effects due to heat transfer by riprap blanket, lack of shading, reduction or removal of riparian organic matter for food and substrate will be removed may also adversely affecting silvery minnow critical habitat. The function of topsoil previously on the slope of the spoil banks to process nutrients and wastes, and its runoff, may also be substantially reduced.

Areas containing riprap composed of dark basalt rock may have significantly different heat capacity than the previous soil and riparian vegetated conditions (Ingham 1999). Such dark basalt would be expected to absorb radiant heat during the day and radiant that heat during the night. Such dark basal material, when inundated by water, will warm that water (Ingham 1999). The change in substrate will change the surface water temperatures during periods when soil and riparian vegetation cooling should occur in the silvery minnow critical habitat PCEs for water of sufficient quality to maintain natural, daily, and seasonally variable water temperatures in the approximate range of greater than 1C and less than 30 C. Such effects may be particularly pronounced when the river channel width is much larger than river depth, and during periods of low flow during summer months. The area expected to experience elevated water temperatures associated with the riprap blankets is the same determined as above, 10.9 acres.

Additionally, it is estimated that construction of the deep toe portions of the riprap protection require dewatering for placement. No information regarding the potential effects or magnitude of groundwater excavation by pumping was provided in the BA. The Service estimated that the levee toe would have a maximum depth of 17 feet. For the estimate, the water table in the excavation exists 8’ below the levee toe and may need to be evacuated by as much as 20 feet for construction. The depth of the wells is varied based on the depth of the construction excavation. The dewatering is accomplished using a deep well type system consisting of wells placed at 50' on center, therefore, such wells may number as many as 100 per mile of the levee installation. Each well will have an electric submersible pump and discharge piping that will convey excavated groundwater to the riparian area on the overbank or to the LFCC. Approximately 31,700 feet of riprap blankets are to be installed, and groundwater depths will be lowered as much as 12 feet. If the Service assumes the average distance from any pump is approximately 25 feet, based on their spacing, then the minimum volume of water to be evacuated in the riparian area will be approximately 9,525,000 cubic feet (31,750 long * 25 wide * 12 deep =), which is approximately 71,251,948 gallons or 219 acre feet of water.

The depletion of oxygen from the water overlying the bottom sediment is primarily caused by the decomposition of organic matter in sediments. For example, Bexfield (2010) reported that unlike groundwater throughout most of the basin, the water at shallow depths below and near the Rio Grande channel tends to have concentrations of DO near or below detection limits, which probably reflects a greater organic-carbon content for sediments within the Rio Grande inner

valley and, therefore, greater oxygen reduction. Similarly, flooding or sprinkling the riparian area with its organic matter accumulations with excavated groundwater can also result in anoxic water conditions when the runoff discharges into the Rio Grande. Valett et al. (2005) found that flooding of the riparian forest soils (Rio Grande floodplain or "bosque") increased the rates of respiration during the flood pulse. In floodplains that were *infrequently* flooded, or where the volume of floodwater was inadequate to flush and dilute the area, the inundation of the forest resulted in widespread low DO in the floodwaters that are capable of adversely affecting fish. Contributions from any low oxygen floodwaters into the main channel would be expected to decrease the DO content within the Rio Grande downstream. Flooding by groundwater pumping discharges are not necessarily a "natural phenomena" that should be compared with the natural flood events described by Ellis et al. (1998) and Valett et al. (2005). Groundwater pumping that discharges directly to the Rio Grande or that discharge into the riparian forest and subsequently runoff into Rio Grande may adversely affect silvery minnow within the mixing zone.

The 219 acre feet of groundwater in the MRGV that is excavated and pumped during riprap installation will likely contain very low (<1 mg/L) oxygen (Bexfield 2010). Water that is pumped from anoxic groundwater sources into the Rio Grande could have adverse effects on silvery minnows. When exposed to low oxygen conditions, fish can attempt to compensate by behavioral responses, such as increased use of ventilation of the aquatic surface, change their activity level or habitat use, and avoidance behaviors, though these activities are known to come at a higher energy cost due to physiological stress (Kramer 1987; BCME 1997). Below some threshold oxygen saturation, fish will be expending excess energy to maintain homeostasis and that some degree of physiological stress will occur (Heath 1995). For example, ventilation rates are often increased, feeding is reduced feeding, movement activity is decreased and increased glycolysis and cortisol release (i.e., a protein associated with physical stress in silvery minnow) can be induced by even short-term, low DO conditions (Kramer 1987; Heath 1995; BCME 1997). Eventually at critically low DO concentrations, fish suffocate and may begin to die. Such hypoxic conditions may also cause a wider range of chronic effects and behavioral responses in fish (Downing and Merkens 1957; Davis 1975; Kramer 1987; Breitburg 1992) that are not fully characterized for silvery minnow.

However, Buhl (2007, 2011a) reported that 50 percent of the test population of silvery minnow larvae (6-days post-hatch in age) died when exposed to water containing DO at 0.7 mg/L (8.7 percent oxygen saturation) during 24- to 96-hr exposures, even when allowed access to the water surface. Buhl (2011a) reported that 50 percent of the test population of adult silvery minnows dies when exposed to water containing DO from 0.8 mg/L (6.7 to 13.2 percent oxygen saturation) after a 3-hr exposure. Buhl (2011a) reported that the highest DO concentration observed without acute mortality to larval silvery minnows (that had no access to the water surface) was 2.4 mg/L (i.e., at 29.8 percent saturation). Buhl (2011a) reported that the highest DO concentration observed without acute mortality to adult silvery minnows (that had no access to the water surface) was 4.4 mg/L (i.e., at 54.3 percent saturation). Those data suggest that larval silvery minnow may be more tolerant than adult silvery minnow to low DO.

Also from the Buhl (2011a) data, the Service expects that adult silvery minnows in water at 25.7 °C (78.3 °F) with DO less than or equal to 4.4 mg/L (i.e., at 54.3 percent saturation) will begin to experience mortality as well as experience adverse effects such as changes in ventilation rates, increased surface water respiration, lack of feeding activity, metabolism changes, or the condition or position of the silvery minnow in the water column will change such that they are at an increased risk of predation. Temperature and pressure can affect the solubility of DO in surface water, and as the activities occur in the winter months, the likelihood of low DO excavated groundwater in mixing zones is reduced in the Middle Rio Grande due to cold water.

Corps will develop a groundwater pumping plan prior to riprap placement. The timing, rate, water volume, and receiving area will be formulated to aerate groundwater to eliminate impacts to aquatic life, riparian vegetation and river levels to the extent possible. The Corps would immediately confer with the Service if hypoxic conditions occur in the Rio Grande as a consequence of groundwater pumping to the river (including runoff across the floodplain). Therefore, while the Service would expect that silvery minnow could exhibit a stress response due to the loss of oxygen by any excavated hypoxic groundwater discharges; Corps conservation measures assure that such discharges to the Rio Grande will be routinely monitored, and if any discharges to the Rio Grande are found to contain inadequate oxygen below 54.3 percent, or 4.4 mg/L (at 25C), then immediate management actions shall be taken by Corps to increase aeration or diversion away from river channel. Sprinkling hypoxic discharges onto the riparian zone might not adequately result in sufficient aeration, especially if organic matter continues to depress the oxygen content of such discharges and therefore, these conditions too shall be monitored by Corps. As necessary, with additional information about the volume, timing, location, oxygen content and temperature of the excavated groundwater discharges the mixing zone of such discharges with the Rio Grande could be estimated to minimize the area of the temporary impacts.

Sluice Gate Installation at Brown Arroyo

Brown Arroyo enters the Rio Grande approximately 22.2 river-miles downstream from SADD. Corps determined that a closure structure (consisting of 10 sluice gates in a zigzag pattern) was needed at Brown Arroyo. This gated closure structure would be designed to pass Brown Arroyo flood flows while preventing longer-duration Rio Grande flood flows from potentially breaching the existing interior drainage facilities and is described below.

During excavation and placement of the additional riprap blankets along Brown Arroyo and sluice gates, conservation measures and construction precautions similar to those described above for the temporary channel crossing would be employed to minimize the potential for water quality degradation or entrapment of fish. Short-term adverse effects on silvery minnows may occur due to disturbance during reconnaissance, and installation of any silt curtains and cofferdams deployed in the water column. The Service expects silvery minnows will be present during the closure of the silt curtain area in approximately 0.3 acres below the ordinary high water mark. The Service anticipates that silt curtains or cofferdams will be used in the river and arroyo channel will reduce turbidity impacts and reduce fish access to construction area. Total acreage affected is estimated at 0.3 acres. Silvery minnows are expected to exhibit an avoidance response to these activities and given the operating speed and location of equipment, as well as the small area affected, the Service does not expect fish will be directly injured.

Avoidance behavior, or fleeing from the disturbance, represents a disruption in normal behaviors and an expenditure of energy that an individual silvery minnows would not have experienced in the absence of the proposed action. However, this form of harassment is expected to be short in duration, with pre-exposure behaviors to resume after fleeing the disturbance. The Brown Arroyo confluence is a natural stormwater return with the Rio Grande and may be favored by silvery minnows (USFWS 2011a). The Service estimated that harassment over the project duration will affect up to the average of silvery minnows reported in the San Acacia Reach since 2003 (page 21), or as many as 9.8 silvery minnows per 100 m^2 (equivalent to 9.8 per 0.0247 acres) (or 9.8 RGSM/0.0247acre *0.3 acres = 119) or 119 silvery minnows may be harassed associated with installation of the Brown Arroyo sluice gates. Silvery minnows that are harassed by construction impacts may also be captured during rescue activities, and silvery minnows that are intentionally captured by biologists must be authorized by a valid ESA Section 10(a)(1)(A) permit. To ensure that schooling minnows do not access the area, silt curtains or cofferdams should be inspected daily to verify connection between the bottom of BMP and the substrate.

The gated floodwall structure would be located where the new levee intersects the outfall channel of Brown Arroyo and will permanently remove 0.3 acres of silvery minnow habitat PCEs with installation of additional riprap blankets as well as remove inundated area away from the access by silvery minnows that, at times, contains the hydrologic regime supporting backwaters with fine substrates and water of sufficient quality.

Ephemeral Channels Fill within 15 Feet of Levee Toe

All ephemeral channel runs along the existing spoil banks will be filled in areas within 15 feet of the new levee by the Corps. The overbank area within the floodway tends to slope from the riverbank downwards toward the spoil bank toe. When inundated, flow becomes concentrated along the spoil bank, and, over time, has formed a small channel paralleling the toe. During proposed levee construction, the Corps would fill such depressions within 15-feet of the riverward toe, grade the surface to that of the adjacent overbank, and re-vegetate it with grass species in order to minimize the potential for erosion of the levee toe. This activity will also intentionally and directly contribute to the vertical accumulation of sediment within the floodway. Non-federal local sponsors who assume operation and maintenance activities during the project duration would be expected to do this same ephemeral channel filling activity. The Corps identified local contouring of the ephemeral channels to direct receding overbanking flows back to the Rio Grande channel. All activities would be conducted in the dry and therefore no silvery minnows would be directly affected. This fill is not expected to change the hydrologic regime, affect aquatic habitat, substrates, and provided no fill occurs within or affects the water quality of the river channel, no silvery minnow critical habitat should be affected.

Tiffany Basin Fill

Tiffany Basin Fill activities occur in the dry. Silvery minnow critical habitat is outside the area of the Tiffany Basin and any associated truck routes. Fill does not change the hydrologic regime of the Rio Grande (as Tiffany Basin is currently protected by a spoil bank), affect aquatic habitat, substrates, and provided no fill occurs within or affects the water quality of the river channel, no silvery minnow critical habitat should be affected.

Effects of the Proposed Action on Flycatchers and Flycatcher Designated Critical Habitat

Summary of Project Effects to Flycatchers and Flycatcher Critical Habitat

Table 3. Summary of the Proposed Action Effects to Flycatcher and Critical Habitat PCEs

Corps BA Proposed Activity	Estimated Incidental Take of Flycatcher Territories	Temporary Impacts to Flycatcher Critical Habitat (Acres)	Long Term Impacts to Flycatcher Critical Habitat (Acres)
Temporary River Crossing	0	0.2	0
East Side Excavation	0	1.1	0
Soil Cement Embankment	0	0	0
Noise and Traffic Disturbance	6	0	0
Riprap Blanket Installation	2	18	2.45
Sluice Gates at Brown Arroyo	0	0.1	0
Tiffany Basin Fill	0	0	0
Earthen Levee Footprint and Vegetation Free Zone[1]	3	58.9	8.41
Levee exacerbated sediment accumulation in floodway[2]	Uncertain	0	50-200
Riparian just West of Levee	0	32	0
Column Totals	11	94.8	60.1-200

[1]Number of flycatchers estimated to be affected by habitat losses due to levee construction (approx. 8.41 acres/2.7 acres/flycatcher territory = 3 flycatcher territories) yet the establishment of 50.4 acres of flycatcher habitat as proposed by the Corps would minimize this effect.

[2]Number of flycatchers estimated to be affected by habitat losses due to the increased sediment accumulation and increasing depth to groundwater is relatively certain by 2029 (approx. 53 acres/2.7 acres/flycatcher territory=20) yet the establishment of 50.4 acres of flycatcher habitat as proposed by the Corps would minimize this effect. Estimates are more uncertain by 2079 and require additional study before the Service would be able to issue an incidental take statement. Acreages of critical habitat affected by the increased sediment accumulation and increasing depth to groundwater is uncertain, but currently estimated to range between 50 and 200 acres.

Temporary River Crossing

Corps seasonal and geographic restrictions (along with flycatcher surveys) should limit any effects to flycatchers in the area of the Temporary River Crossing. A portion (0.2 acres) of the temporary river crossing area does occur within the location of flycatcher designated critical habitat (Figure 7). Therefore, 0.2 acres of flycatcher critical habitat PCEs, insect prey populations, will be disturbed temporarily, but its conservation value for flycatchers will return after the temporary crossing is removed and area is wetted and aquatic insects associated with the water and saturated substrate will again emerge to become prey for flycatchers.

East Side Excavation

Corps seasonal and geographic restrictions (along with flycatcher surveys) should limit any effects to flycatchers. Currently, the east side excavation is not inundated until the discharge measured at the San Acacia gage exceeds 25,000 cfs. Vegetation currently consists of riparian shrubs: 5.0 acres of relatively dense salt cedar, 6.0 acres of short sparse salt cedar and coyote willow along the bankline. Following excavation, the lowest 3.1 acres would become part of the active Rio Grande channel (that is, would be excavated to an elevation below that of the 50%-chance flow event). A 1.1-acre band of coyote willow and seep-willow will be planted by the Corps along the new bank-line within these 3.1 acres. The upper 9.3 acres would entail a bench that would be only inundated by the 10%-chance flow event (15,400 cfs at the San Acacia gage), and would be revegetated by upland grasses and native forbs and shrubs. (see Figure 7)

Flycatcher designated critical habitat does occur in the area of the East Side Excavation. However, revised critical habitat is identified only on the 3.1-acre portion of the East Side Excavation, and on the 5.0 acres of relatively dense tamarisk on the bench. The 3.1 acres will continue to provide moist soils that contribute insect prey populations and revegetation with willows will restore 1.1 acres to the value of the PCEs in the critical habitat areas with no net gain or loss in the 3.1 acre area. However, the proposed action would remove a total of 5 acres proposed critical habitat PCEs that include areas of dense riparian foliage and replant it with upland grasses and shrub, thereby removing the PCEs (Figure7). However, Ahlers et al. (2010) indicated that this bench containing dense tamarisk vegetation is unsuitable as flycatcher habitat. Therefore, no loss of flycatcher critical habitat occurs in the bench area. The 1.1 acres of willows lost and subsequent gains by replanting willows along the edge of the 3.1-acre excavated area do not permanently modify flycatcher critical habitat.

Floodwall Installation and Soil Cement Embankment

Seasonal and geographic restrictions and flycatcher surveys should limit any effects to flycatchers. The cement floodwall and soil cement embankment will constructed on top of the bank beginning at a point about 400 feet upstream of the SADD and extending 650 feet downstream (~1,000 feet total, minus 50 feet around SADD) and then soil cement embankment will travel 1.1 miles south approximately 20 feet wide. Nearly the entire area encompassing the floodwall and apron is currently disturbed and devoid of vegetation. Riparian vegetation in the form of dense salt cedar occurs along the 1.1-mile area to be constructed as the Soil Cement

Embankment. Only migrant flycatchers have been detected near there and the river channel nearby (Moore and Ahlers 2011). Flycatcher designated critical habitat is only designated along the southernmost portion of the Soil Cement Embankment area for approximately 0.4 miles, and with a 20 foot width, in 1 acre (2,112 feet long by 20 feet wide). Flycatcher designated critical habitat occurs along the entire length of the Soil Cement Embankment, for 1.1 miles, and with a 20 foot width, in approximately 2.7 acres (5,808 feet long x 20 feet wide). However, the riparian vegetation is not currently suitable to support flycatcher critical habitat PCEs for breeding habitat (Ahlers et al. 2010).

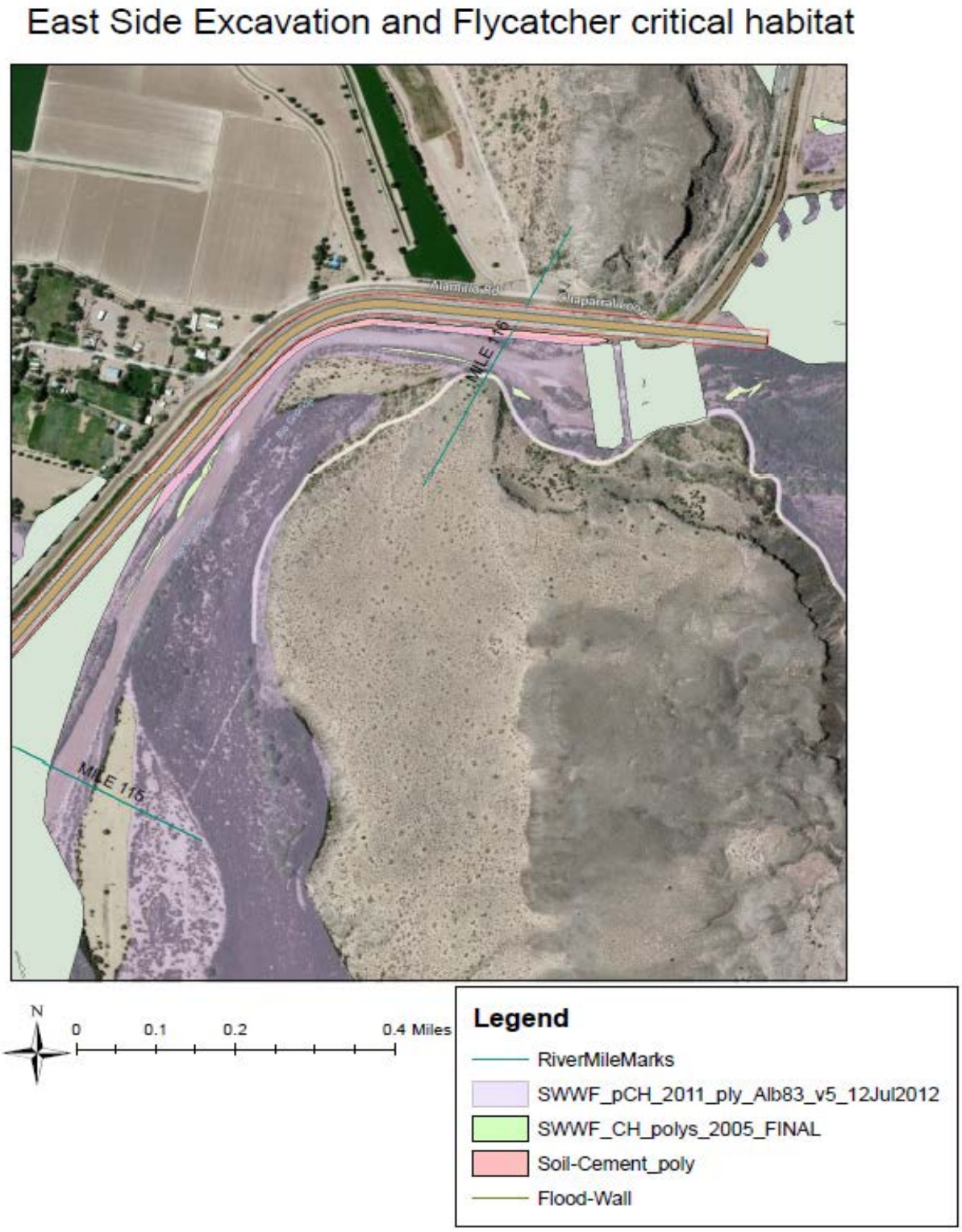

Figure 7. Location of the Temporary River Crossing and East Side Excavation below SADD and 2005 designated critical habitat and recently revised 2013 flycatcher designated critical habitat (i.e., SWWF_pCH_2011_ply_Alb83_v5_12_Jul2012).

Noise and Traffic Disturbance

Levee construction measures may not adequately minimize effects of disturbance (e.g., noise, dust, human activities or traffic) to flycatchers. The effect of the proposed action on traffic patterns along the spoil bank road or LFCC road were not quantified and are expected to increase significantly for the duration of the project (USACE 2012b). The effects of the proposed action on noise in the environment were not quantified and are expected to increase significantly for the duration of the project. The use of the spoil bank, levee, or riparian vegetation to provide adequate buffers between heavy equipment or other traffic and noise along roads within 0.25 miles was not quantified in the BA. Many flycatchers have routinely paired and nested in this area from River mile 77 through River mile 87, and many territories occur within 300 ft of the spoil bank. After consultation with the Service, Corps was able to provide additional information on strict disturbance prohibitions for heavy truck traffic and noise reductions necessary to protect flycatcher breeding behaviors.

Habib et al. (2007) assessed the impacts of noise on ovenbird (*Seiurus aurocapillus*) pairing success and found a significant reduction in pairing success at breeding sites affected by noise and disturbance compared with noiseless areas. Habib et al. (2007) hypothesized that noise interferes with a male's song, such that females may not hear the male's song at greater distances and/or females may perceive males to be of lower quality because of distortion of song characteristics. Therefore, chronic noise pollution could be an important factor affecting bird population distributions including those of flycatchers in the MRGV. The Service assumed that one flycatcher territory would not successfully establish a pair with nest in the area between River-mile 77 to 89, during each year that disturbances were not further ameliorated. As earthen levee installation will occur at a rates of approximately 2 miles per year, total disturbance impacts were estimated to affect at least one female pairing per year, that would not successfully pair with a territorial male due to noise and disturbance in the area between River-mile 77 to 89, or up to 6 flycatcher territories could be disturbed by activity in that 12 miles. While adhering to seasonal and geographic disturbance restrictions for flycatchers to the maximum extent, additional temporal restrictions on heavy truck traffic noise and disturbance during flycatcher breeding season should further minimize impacts to breeding flycatchers. However, flycatchers may nonetheless be adversely affected by traffic noise and disturbance. Therefore, flycatcher surveys will be necessary to determine the effectiveness of Corps conservation measures for heavy truck traffic.

Riprap Blankets

Seasonal and geographic restrictions and flycatcher surveys should limit effect on flycatchers. The loss of suitable flycatcher critical habitat PCEs in 4.9 acres (as described below) may adversely affect up to 2 flycatcher territories (based on 2.7 acres/territory and rounded up– see flycatcher status above). Corps calculated the area of suitable breeding habitat that would be affected by installation of riprap blankets (at 0.42 acres), as well as suitable habitat adversely affected by the vegetation free zone (at 2.03 acres) (i.e., combined total for riprap blanket installation and vegetation free zone is 2.45 acres).

The Service estimated that construction of the deep toe portions of the riprap would require dewatering of groundwater for approximately 6 miles for riprap blanket placement. The Service expects that as much 9,525,000 cubic feet (31,750 long * 25 wide * 12 deep), which is approximately 71,251,948 gallons or 219 acre feet of groundwater will be pumped from the ground below the riparian habitat. The width and length of groundwater extraction area totals 18.2 acres (31,750 * 25 = 793,750 square feet). Replenishment of groundwater and water tables may not be fast, resulting in the dehydration stress of riparian vegetation that may support breeding flycatchers. The duration and distance of the groundwater depletion effects in flycatcher breeding habitat were not estimated by Corps. Corps will develop a groundwater pumping plan prior to riprap placement. The timing, rate, water volume, and receiving area will be formulated to eliminate or reduce impacts to riparian vegetation to the extent possible. Therefore, the Service identified the area affected (2.45 acres) by installation of the riprap blankets and a similar area (based on width)associated with an initial area groundwater excavation associated riparian stress as estimated by the Service (2.5 acres) for the first riprap installation, along with Corps monitoring to determine effectiveness of their groundwater pumping plan.

The total affected area would be 4.9 acres and the breeding habitat flycatcher PCEs of dense riparian vegetation and insect prey populations may be temporarily adversely affected by groundwater excavation until such adverse effects are quantified and reduced by Corps groundwater pumping plan. If Corps groundwater pumping plan is found not effective, then as many as 18.2 acres could be adversely affected. The Service anticipates that only the initial riprap installation area (~2.5 acres) would be temporarily adversely affected by groundwater pumping, and expect Corps groundwater pumping plan to quantify and ameliorates adverse effects to the remaining areas potentially affected (18.2 – 2.5 acres = 15.7 acres). Therefore, 2.5 acres due to groundwater pumping will be temporarily adversely affected, and as described by Corps, 2.45 acres will be permanently adversely affected by riprap installation and vegetation free zone areas associated with riprap blankets.

The effect of activities that alter groundwater can lead to the reduction of water tables in or below riparian habitats that may support flycatchers (USFWS 2002, Parametrix 2008). High water tables in floodplains and near river channels sustain extensive growth of riparian vegetation that provide dense riparian habitat for flycatchers and insect prey populations. Receding water levels will likely stress or kill willows, depending on the extent or time they are dewatered by project dewatering activities and including any exacerbation by an ongoing drought. Groundwater pumping has resulted in water table declines along many rivers and can be a major factor in the quality of flycatcher habitat (Briggs 1996; USFWS 2002). The net result of lowered water tables has been declines in river flow, with stress, injury and loss of riparian vegetation. Under stress, dense tamarisk patches can be prone to fire that can directly affect flycatcher habitat (Paxton et al. 2008a). Reduced groundwater and water tables could affect riparian vegetation vigor, quality, and flycatcher survival and therefore, the proposed action may adversely affect flycatchers, flycatcher breeding habitat and potentially result in nest failure or flycatcher egg, nestling or fledgling death and breeding habitat abandonment in areas where substantial groundwater excavation occurs. Whenever flycatcher-breeding habitats become degraded, diminished, or fragmented, flycatchers will likely experience stress, a reduction of

fitness, reduced mating or nesting success, increased time and energy expenditures, or an impaired ability to defend nesting or wintering sites, which could ultimately result in a population reduction. As described above, up to 2 flycatcher territories may be adversely affected by modification of flycatcher breeding habitat. These critical habitats should be reviewed for any changes to the PCEs prior to initiation of construction phases that are associated with riprap installation and groundwater pumping through the year 2032.

Sluice Gate Installation at Brown Arroyo

Seasonal and geographic restrictions and flycatcher surveys should limit effects on flycatchers. The sluice gates and riprap blanket placement along Brown Arroyo occurs in 0.3 acres of designated critical habitat. Riparian vegetation in the form of salt cedar occurs there now. Only migrant flycatchers have been detected near there and the river channel nearby (Moore and Ahlers 2011). While the riparian vegetation is not currently suitable to support flycatcher critical habitat PCEs for breeding habitat, the inundated area (~0.1 acres) may provide insect prey populations. Temporary construction disturbance of 0.1 acres of inundated area are expected. However, permanent losses of inundated areas providing insect prey populations to flycatchers are not expected by installation of sluice gates at Brown Arroyo. These critical habitats should be reviewed for changes to the PCEs prior to initiation of construction in 2014.

Tiffany Basin Fill

Seasonal restrictions and flycatcher surveys will limit disturbance of flycatchers. However, heavy machinery may nonetheless affect flycatchers through noise and disturbance impacts as described in the Noise and Traffic Disturbance above. No flycatchers have been detected in the Tiffany Basin, although a few surveys have been conducted. Lone male flycatcher territories were detected within 0.25 miles of the edge of the Tiffany Basin Fill in 2006 and 2008, and six other similar territories were detected within 0.5 miles at approximately river-mile 72.5. If a flycatcher territory were to become established within 0.25 mi of the Tiffany Basin, there may be disturbance effects of year round trucking activity if spoil bank is an insufficient buffer.

Spoil from removal of the spoil banks and various excavations will be deposited up to 6.5 feet deep throughout this the Tiffany Basin, permanently rendering it suitable for upland, rather than riparian, vegetation for the duration of the project. The 300-acre spoil deposition area within the Tiffany Basin is currently vegetated by relatively dense stands of salt cedar but is currently unsuitable as flycatcher breeding habitat (Ahlers et al. 2010). The basin lies within the 10%-chance floodplain behind a continuation of the spoil bank. Any floods that may occur would likely affect the riparian vegetation in the Tiffany Basin. Riparian vegetation conditions would also be expected to change in ways described below over the 70-year project duration. For example, invasion by tamarisk beetles, effects of droughts, and potentially, fires, or floods are likely to change quantify and quality of riparian vegetation in the Tiffany Basin (also. see cumulative effects below). Conversion to uplands permanently removes 300 acres from flycatcher critical habitat designated critical habitat. However, the riparian vegetation is not currently suitable to support flycatcher critical habitat PCEs for breeding habitat (Ahlers et al. 2010). These critical habitats should be reviewed for changes to the PCEs routinely during the duration of activities until 2032.

Earthen Levee Installation, Footprint, Vegetation Free Zone, and Levee Hydrology Impacts

Seasonal and geographic restrictions and flycatcher surveys during levee installation should guarantee no physical disturbance of flycatchers. Corps Operation and Maintenance (O&M) manuals provided to project sponsors that integrate endangered species monitoring and measures protective of endangered species and their habitats during O&M activities should guarantee no physical disturbance of flycatchers or additional habitat impacts in the future. Removal of vegetation by levee footprint and after levee installation, from the vegetation free zone 15 feet into the floodway would adversely affect vegetation that contributes to flycatcher critical habitat PCEs within the floodway. The proposed action removes 58.9 acres of riparian vegetation during levee installation and in vegetation free zone, ultimately converting 29.5 acres of riparian vegetation into grasslands. Corps identifies the revegetation of 16.4 acres riparian habitat as a conservation measure in the BA (Table 5.1, page 74), and the Service assumed these 16.4 acres were part of the 50.4 total acres later identified by Corps (2012e). Corps estimates that a total of 8.41 acres is currently suitable for flycatcher breeding habitat and provides the entire flycatcher critical habitat PCEs. Of those 8.4 acres, 5.7 acres of suitable flycatcher habitat are adversely affected by the vegetation free zone and 2.7 acres are adversely affected by the area of installation of the new levee in an area called the footprint. Permanent removal of suitable flycatcher habitat without offsetting measures, minimization and/or mitigation of PCEs modify flycatcher critical habitat. Corps proposed action (USACE 2013) will provide 50.4 acres of suitable flycatcher habitat to offset levee installation footprint and vegetation free zone impacts.

The effects of the levee, the inspection and slurry trenches, the levee drainage features, the levee interception of precipitation, and the subsequent reduction of riparian areas inside the floodway on groundwater levels, if any, were not quantified in the BA (USACE 2012a) or in the SEIS (USACE 2012b). Changes in groundwater levels or changes in hydrology can be detrimental to riparian vegetation and riparian vegetation establishment (USFWS 2002; Parametrix 2008). Whether the slope of the new levee, including its riprap blankets, and soil cement embankment, or vegetation free zones alter the amount of precipitation or infiltration under, on, or around the levee, and extent those hydrological changes may have on groundwater levels are unknown.

Levee Exacerbation of Sediment Accumulation and Impacts to Riparian Vegetation

Over the duration of the San Acacia Levee Project, the accumulation of sediment in the floodway exacerbated by the levee will result in a further increase in the physical separation of riparian vegetation from groundwater that is necessary for flycatcher habitat. The existing spoil bank, as well as the proposed San Acacia Levee Project levee, both restrict the lateral extent of the floodplain into the Floodway by approximately 50 percent its former width below Highway 380. With the floodable area approximately reduced by half (i.e., into the managed floodway) and with a historically similar sediment load, dynamics, and deposition by the Rio Grande and its tributaries, the vertical accumulation of sediment approximately doubles in elevation/height. Over the last 50 years, floodway elevations have raised by up to 12 feet as exacerbated by the spoil bank. However, once replaced, the proposed San Acacia Levee Project will continue to raise it up to 11 feet more in the San Acacia Levee Project area (USACE 2012b). Note that wherever the spoil bank remains, and for however long it lasts, the spoil bank would continue to

exacerbate sediment accumulation within the floodway into the future (USACE 2012d, e). Nonetheless, the functional life of the spoil bank, given its current height, and the height of flood flows, suggests that the spoil bank is not likely to last beyond 2040. Spoil bank integrity is currently maintained by Reclamation and MRGCD (USBR 2001; 2012), but heroic measures are inadequate to prevent its likely breaching or eventual overtopping (USACE 2012b and Table 3).

Even with an entirely unobstructed or unconstrained floodplain (i.e., both the historical and active floodway), the natural mass load of sediment delivered by the Middle Rio Grande would likely spread out, aggrade, and accumulate in vertical height approximately half (0.25 feet/year) that of the projected accumulation depth of approximately (0.5 feet per year) of the spoil bank/levee (USACE 2012b). The Service discounted the natural vertical accumulation of floodway height (Table 4) from its effects analysis. Nonetheless, with average depth to groundwater ranging from 8 to 12 feet below the average height of the floodway elevation, it suggested that riparian vegetation was currently stressed (Table 5) and increasing the height of the floodway would continue to stress riparian vegetation and result in flycatcher habitat loss in the future. Service estimates of sediment accumulation in the San Acacia Project Area by 2079, suggested high sediment accumulation (Figure 8).

The effect of earthen levees indirectly adversely affects the depth to groundwater in or below riparian habitats that may support flycatchers (Van Cleave 1935; Crawford et al. 1993; USFWS 2002, 2013; Parametrix 2008; Isaacson 2009; Gunning 2010; Merritt and Bateman 2012). High water tables in floodplains and near river channels sustain extensive growth of riparian vegetation that provide dense riparian shrub habitat for flycatchers and insect prey populations. Receding groundwater levels will likely stress or kill willows, depending on the extent or time they are dewatered and including any exacerbation by an ongoing drought and the effects of water operations and flood control activities upstream. The net result of lowered water tables has been declines in river flow, with stress, injury and loss of riparian vegetation and reduced seedling establishment and survival of native riparian vegetation.

Assuming an average increase in the depth to groundwater in the future (Table 4) and an average increase in floodway sediment accumulation resulting terrace heights that may no longer be able to be colonized by riparian vegetation that constitutes of flycatcher habitat, the Service estimated the total future flycatcher habitat loss to be approximately 2,010 acres, and attributed between 195 to 460 acres of that flycatcher habitat loss due to specifically to the San Acacia Levee Project and the remainder to the spoil bank (Table 7). (See USFWS 2013 for additional information). Corps (2012e; Corps 2013) and the Service have identified uncertainties associated with these analyses and have described a method of analysis to arrive at a more certain estimate of flycatcher habitat impacts due to sediment accumulation. Corps and the Service (Corps 2013) agreed that the likely range of impacts to flycatcher habitat would range from 50.4 to 200 acres, subject to additional analyses to reduce the uncertainties associated with these estimates.

In addition, there are an uncertain number of flycatchers and flycatcher habitats affected by levee exacerbated sediment accumulation, for the duration of the project. We have estimated that the continued accumulation of sediment in the floodway will result in the loss of flycatcher habitat over time. Though we can estimate this loss, it there are many factors affecting sediment

accumulation which are uncertain. The sediment accumulation is not anticipated to result in the loss of flycatcher habitat until (1% by 2019, 3% by 2029, or 28% by 2079), and it is reasonably certain to result in the loss of habitat that would sufficiently support 20 flycatcher territories by 2029 (i.e., 3%, ~53 acres/2.7 acres/flycatcher territory). As a proposed conservation measure for this project, the Corps is proposing to create between 50.4 acres of replacement habitat that would partially offset the 2029 loss. The Corps has also proposed additional scientific analysis, monitoring and modeling to increase certainty in the loss expected by 2079 with offsetting measure equal to that loss described and to support further ESA consultation.

In summary, sediment accumulation in the floodway, particularly in the southern reaches below Highway 380, is exacerbated by levees' constriction of the floodable area, and will raise the floodway elevations above the water table that is necessary to sustain and establish robust riparian vegetation throughout the floodway that is used by flycatchers. Over the San Acacia Levee Project duration, the floodway elevation will increase up to 12 feet in some locations but the range of sediment accumulation and subsequent estimates of impacts to flycatcher habitat in the future were uncertain. Additionally, sediment accumulation and groundwater levels will likely be influenced by regional droughts, groundwater withdrawals, and by land use, water operations and flood control activities in the upstream watershed. Nonetheless, the potential loss of up to 200 acres of suitable flycatcher habitat, identified as critical to its long term survival and recovery (USFWS 2005, 2011c) within the floodway could adversely affect flycatcher survivorship and recovery in the San Acacia Reach.

Riparian vegetation as it currently exists will likely change over the duration of the proposed action. Therefore, the qualities of riparian habitat that may be affected and would be expected to change over the next 70 years. The current flycatcher habitat suitability determinations used by the Service in this Opinion (Ahlers et al. 2010) would be expected to change over time.

Table 4. Corp (2012b) estimate of sediment accumulation in the San Acacia Levee Project Area, amount of sediment accumulation exacerbated by spoil bank/levee, and Service estimates of ground water depths currently and as compared to expected sediment accumulation heights in the future.

San Acacia Reach Sites as listed in Table 3.1 of the USACE (2012b) GRR/SEIS II, Page 3.8, which quantifies changes in sediment accumulation in the action area.	Service *discounted* 50 percent of sediment accumulation as was described by USACE (2012b) to 1/2 height of increase over next 50 years due to natural conditions. This column reflects only half of the sediment accumulation, in feet.	Using groundwater levels in the San Acacia Reach as described by SSP&A (2002), Parametrix (2008), Beman (2012), the Service estimated groundwater levels (in feet below surface) and extrapolated that range for depth to water for the average Floodway elevation (Note: ground water fluctuations, drought, & reduced flow would increase depth to GW) (feet).	Service added column 2 (left) for 50% of sediment accumulation to the average depth to ground water below the Floodway to estimate its depth within 50 years, in feet.
17 BdA	0.9	8 to 12	9 to 13
18 BdA	1.3	8 to 12	9.3 to 13.3
19 BdA RM 78	2.2	8 to 12	10.2 to 14.2
20 BdA	3.1	8 to 12	11.1 to 15.1
21 Tiff	3.8	8 to 12	11.8 to 15.8
22 SM	5.6	8 to 12	13.6 to 17.6

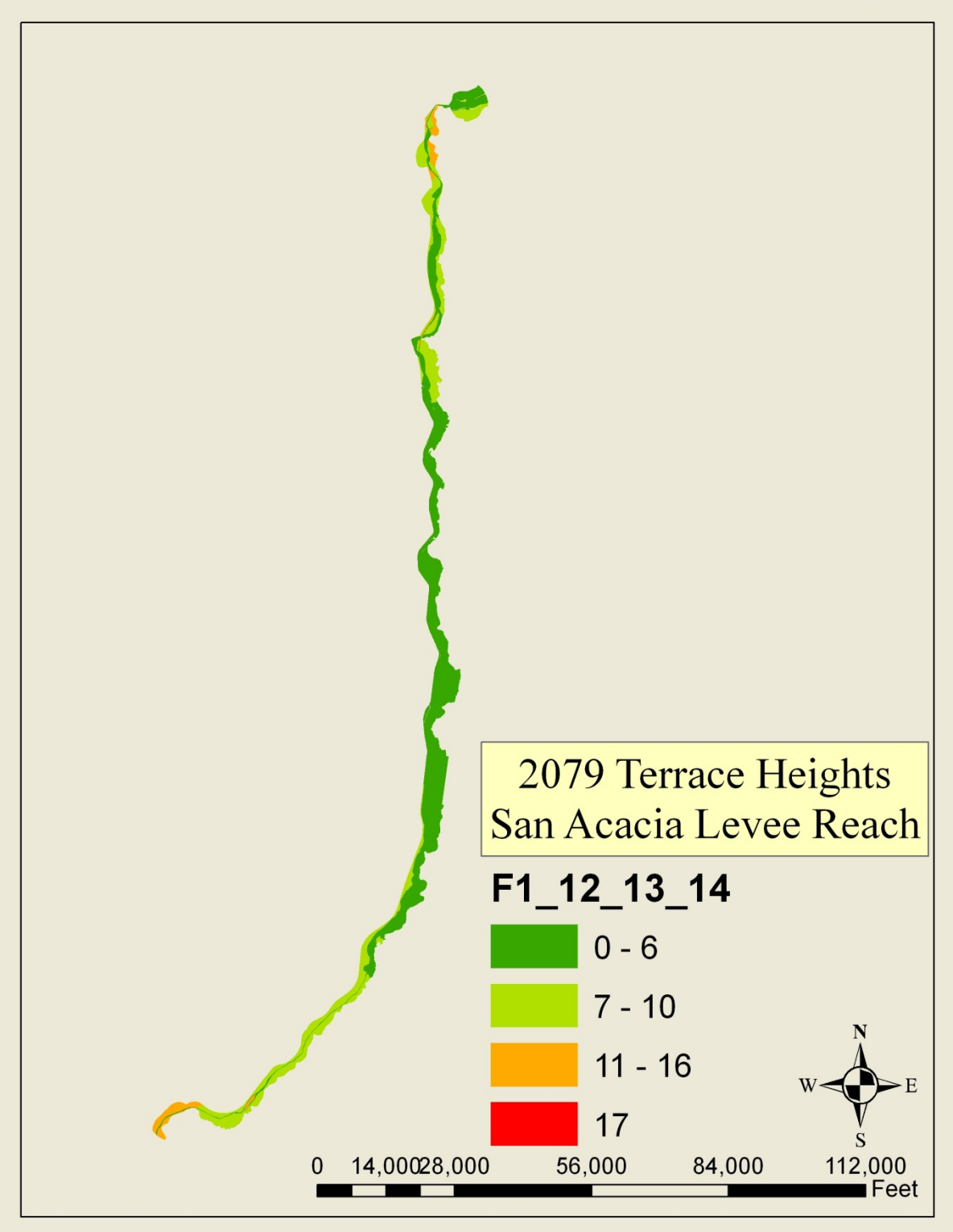

Figure 8. Service estimate of sediment accumulation by location and height over 50 years. Note: 'F1_12_13_14' legend means elevation in feet, with colors representing ranges of floodway terrace height elevations in feet due to sediment accumulation.

Table 5. Depth to groundwater for native and nonnative riparian vegetation in the Middle Rio Grande resulting in healthy, stressed, crown dieback or mortality, in feet.

Riparian species & separation from groundwater effect	Healthy (feet)	Stressed (feet)	Crown dieback (feet)	Mortality (feet)
willows	0 – 6.5	6.6 – 7.4	7.5 – 9.8	> 10
cottonwood	0 – 7.4	7.5 – 9.8	9.9 – 16.4	> 16
tamarisk	0 – 7.4	7.5 – 8.2	> 8.2	> 100
(Sources: Horton et al. 2001, Parametrix 2008, Caplan et al. 2012)				

Table 6. Average (and 95% confidence interval) of Percentage of flycatcher habitat 50 m near channel areas or in overbanking areas (see Ahlers et al. 2010 for methods, description, subreach site locations and names)

Amounts of suitable and moderate flycatcher habitat (Ahlers et al. 2010) for each subreach within San Acacia Reach	Percentage Suitable or Moderate flycatcher habitat outside 50 m or during overbanking	Percent Suitable or Moderate Habitat within 50 m near channel or during overbanking	Percentage flycatcher habitat outside 50 m of river channel or overbanking areas
SV/LJ-Suitable (S)	7	2	71
SV/LJ-Moderate (M)	19	8	56
San Acacia S	2	1	50
San Acacia M	9	4	56
Escondida M	7	5	29
BdA S	1	1	0
BdA M	16	16	0
Tiffany S	4	3	25
Tiffany M	5	2	60
San Marcial S	16	10	25
San Marcial M	14	6	57
Average and 95 percent confidence interval of suitable or moderate flycatcher habitat outside of 50m and outside of overbanking.			40% (95%CI = 195 to 460 acres)

Riparian Areas West of Levee

Flycatchers are known to use riparian areas in and near the LFCC for migratory stopover habitat (Yong and Finch 1997). Extension of the levee toe and the vegetation free zone toward the LFCC on the west side is expected to affect riparian vegetation there. The Service estimates that approximately 32 acres of riparian vegetation may be adversely affected and could affect flycatchers that utilize the area. Corps has committed to flycatcher surveys along this west edge to determine the potential effects to nesting flycatchers in this area.

The Service (USFWS 2013) designated approximately 9,333 acres of critical habitat for the flycatcher in the historical floodplain west of the levee. With construction of the engineered levee, the historical floodplain is effectively removed west of the levee by the proposed action from any flood events greater than 1 percent chance event (e.g., a 500-year flood). Therefore, the proposed action potentially removes all possible flooding or avulsion events contributing to flycatcher critical habitat and may foster development, including groundwater pumping, on the historical floodplain west of the levee. Substantial increases in urban and residential development within the historical floodplain may lead to additional groundwater wells, as such individual wells are often not monitored, and cumulative effects of individual wells to groundwater levels are unknown. Riparian critical habitat in this area was dependent on the location of the nearby river channel, floodplain soils, subsurface water, floodplain shape, and was driven by the wide variety of high, medium, and low flow events. Flooding was part of flycatcher critical habitat there as it occurred at periodic frequencies that recharged aquifers, deposited and moisten fine floodplain soils, which conditions created seedbeds for riparian vegetation germination and growth within the critical habitat boundaries. Soils from historic flooding still contribute to the nutrients, minerals, and substrate used by riparian vegetation and agricultural crops that grow there today. Reduction or elimination of flooding has the potential for impoverishing flood recession cropping, groundwater recharge, natural vegetation, wildlife and livestock population in the flood plain that are adapted to the natural flood cycles.

Critical habitat areas to the west of the levee were based upon data sources including delineating the lateral extent of the riparian zones for using the National Wetlands Inventory (NWI) digital data from the mid 1980's, 2001, 2002; and (2) Federal Emergency Management Agency (FEMA) 1995, Q3 100 year flood data, and other data. With construction of the engineered levee, the historical floodplain is effectively removed west of the levee by the proposed action from any flood events greater than 1%. In addition, development will progress without the burden of individual flood insurance or implementing regulations. Therefore, the proposed action removes the majority of all possible flooding or avulsion events, and fosters development, including groundwater pumping, that may affect flycatcher critical habitat on the agricultural floodplain west of the levee. The current status of flycatchers in the Middle Rio Grande Management Unit, its abundance (>300 territories) and suitable habitat (Ahlers et al. 2010) within the floodway suggests that the lack of flooding in the historical floodplain and its critical habitat are not, at this time, critical to the recovery of the flycatcher regionally. Additionally, flycatcher critical habitat in the historical floodplain may be sustained by other sources of water or groundwater.

San Acacia Levee Project Effects Summary:

Construction, operation and maintenance of the levee project are expected to result in adverse effects to silvery minnow and 13.5 acres of its designated critical habitat. Adverse effects to individual silvery minnow (436 individuals estimated to be affected) in the form of harassment are anticipated. In addition, the Service has predicted adverse changes to PCEs of designated critical habitat will result from the earthen levee, vegetation free zone, soil cement embankment, riprap blanket, sluice gates at Brown Arroyo, the East Side Excavation, and the temporary river crossing, some of which are temporary and 13.5 acres others permanent. The Corps is proposing to create 2.2 acres of in-channel silvery minnow habitat.

Construction, operation and maintenance of the levee project are expected to result in adverse effects to 11 flycatcher territories and between 60 to 200 acres of its suitable and designated critical habitat. The Corps has proposed to create 50.4 acres of flycatcher breeding habitat which will assist in minimizing adverse effects of the levee project. Traffic near flycatcher territories is estimated to adversely affect 6 territories. The loss of habitat due to groundwater effects resulting from the riprap blanket installation is anticipated to adversely affect 2 flycatcher territories and permanently impact 2.45 acres of designated flycatcher critical habitat. Construction of the levee and the vegetation-free zone will result in the temporary loss of 58.9 of critical habitat and permanent loss of 8.41 acres. The Service's analysis predicted the potential of the levee to alter flycatcher critical habitat PCEs of up to 460 acres as a result of the sediment accumulation in the floodway and riparian vegetation separation from groundwater. However, the uncertainty associated with this analysis in attempting to predict effects of the proposed levee that are decades into the future calls for a monitoring, modeling and continued scientific analysis. The effect of the levee-induced sediment accumulation on flycatcher critical habitat to the year 2029 is more certain and is within an estimated range of 50 to 200 acres.

Cumulative Effects

Cumulative effects include the effects of future state, tribal, local or private actions that are reasonably certain to occur in the action area. Future federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to Section 7 of the ESA. This Opinion summarizes, in general terms, the types of activities that are likely to occur, based on continuation of existing actions and likely future development.

Human Population, Land, and Water Use Changes

Population in the Middle Rio Grande Valley (including Socorro) has doubled every twenty years since the 1950s and will continue to grow. Growth has been driven by high birth rates, higher infant survival rates, and immigration. Other factors include increased border and military installation activities, increased manufacturing in a free trade zone, and increased availability of agricultural and industrial jobs, as well as affordable housing, a high standard of living, and availability of freshwater (Schmandt 2010). Increasing urbanization and development within the historic floodplain would continue to eliminate remnant riparian areas located outside the levees, while putting increased pressure on the riparian habitat and wildlife (USFWS 2001, 2011c).

Irrigated land will likely shrink in the MRGV due to market forces and urbanization. Because irrigation uses over 75 percent of surface river water a reduction in agricultural land use may have important impacts on future water demands. Changes in irrigation use may also have significant impacts on surface and groundwater hydrology, agricultural economic activities, and population growth. Drought resistant or less water-intensive crops and improved irrigation techniques (e.g., lining of canals, use of modern sprinkler systems, floodwater capture) may result in substantial surface water conservation without economic loss (Schmandt 2010). Municipalities will also likely increase water conservation, reuse, recycle, and improve water quality, as well as repair of leaky distribution systems (Schmandt 2010). Regional water markets may be developed to facilitate the transfer of water rights from agricultural to municipal uses (Schmandt 2010), particularly during multiyear droughts (Schmandt 2010). Overall water quality may continue to decline and salinity increase such that riparian habitats may be further imperiled. Methodologies for developing flow recommendations and managing rivers could result in some improvements to salinity levels and sustained riparian vegetation. Desalinization of water may also become cost effective or agricultural production may also be severely constrained and reduce salt load in the future (Schmandt 2010).

General cumulative effects will likely continue to include:

- Increases in development and urbanization in the historical floodplain that result in reduced peak flows because of the flooding threat. Development in the floodplain makes it more difficult, if not impossible, to transport large quantities of water that will overbank and create low velocity habitats for silvery minnows and flycatchers.

- Increased urban use of water, including municipal and private uses. Further use of surface water from the Rio Grande will reduce river flow and decrease available habitat for the silvery minnow and flycatcher.

- Human activities that may adversely impact the flycatcher by decreasing the amount and suitability of habitat include dewatering the river for irrigation; increased water pollution from non-point sources; habitat disturbance from recreational use, and urban development.

- Wildfires and wildfire suppression in the riparian areas along the Lower Rio Grande may have an adverse effect on flycatchers. Wildfires can be common occurrence in the bosque (riparian area) along the Rio Grande. The increase in wildfires has been attributed to increasingly dry, fine fuels and ignition sources. The spread of the highly flammable plant, tamarisk, and drying of river areas due to river flow regulation, water diversion, lowering of groundwater tables, and other land practices is largely responsible for these fuels. Wildfires have the potential to injury silvery minnow and destroy flycatcher habitat.

- The removal of non-native vegetation, such as salt cedar by tamarisk beetles will adversely affect the amount of available flycatcher habitat in the short term. In areas where non-native trees are removed and replaced with native vegetation as part of a restoration project, habitat may be created. Where phreatophyte removal or tamarisk beetle defoliation is not followed by restoration, habitat for the flycatcher and support of the PCEs of silvery minnow critical habitat will be reduced.

- The effect global warming may have on the flycatcher and silvery minnow is still unpredictable. Higher temperatures lead to higher evaporation rates that may reduce the amount of runoff, groundwater recharge, and lateral extent of rivers such as the Rio Grande. Increased temperatures may also increase the extent of area influenced by drought (Lenart 2003). Increased temperatures will directly affect silvery minnow development (Davis and Lusk 2012)

The Service anticipates that these conditions and types of activities will continue to threaten the survival and recovery of the silvery minnow and flycatcher by reducing the quantity and quality of habitat through the continuation and expansion of habitat degrading actions.

VI. CONCLUSION

After reviewing the current status of the silvery minnow and the flycatcher, the environmental baseline for the action area, the anticipated effects of the proposed action, and the cumulative effects, it the Service's biological opinion that the Corps proposed action of construction, operation and maintenance of the Rio Grande Floodway, San Acacia to Bosque del Apache Unit, as proposed in the May 8, 2012 BA and subsequent correspondence with the Service during this consultation, is not likely to jeopardize the continued existence of the silvery minnow or the flycatcher. In addition, the project is not likely to adversely modify or destroy designated silvery minnow critical habitat or designated flycatcher critical habitat. We expect the level and type of take associated with the project in unlikely to appreciably diminish the population of the silvery minnow or the flycatcher in the San Acacia reach or for the species as a whole.

INCIDENTAL TAKE STATEMENT

Section 9 of the Act and federal regulation pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by the Service to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. Harass is defined by the Service as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act provided that such taking is in compliance with the terms and conditions of this incidental take statement.

The measures described below are non-discretionary, and must be undertaken by Corps so that they become binding conditions of any grant or permit issued, as appropriate, for the exemption in section 7(o)(2) to apply. The action agency has a continuing duty to regulate the activity covered by this incidental take statement. If Corps (1) fails to assume and implement the terms and conditions or (2) fails to require adherence to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, Corps must report the progress of the action and its impact on the species to the Service as specified in the incidental take statement. [50 CFR §402.14(i)(3)].

Amount or Extent of Take Anticipated

The Service anticipates incidental take of 436 silvery minnows (79+238+119) in the form of harassment during installation of silt curtains or cofferdams for construction of the temporary river crossing, the floodwall and soil cement embankment, and the sluice gates at Brown Arroyo.

The Service anticipates take of 6 flycatcher territories in the form of disturbance due to traffic within 0.25 mile of flycatcher territories, and take of 2 territories in the form of disturbance caused by loss of suitable habitat due groundwater changes during riprap blanket installation. Loss of 8.41 acres of flycatcher critical habitat due to construction of the levee and the vegetation-free zone will result in an additional loss of 3 flycatcher territories. Between 50 and 200 acres of additional flycatcher critical habitat is projected to be lost due to levee-exacerbated sediment accumulation in the floodway, but this effect is minimized by the creation of 50.4 acres of flycatcher breeding habitat. Therefore, no incidental take was assigned to this loss of habitat.

Effect of Take

The Service has determined that this level of anticipated take is not likely to result in jeopardy to the silvery minnow or the flycatcher. The proposed action is likely to have adverse effects on individual silvery minnows but those effects are not anticipated to result in any long-term consequences on the population. Incidental take of silvery minnows will result from harassment and harm of any individuals that may occupy habitats disturbed by deployment of silt curtains or cofferdams or even heavy equipment or that may occupy critical habitat that becomes permanently or temporarily lost. The proposed action is likely to have adverse effects on individual flycatcher territories but those effects are not anticipated to result in any long-term consequences on the population. Incidental take of flycatchers will result from disturbance of territories caused by the noise and dust created by heavy equipment and other traffic on adjacent dirt roadways and degradation or loss of suitable habitat over the duration of the proposed action.

Reasonable and Prudent Measures

The Service believes the following Reasonable and Prudent Measures (RPMs) are necessary and appropriate to minimize impacts of incidental take of flycatcher and silvery minnow due to activities associated with the proposed action.

1. Conduct flycatcher and flycatcher habitat surveys and monitor flycatcher critical habitat.

2. Minimize take of flycatchers due to construction activities occurring within 0.25 mile of occupied habitat.

3. Minimize take of flycatchers due to habitat degradation or loss caused by the proposed action.

4. Minimize take of silvery minnows due to construction activities.

5. Reduce likelihood of take of silvery minnow and flycatcher for project duration (currently until 2082).

Terms and Conditions

Compliance with the following terms and conditions must be achieved in order to be exempt from the prohibitions of section 9 of the ESA. These terms and conditions implement the RPMs described above. These terms and conditions are non-discretionary.

To implement RPM 1, Corps shall:

1.1. Conduct flycatcher protocol surveys covering the floodway west of the Rio Grande channel from 0.5 mile north of San Acacia Diversion Dam to the San Marcial railroad bridge. These surveys shall commence in the breeding season prior to anticipated construction in a given segment of the action area, and shall continue annually through the third breeding season following construction in each given segment (USACE 2012d).

1.2. Conduct flycatcher protocol surveys performed by biologists that possess a Section 10(a)(1)(A) permit, and report to the Service in accordance with the permit. (USACE 2012d).

1.3. Monitor groundwater pumping for construction activities in the floodway to determine its effect on riparian habitats. (USACE 2012d).

1.4. Conduct flycatcher protocol surveys within critical habitat located within 0.25-mile west of the Low Flow Conveyance Channel canal, from the San Acacia Diversion Dam to Tiffany Junction. These surveys will be conducted for a single breeding season, and should be commensurate in time to flycatcher surveys within the floodway for a given construction-segment of the action area. (USACE 2012d).

1.5. The Corps will monitor groundwater-surface water interaction and dynamics in the San Acacia reach per 3.5 below; and will assist resource management agencies in the analysis, modeling, planning, and adaptive management of activities relating to future sediment, habitat, and flow issues.

To implement RPM 2, Corps shall:

2.1 Construction may occur throughout the calendar year; however, no construction would be performed within 0.25 mile of occupied flycatcher territories during the breeding season; that is, from the date of the second protocol survey of the season through August 15. Construction traffic may continue year-round along the LFCC maintenance roads.

2.2 Each Corps construction contract will include requirements that ensure the contractor's compliance with all pertinent terms and conditions of the Service's Incidental Take Statement; pertinent information on the presence or locations of flycatchers; and requisite work restrictions. As needed, the Corps will formally update pertinent information and requirements throughout the duration of the contract. (USACE 2012d).

2.3 If traffic or other proposed action activities do occur within the 0.25-mile radius of a breeding territory, then those territories/nests will be monitored according to standard protocols, but at least every two weeks to determine continued occupancy.

To implement RPM 3, Corps shall:

3.1 Coordinate development of 50.4 acres of flycatcher habitat with the Service's NMESFO prior to implementation. If habitat is proposed to be developed on National Wildlife Refuge lands, the Corps will also coordinate with the Service's Refuges. If applicable, the Corps will obtain Refuges approval before proceeding.

3.2 Prepare and implement a flycatcher habitat mitigation and adaptive management plan for the San Acacia Reach. The plan will include Best Management Practices to minimize effects to the flycatcher, and its critical habitat. The plan will identify specific areas for habitat management with a schedule for completing development of 50.4 acres of dense riparian shrub habitat possessing primary constituent elements of critical habitat. The habitats shall be developed prior to, or immediately following, the loss of critical habitat due to specific construction activities of the proposed action. The plan will be reviewed and approved by the Service and should be completed by December 31, 2014. (USACE 2012e).

3.3 Assure that the water used for dust suppression will not harm nesting or migrating flycatchers. (USACE 2012d).

3.4 Utilize results obtained during implementation of RPM 1 to limit effects on flycatcher habitat.

3.5 The uncertainty surrounding the impact of the levee project-exacerbated sediment accumulation on flycatcher habitat will be clarified through a program of monitoring, modeling, and scientific analysis conducted by the Corps once construction has started. Methods for calculating the habitat area that may be at risk due to aggradation follow:

3.5.1 Mitigation of habitat is described as creating or managing the number of acres to provide a functioning flycatcher habitat for the duration of the project. Creation of newly built habitat is not necessarily required.

3.5.2 Calculation Methods: Corps, in coordination with the Service's New Mexico Ecological Services Field Office shall determine distance from levee that vegetation may be affected by increased depth to the water table.

3.5.3 Corps shall project surface aggradation from USACE's 50 yr projections and estimate the future ground elevations.

3.5.4 Corps shall compare information gained from 3.5.1 and 3.5.2 with most current suitable and moderately suitable habitat information.

3.5.5 Based on a program of monitoring, modeling, and scientific analysis, the Corps shall determine and develop commensurate mitigation for the duration of the project.

To implement RPM 4, Corps shall:

4.1 Coordinate development of silvery minnow habitat with the Service's NMESFO prior to implementation. If habitat is proposed to be developed on National Wildlife Refuge lands, the Corps will also coordinate with the Service's Refuges. If applicable, the Corps will obtain Refuges approval before proceeding.

4.2 For bankline construction, the Corps, in coordination with the Service, will establish and implement a design standard applicable to deployment of erosion control screens (e.g., silt curtains or wattles, etc.) that insure protection of water quality. For in-river construction, the Corps, in coordination with the Service, will establish and implement a coffer dam design standard applicable to prevent fish access to the construction site and insure protection of water quality. Coffer dams and erosion protection screens will be inspected daily to maintain the connection to the substrate and will be removed following construction. (USACE 2012d).

4.3 Prepare and implement a silvery minnow habitat mitigation and adaptive management plan for the San Acacia Reach. The plan will include Best Management Practices for construction to minimize effects to the silvery minnow, and its critical habitat. The adaptive management section will provide recommendations for silvery minnow and habitat monitoring focused on reproduction and recruitment. The plan will identify specific areas for habitat management with a schedule for completing construction of a minimum of 13.5 acres of silvery minnow critical habitat possessing the primary constituent elements. The habitats shall be constructed prior to, or immediately following, the loss of critical habitat due to specific construction activities in the proposed action. The plan will be reviewed and approved by the Service and should be completed by December 31, 2014. (USACE 2012d,e).

4.4 Fish sampling will be conducted by biologists that possess a Section 10(a)(1)(A) permit, and report to the Service in accordance with the permit. (USACE 2012d).

4.5 Monitor groundwater pumping for construction activities in the floodway to determine its effect on aquatic habitats (USACE 2012d). Oxygen content in excavated groundwater will be measured to ensure no hypoxic conditions occur. The Corps will develop a groundwater pumping plan prior to riprap placement. The timing, rate, water volume, and receiving area will be formulated to aerate groundwater to eliminate impacts to aquatic life, riparian vegetation and river levels to the extent possible. The Corps would immediately confer with the Service if hypoxic conditions occur in the Rio Grande as a consequence of groundwater pumping to the river (including runoff across the floodplain). (USACE 2012d).

4.6 Assure that water used for dust suppression does not reduce water availability for silvery minnow; assure the quality of water used for dust suppression; use water from sources other than those used by silvery minnow; if water must be removed from the low flow conveyance channel, assure no impact to the low flow conveyance channel pumping program. (USACE 2012d).

4.7 Monitor pH as part of the soil cement construction. Samples from the river channel, within the coffer dam, and on the soil cement to detect changes due to soil cement through the curing process. Monitoring data will be reported to the Service to demonstrate complete curing of the soil cement will not alter river pH upon contact with the surfaces. (USACE 2012d).

4.8 Prepare and implement a study to document water temperature daily and seasonally upstream and downstream where river is in contact with riprap. Water temperature conditions associated with the riprap blankets will be monitored upstream and downstream daily and seasonally to determine the water temperature effects associated with the riprap in silvery minnow habitats. The Corps will evaluate the

thermal effects of riprap and slackwater habitat on river water temperature to ensure no detrimental effects to silvery minnow occur.

4.9 Each Corps construction contract will include requirements that ensure the contractor's compliance with all pertinent terms and conditions of the Service's Incidental Take Statement; pertinent information on the presence or locations of silvery minnow; and requisite work restrictions. As needed, the Corps will formally update pertinent information and requirements throughout the duration of the contract. (USACE 2012d).

4.10 Report to the Service finding of any injured, rescued, or dead silvery minnows associated with project activities (USACE 2012d).

To implement RPM 5, Corps shall:

5.1 Develop an Operation and Maintenance (O&M) manual, in coordination with the Service's NMESFO, prior to turning the project over to the project sponsors

5.2 Include in the O&M manual requirements that the project sponsor integrates endangered species monitoring and measures protective of endangered species and their habitats during its O&M activities; recommendations to coordinate with Service's NMESFO regarding any emergency repair work; and coordinates with and reports to the Service's NMESFO on its O&M activities. These requirements will include standard Corps' best management practices (BMPs), the BMPs developed specifically for this project, and avoidance periods. (USACE 2012d).

For all RPMs, Corps shall monitor the implementation of the RPMs and their associated terms and conditions, and report their status to the Service's NMESFO annually, no later than February 20 for the previous calendar year's report. Ensure that the Service receives electronic copies of all reports and plans related to implementation of these RPMs and terms and conditions, including but not limited to species monitoring/surveying, habitat and water quality monitoring, flycatcher habitat management plan, silvery minnow habitat management plan, and site specific construction and mitigation designs. These reports should reference Consultation # 02ENNM00-2012-F-0015 and should be sent to the email address nmesfo@fws.gov or by mail to the New Mexico Ecological Services Field Office, 2105 Osuna Road NE, Albuquerque, New Mexico 87113.

Conservation Recommendations

Section 7(a)(1) of the ESA directs Federal agencies to utilize their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information. The Service recommends the following conservation activities:

1. Encourage adaptive management of flows and conservation of water to benefit silvery minnow, flycatcher, New Mexico jumping mouse, and yellow-billed cuckoo habitat in the Middle Rio Grande.
2. Enhance spring flows in the Middle Rio Grande.
3. Return LFCC low flows to the river channel.
4. Increase the frequency and duration of flooding events in the floodway.
5. Time high flow with native plant species seed dispersal.
6. Implement recommendations for the San Acacia Reach (Parametrix 2008).
7. Increase groundwater storage (focus on east side of the Floodway).
8. Establish management tools to work within climatic variation of water availability expected within the life of the San Acacia Levee Project.
9. Work to secure long-term water sources to support habitat restoration activities in the Middle Rio Grande.
10. Restore channel function, form, and processes.
11. Maintain the cottonwood bosque and re-establish cottonwood regeneration.
12. Address floodplain structural encroachment.
13. Monitor groundwater levels, as needed
14. Create wetlands and marshes within the Floodway.
15. Lower abandoned terraces within the Floodway.
16. Enhance groundwater storage and interaction.
17. Remove jetty jacks.
18. Eliminate structural limitations on flooding.
19. Manage future development in the floodplain.
20. Conduct surveys for Pecos sunflower in advance of construction cycles and use the information to support its conservation.
21. Investigate opportunities to transplant Pecos sunflower into project area.

RE-INITIATION NOTICE

This concludes formal consultation on the action(s) described in the May 9, 2012 Biological Assessment of Rio Grande Floodway, San Acacia to Bosque del Apache Unit. As provided in 50 CFR § 402.16, re-initiation of formal consultation is required where discretionary federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) The amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or designated critical habitat in a manner or to an extent not considered in this Opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or designated critical habitat not considered in this Opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any activities causing such take must immediately cease pending re-initiation.

In future correspondence on this project, please refer to consultation number 02ENNM00-2012-F-0015. If you have any questions or would like to discuss any part of this Opinion, please contact Lori Robertson at (505) 761-4710 or Joel D. Lusk of my staff at (505) 761-4709.

Sincerely,

Wally Murphy

cc:

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Regional Section 7 Coordinator, Region 2 (ES), U.S. Fish and Wildlife Service, Albuquerque, NM
Middle Rio Grande Conservancy District, Albuquerque, NM (Attn: Subhas Shah)
New Mexico Interstate Stream Commission, Santa Fe, NM (Attn: Estevan Lopez)

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In future correspondence on this project, please refer to consultation number 02ENNM00-2012-F-0015. If you have any questions or would like to discuss any part of this Opinion, please contact Lori Robertson at (505) 761-4710 or Joel D. Lusk of my staff at (505) 761-4709.

Sincerely,

Wally Murphy

cc:

Assistant Regional Director, Region 2 (ES), U.S. Fish and Wildlife Service, Albuquerque, NM
Regional Section 7 Coordinator, Region 2 (ES), U.S. Fish and Wildlife Service, Albuquerque, NM
Middle Rio Grande Conservancy District, Albuquerque, NM (Attn: Subhas Shah)
New Mexico Interstate Stream Commission, Santa Fe, NM (Attn: Estevan Lopez)

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Appendix A. San Acacia Levee Project Action Area. Source: USACE 2012b. With- and Without-Project Floodplains for the 1%-chance Event. Figures 5.3 through 5.9 in, Draft General Reevaluation Report and Supplemental Environmental Impact Statement II: Rio Grande Floodway, San Acacia to Bosque del Apache Unit, Socorro County, NM. U.S. Army Corps of Engineers, Albuquerque District, Albuquerque, New Mexico.

Figure 5.3Without- and With-Project Floodplains Index

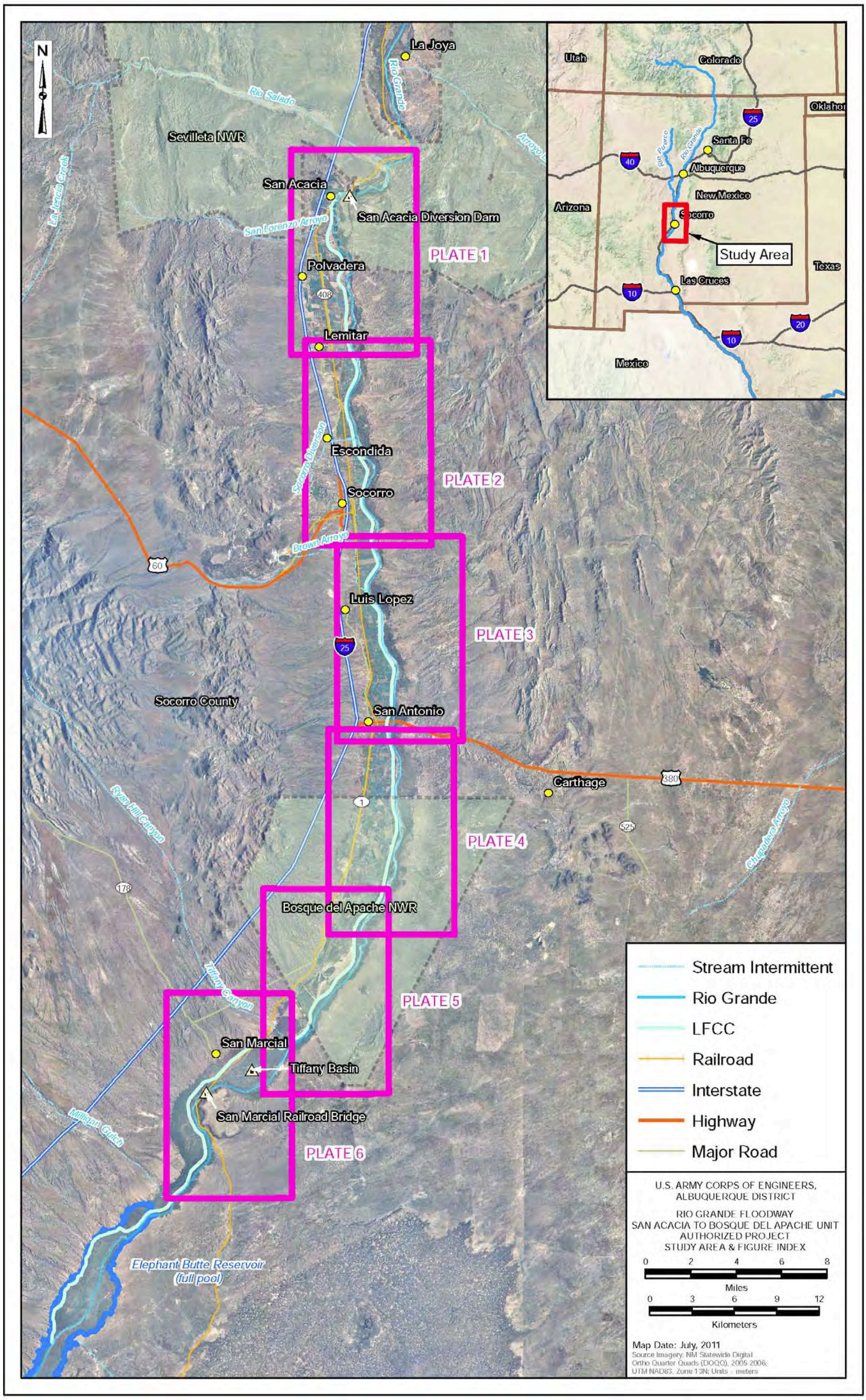


Figure 5.4Without-Project Floodplains and With-Project Floodplains (Alternative A at Base Levee + 4 ft levee height)

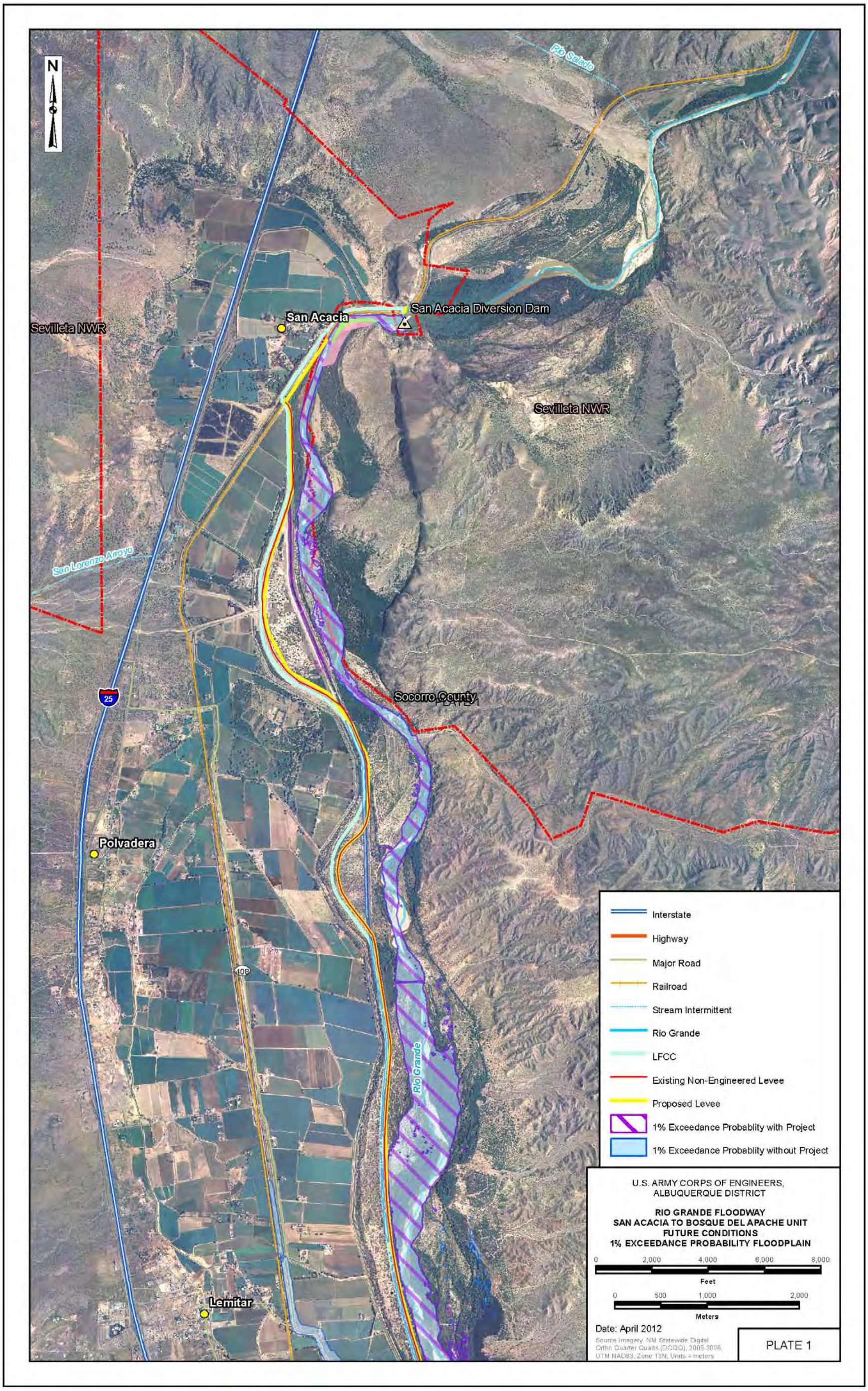


Figure 5.5Without-Project Floodplains and With-Project Floodplains (Alternative A at Base Levee + 4 ft levee height)

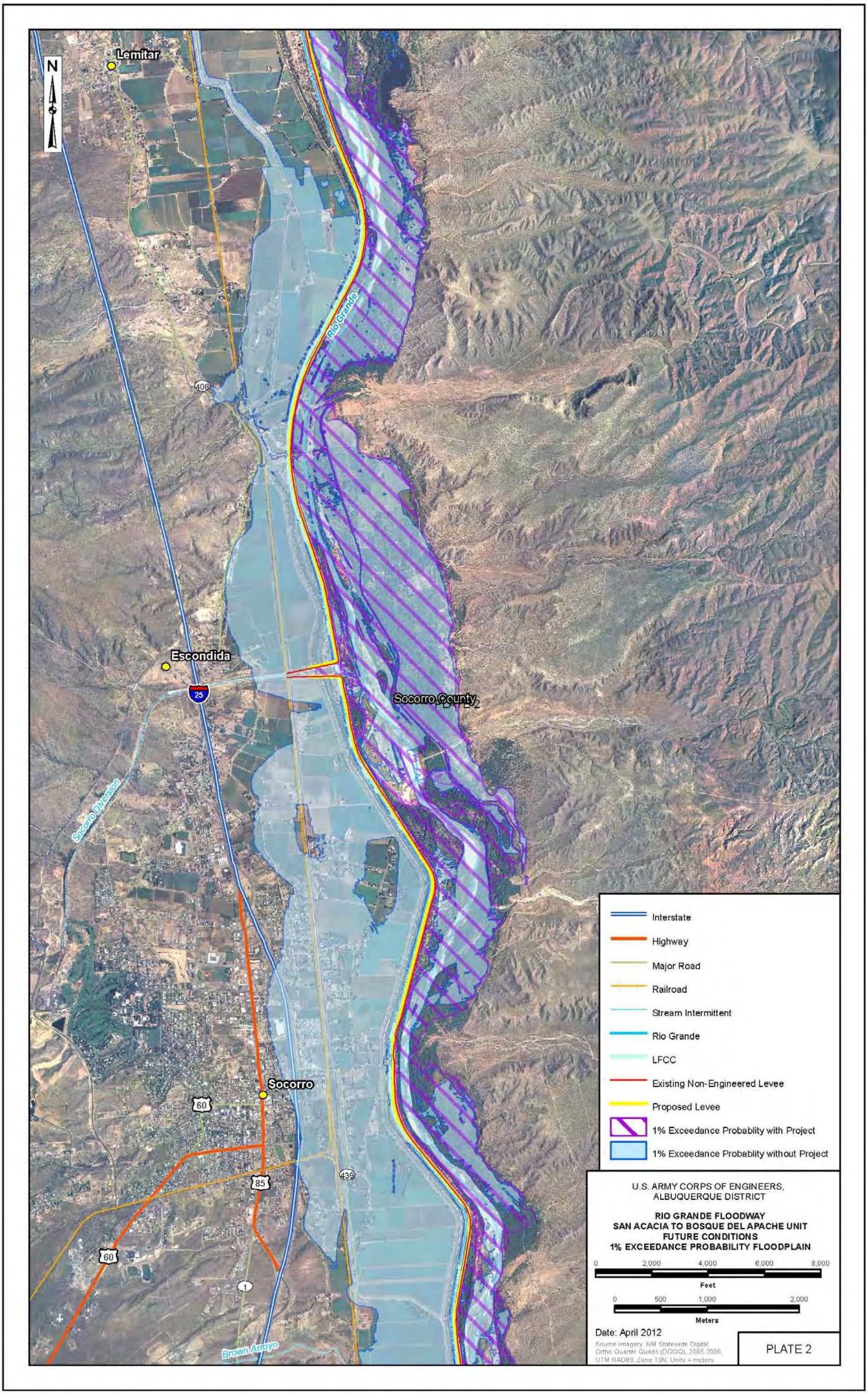


Figure 5.6Without-Project Floodplains and With-Project Floodplains (Alternative A at Base Levee + 4 ft levee height)

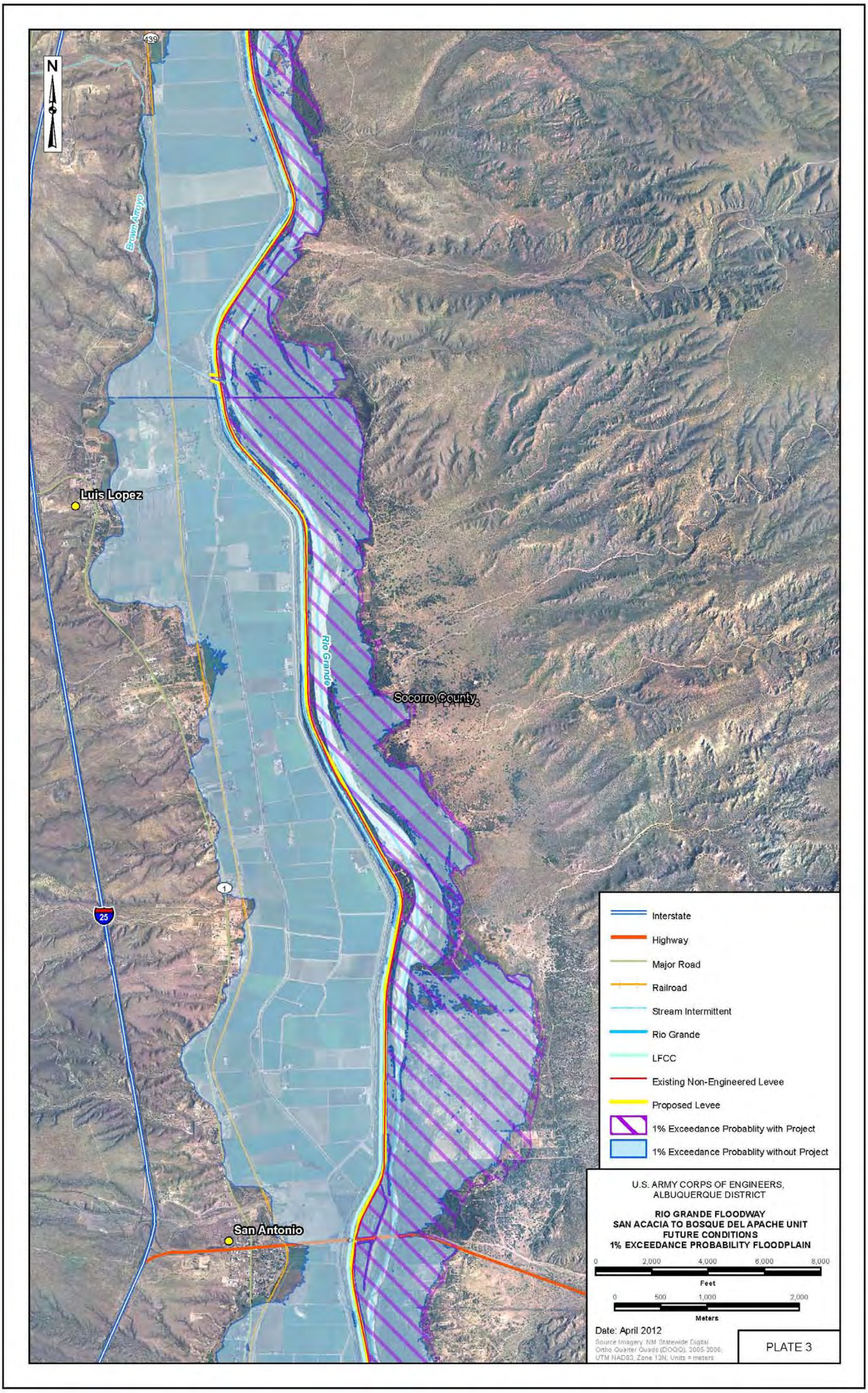


Figure 5.7Without-Project Floodplains and With-Project Floodplains (Alternative A at Base Levee + 4 ft levee height)

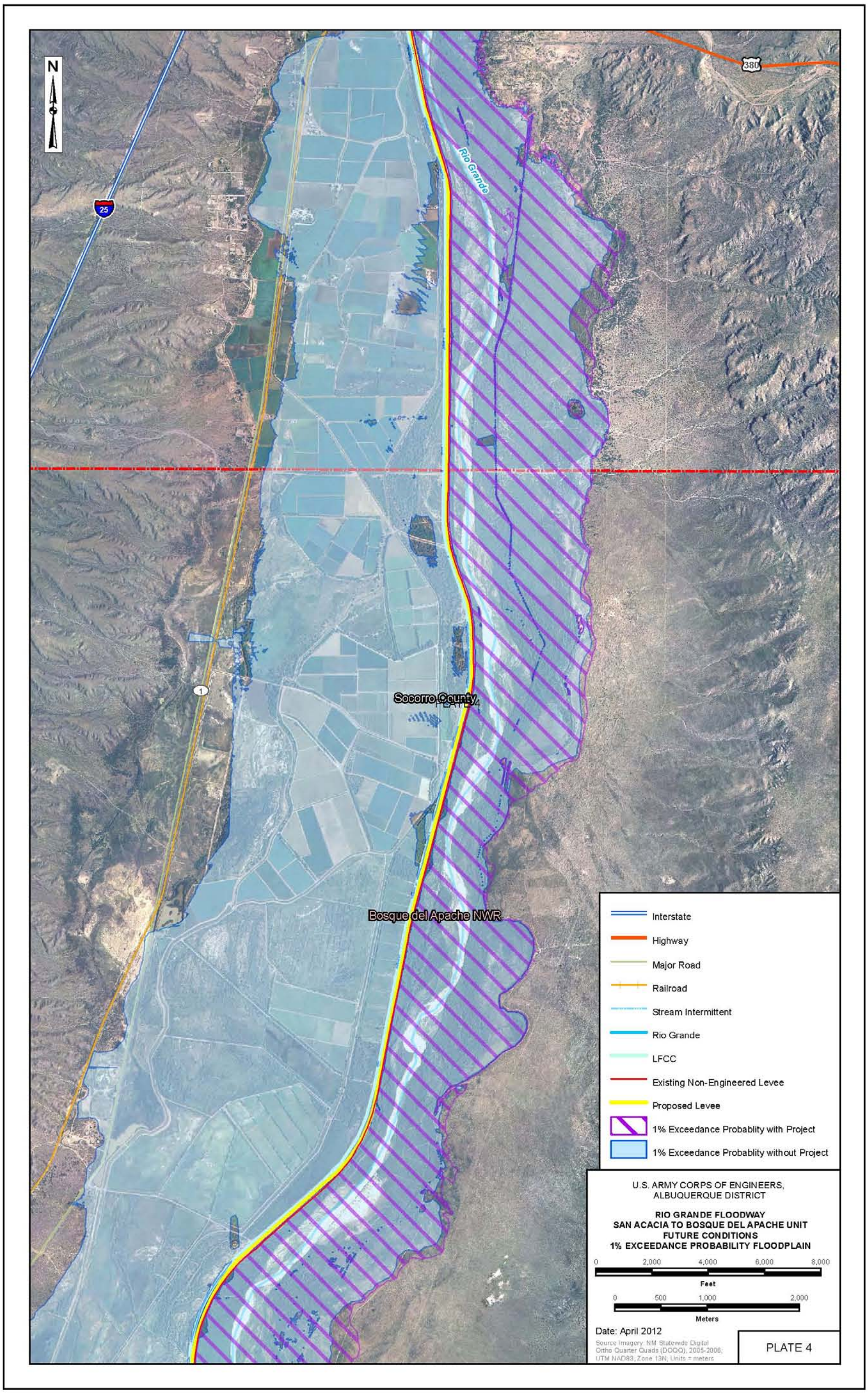


Figure 5.8Without-Project Floodplains and With-Project Floodplains (Alternative A at Base Levee + 4 ft levee height)

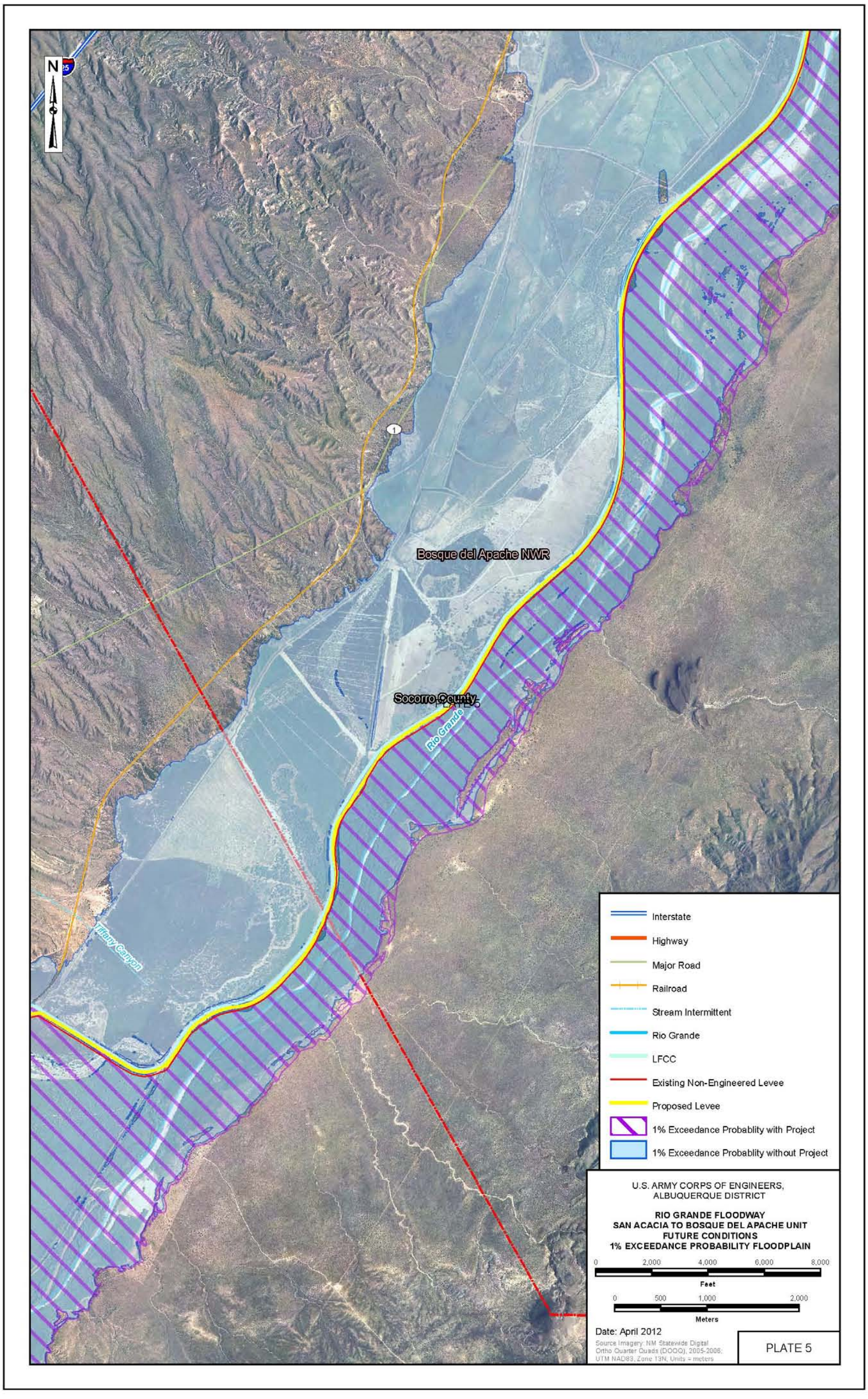
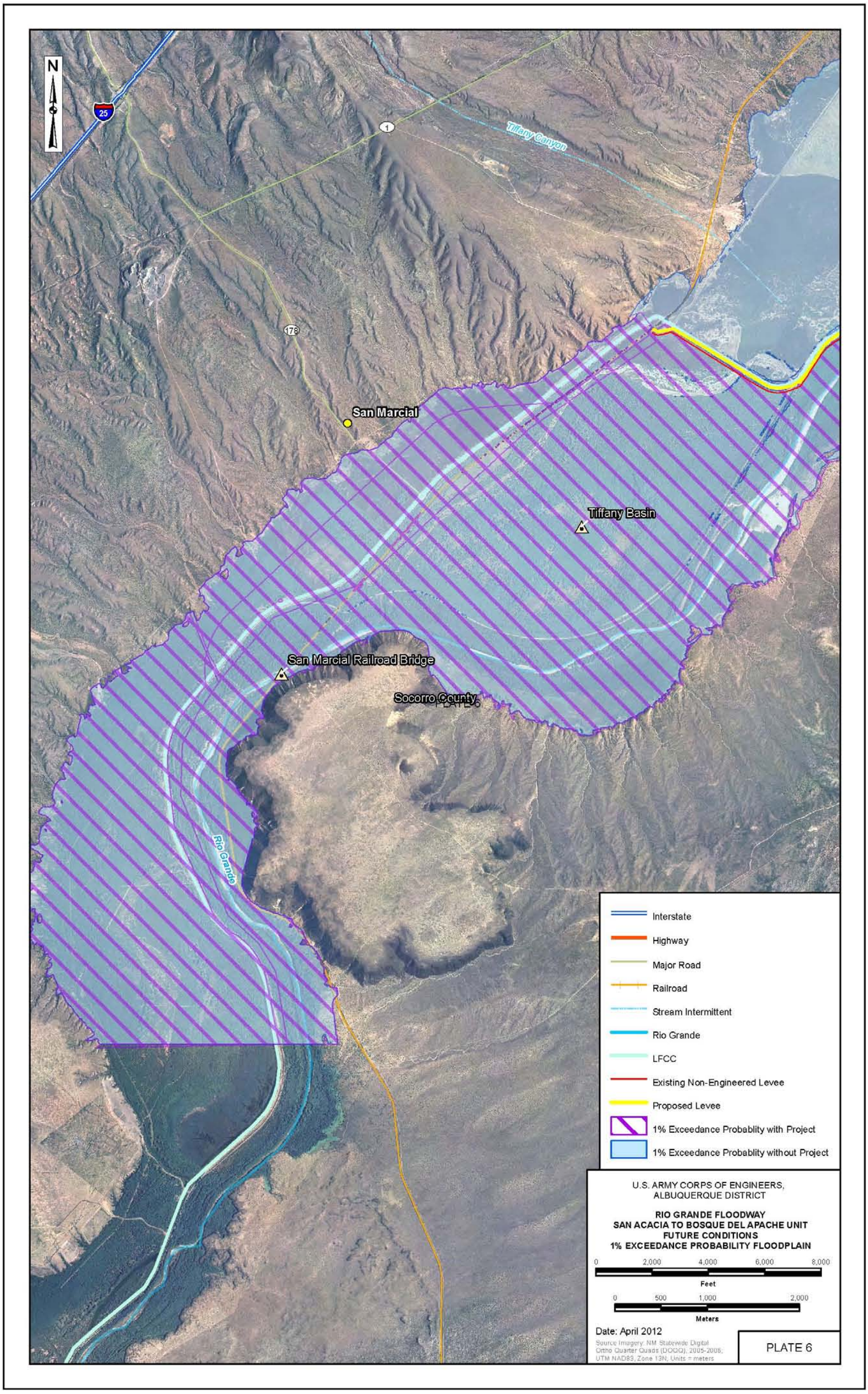


Figure 5.9Without-Project Floodplains and With-Project Floodplains (Alternative at Base Levee + 4 ft levee height)



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Appendix B. 2012 Status of the Southwestern Willow Flycatcher in the Middle and Lower Rio Grande Management Units. Moore, S. D. 2012. WIFL Survey Site Summary Table 2012. November 8, 2012, 3:48AM, email with attachment titled, "WIFL Survey Site Summary Table 2012," from S.D. Moore, U.S. Bureau of Reclamation, Denver, Colorado, to D. Hill, U.S. Fish and Wildlife Service, Albuquerque, New Mexico.

Bureau of Reclamation Summary of 2012 WIFL Detections within the Rio Grande, NM.

Site Name	WIFLs Observed[1]	Est. Number of Pairs	Est. Number of *E.t. extimus*[2]	Est. Number of Territories	Nest (s) Found[3]	Nest Success	Comments	County
La Cienega	4	0	0	0	N/A	N/A	4 Migrants	Santa Fe
BLM Survey Sites	4	0	0	0	N/A	N/A	4 Migrants	
Frijoles Reach	7	0	0	0	N/A	N/A	7 Migrants	Sandoval
BL-05	2	0	0	0	N/A	N/A	2 Migrants	Socorro
BL-06	2	0	0	0	N/A	N/A	2 Migrants	Socorro
BL-09	3	0	0	0	N/A	N/A	3 Migrants	Valencia
BL-10	18	4	12	8	Yes (4)	4 Successful	6 Migrants; 4 Unpaired males; 4 Pairs w/ nests	Valencia
BL-11	9	3	6	3	Yes (4)	4 Successful	3 Migrants; 3 Pairs w/ nests	Valencia
BL-12	5	0	0	0	N/A	N/A	5 Migrants	Valencia
BL-13	6	0	0	0	N/A	N/A	6 Migrants	Valencia
BL-14	6	0	1	1	N/A	N/A	5 Migrants; 1 Unpaired male	Valencia
BL-15	7	0	0	0	N/A	N/A	7 Migrants	Valencia
BL-16	3	0	0	0	N/A	N/A	3 Migrants	Valencia
BL-17	9	0	0	0	N/A	N/A	9 Migrants	Valencia
BL-19	1	0	0	0	N/A	N/A	1 Migrant	Valencia
BL-21	1	0	0	0	N/A	N/A	1 Migrant	Valencia
BL-22	3	0	0	0	N/A	N/A	3 Migrants	Valencia
BL-24	5	0	0	0	N/A	N/A	5 Migrants	Valencia
BL-25	2	0	0	0	N/A	N/A	2 Migrants	Valencia
BL-26	2	0	0	0	N/A	N/A	2 Migrant	Valencia
BL-27	3	1	2	1	Yes (2)	2 Successful	1 Migrant; 1 Pair w/nest	Valencia
BL-28	2	0	0	0	N/A	N/A	2 Migrants	Valencia
BL-29	5	0	0	0	N/A	N/A	5 Migrants	Valencia
BL-30	1	0	0	0	N/A	N/A	1 Migrant	Valencia
SV-11	4	1	2	1	No	N/A	2 Migrants; 1 Pair	Socorro
SV-12	3	0	0	0	N/A	N/A	3 Migrants	Socorro
SV-13	1	0	0	0	N/A	N/A	1 Migrant	Socorro
SV-14	1	0	0	0	N/A	N/A	1 Migrant	Socorro
Belen Reach [4] Summary	104	9	23	14	10	10 Successful	81 Migrants; 5 Unpaired males; 1 Pair; 8 Pairs w/nests	

Site Name	WIFLs Observed[1]	Est. Number of Pairs	Est. Number of *E.t. extimus*[2]	Est. Number of Territories	Nest (s) Found[3]	Nest Success	Comments	County
SV-02	5	0	0	0	N/A	N/A	5 Migrants	Socorro
SV-03	3	0	0	0	N/A	N/A	3 Migrants	Socorro
SV-04	5	0	0	0	N/A	N/A	5 Migrants	Socorro
SV-06	2	0	0	0	N/A	N/A	2 Migrants	Socorro
SV-07	4	0	0	0	N/A	N/A	4 Migrants	Socorro
SV-09	11	5	11	6	Yes (5)	4 Failed 1 Successful	1 Unpaired male; 1 Pair; 4 Pairs w/ nests	Socorro
SV-10	1	0	0	0	N/A	N/A	1 Migrant	Socorro
Sevilleta/ La Joya [5] Reach Summary	31	5	11	6	5	4 Failed 1 Successful	20 Migrants; 1 Unpaired male; 1 Pair; 4 Pairs w/nests	
LF-01	7	0	0	0	N/A	N/A	7 Migrants	Socorro
LF-02	3	0	0	0	N/A	N/A	3 Migrants	Socorro
LF-38	3	0	0	0	N/A	N/A	3 Migrants	Socorro
LF-39	3	0	0	0	N/A	N/A	3 Migrants	Socorro
LF-40	2	0	0	0	N/A	N/A	2 Migrants	Socorro
San Acacia Reach [6] Summary	18	0	0	0	N/A	N/A	18 Migrants	
LF-03	9	1	3	2	Y (1)	1 Successful	6 Migrants; 1 Unpaired male; 1 Pair w/ nest	Socorro
LF-04	2	0	0	0	N/A	N/A	2 Migrants	Socorro
LF-06	3	0	0	0	N/A	N/A	3 Migrants	Socorro
LF-07	9	0	0	0	N/A	N/A	9 Migrants	Socorro
LF-08	21	4	16	12	Yes (1)	1 Unknown	5 Migrants; 8 Unpaired males; 3 Pairs; 1 Pair w/ nest	Socorro
LF-33	10	3	8	5	Yes (4)	2 Failed 2 Successful	2 Migrants; 2 Unpaired males; 3 Pairs w/ nests	Socorro
LF-34	4	0	3	3	N/A	N/A	1 Migrant; 3 Unpaired males	Socorro
LF-42	6	0	0	0	N/A	N/A	6 Migrants	Socorro
LF-43a	4	0	0	0	N/A	N/A	4 Migrants	Socorro
LF-43b	8	0	0	0	N/A	N/A	8 Migrants	Socorro
LF-44a	3	0	0	0	N/A	N/A	3 Migrants	Socorro
LF-45	5	0	1	1	N/A	N/A	4 Migrants; 1 Unpaired male	Socorro

Site Name	WIFLs Observed[1]	Est. Number of Pairs	Est. Number of *E.t. extimus*[2]	Est. Number of Territories	Nest (s) Found[3]	Nest Success	Comments	County
Escondida Reach [7] Summary	84	8	31	23	6	2 Failed 3 Successful 1 Unknown	53 Migrants; 15 Unpaired males; 3 Pairs; 5 Pairs w/ nests	
BA-01	1	0	0	0	N/A	N/A	1 Migrant	Socorro
BA-03N	5	1	2	1	Yes (1)	1 Unknown	3 Migrants; 1 Pair w/ nest	Socorro
BA-03S	2	0	0	0	N/A	N/A	2 Migrants	Socorro
BA-04N	9	0	1	1	N/A	N/A	8 Migrants; 1 Unpaired male	Socorro
BA-04S	3	0	0	0	N/A	N/A	3 Migrants	Socorro
BA-05	13	3	9	6	Yes (3)	1 Failed 2 Successful	4 Migrants; 3 Unpaired males; 3 Pairs w/ nests	Socorro
BA-06N	21	6	18	12	Yes (8)	6 Failed 1 Successful 1 Unknown	3 Migrants; 6 Unpaired males; 1 Pair; 5 Pairs w/ nests	Socorro
BA-06S	22	9	21	12	Yes (11)	10 Failed 1 Successful	1 Migrant; 3 Unpaired males; 3 Pairs; 6 Pairs w/ nests	Socorro
BA-07	7	1	3	2	Yes (2)	2 Failed	4 Migrants; 1 Unpaired male; 1 Pair w/ nest	Socorro
BA-08	1	0	0	0	N/A	N/A	1 Migrant	Socorro
BA-09	9	0	5	5	N/A	N/A	4 Migrants; 5 Unpaired males	Socorro
BA-10	26	9	21	12	Yes (13)	8 Failed 5 Successful	5 Migrants; 3 Unpaired males; 1 Pair; 8 Pairs w/nests	Socorro
Bosque del Apache Reach[8] Summary	119	29	80	51	38	27 Failed 9 Successful 2 Unknown	39 Migrants; 22 Unpaired males; 5 Pairs; 24 pairs w/nests	
LF-21	2	0	1	1	N/A	N/A	1 Migrant; 1 Unpaired male	Socorro
LF-25	1	0	0	0	N/A	N/A	1 Migrant	Socorro
LF-35	1	0	0	0	N/A	N/A	1 Migrant	Socorro
LF-36	3	0	0	0	N/A	N/A	3 Migrants	Socorro
Tiffany Reach [9] Summary	7	0	1	1	N/A	N/A	6 Migrants; 1 Unpaired male	
LF-10	1	0	0	0	N/A	N/A	1 Migrant	Socorro
LF-12	1	0	0	0	N/A	N/A	1 Migrant	Socorro
LF-13	4	0	2	2	N/A	N/A	2 Migrants; 2 Unpaired males	Socorro

Site Name	WIFLs Observed[1]	Est. Number of Pairs	Est. Number of *E.t. extimus*[2]	Est. Number of Territories	Nest (s) Found[3]	Nest Success	Comments	County
LF-14	7	1	4	3	No	N/A	3 Migrants; 2 Unpaired males; 1 Pair	Socorro
LF-15	5	0	0	0	N/A	N/A	5 Migrants	Socorro
LF-16	1	0	0	0	N/A	N/A	1 Migrant	Socorro
LF-17	37	15	37	22	Yes (21)	16 Failed 4 Successful 1 Unknown	7 Unpaired males; 15 Pairs w/ nests	Socorro
LF-17a	43	21	43	22	Yes (32)	23 Failed 6 Successful 3 Unknown	1 Unpaired male; 1 Pair; 20 Pairs w/ nests	Socorro
LF-17b	5	1	4	3	Yes (1)	Successful	1 Migrant; 2 Unpaired males; 1 Pair w/ nest	Socorro
LF-18	1	0	0	0	N/A	N/A	1 Migrant	Socorro
LF-19	1	0	0	0	N/A	N/A	1 Migrant	Socorro
LF-27	1	0	0	0	N/A	N/A	1 Migrant	Socorro
LF-28	2	0	0	0	N/A	N/A	2 Migrants	Socorro
LF-31	1	0	0	0	N/A	N/A	1 Migrant	Socorro
LF-32	3	0	0	0	N/A	N/A	3 Migrants	Socorro
LFCC-01	11	4	8	4	Yes (3)	3 Failed	3 Migrants; 2 Pairs; 2 Pairs w/ nests	Socorro
LFCC-02	2	0	2	2	N/A	N/A	2 Unpaired males	Socorro
LFCC-03	7	2	7	5	Yes (2)	1 Failed 1 Unknown	3 Unpaired males; 2 Pairs w/ nests	Socorro
LFCC-04	3	0	0	0	N/A	N/A	3 Migrants	Socorro
LFCC-05b	4	0	0	0	N/A	N/A	4 Migrants	Socorro
DL-01	26	12	26	14	Yes (8)	8 Failed	2 Unpaired males; 6 Pairs; 6 Pairs w/ nests	Socorro
DL-01a	20	7	19	12	Yes (6)	5 Failed 1 Unknown	1 Migrant; 5 Unpaired males; 3 Pairs; 4 Pairs w/ nests	Socorro
DL-02	59	21	51	30	Yes (22)	13 Failed 9 Successful	8 Migrants; 9 Unpaired males; 3 Pairs; 18 Pairs w/ nests	Socorro
DL-03	1	0	0	0	N/A	N/A	1 Migrant	Socorro
DL-04 & 4a	5	0	0	0	N/A	N/A	5 Migrants	Socorro

Site Name	WIFLs Observed[1]	Est. Number of Pairs	Est. Number of *E.t. extimus*[2]	Est. Number of Territories	Nest (s) Found[3]	Nest Success	Comments	County
DL-06	14	3	8	5	Yes (4)	3 Failed 1 Successful	6 Migrants; 2 Unpaired males; 1 Pair; 2 Pairs w/ nests	Socorro
DL-07	22	5	19	14	Yes (5)	4 Failed 1 Successful	3 Migrants; 9 Unpaired males; 1 Pair; 4 Pairs w/ nests	Socorro
DL-08	30	9	20	11	Yes (7)	3 Failed 4 Successful	10 Migrants; 2 Unpaired males; 3 Pairs; 6 Pairs w/ nests	Socorro
DL-09	31	13	28	15	Yes (16)	9 Failed 3 Successful 4 Unknown	3 Migrants; 2 Unpaired males; 2 Pairs; 11 Pairs w/ nests	Socorro
DL-10	11	2	8	6	Yes (3)	3 Failed	3 Migrants; 4 Unpaired males; 2 Pairs w/ nests	Socorro
DL-11	2	0	0	0	N/A	N/A	2 Migrants	Socorro
DL-12	62	29	59	30	Yes (50)	33 Failed 15 Successful 2 Unknown	3 Migrants; 1 Unpaired male; 29 Pairs w/ nests	Socorro
EB-01	32	13	28	15	Yes (23)	10 Failed 11 Successful 2 Unknown	4 Migrants; 2 Unpaired males; 13 Pairs w/ nests	Socorro
EB-03	3	0	0	0	N/A	N/A	3 Migrants	Socorro
EB-04	7	0	4	4	N/A	N/A	3 Migrants; 4 Unpaired males	Socorro
EB-06	1	0	0	0	N/A	N/A	1 Migrant	Sierra
EB-07	13	5	13	8	Yes (8)	4 Failed 3 Successful 1 Unknown	3 Unpaired males; 5 Pairs w/ nests	Sierra
EB-08	1	0	1	1	N/A	N/A	1 Unpaired male	Sierra
EB-09	31	12	27	15	Yes (12)	4 Failed 7 Successful 1 Unknown	4 Migrants; 3 Unpaired males; 3 Pairs; 9 Pairs w/nests	Sierra
EB-13S	3	0	2	2	N/A	N/A	1 Migrant; 2 Unpaired males	Sierra
EB-14	1	0	1	1	N/A	N/A	1 Unpaired male	Sierra
EB-15	6	3	6	3	No	N/A	3 Pairs	Sierra
EB-16	6	3	6	3	No	N/A	3 Pairs	Sierra
San Marcial Reach [10] Summary	527	181	433	252	223	142 Failed 65 Successful 16 Unknown	94 Migrants; 71 Unpaired males; 32 Pairs; 149 Pairs w/nests	

Site Name	WIFLs Observed[1]	Est. Number of Pairs	Est. Number of *E.t. extimus*[2]	Est. Number of Territories	Nest (s) Found[3]	Nest Success	Comments	County
Caballo Delta	2	1	2	1	Y (1)	Unknown	1 Pair w/nest	Sierra
HA-01	18	8	18	10	Y (8)	1 Failed 7 Unknown	2 Unpaired males; 8 Pairs w/ nests	Dona Ana
HA-02	18	7	17	10	Y (6)	1 Failed 2 Successful 3 Unknown	1 Migrant; 3 Unpaired males; 1 Pair; 6 Pairs w/ nests	Dona Ana
HA-03	2	1	2	1	Y (1)	Failed	1 Pair w/ nest	Dona Ana
HA-04	7	3	7	4	Y (3)	2 Failed 1 Unknown	1 Unpaired male; 1 Pair; 2 Pairs w/ nests	Dona Ana
HA-05	3	0	0	0	N/A	N/A	3 Migrants	Dona Ana
HA-06	4	0	0	0	N/A	N/A	4 Migrants	Dona Ana
Selden Canyon	2	0	0	0	N/A	N/A	2 Migrants	Dona Ana
Radium Springs	10	2	4	2	No	N/A	6 Migrants; 2 Pairs	Dona Ana
Lower Rio Grande [11] Summary	64	21	48	27	18	5 Failed 2 Successful 11 Unknown	16 Migrants; 6 Unpaired males; 4 Pairs; 17 Pairs w/ nests	
2012 TOTALS	**967**	**254**	**629**	**375**	**301**	**180 Failed 90 Success 31 Unknown**	**338 Migrants; 121 Unpaired males; 46 Pairs; 208 Pairs w/ nests**	
The line below contains summary data for the Middle Rio Grande Management Unit only. Modified by J. Lusk, USFWS, February 2013.								
2012 Totals for MRG Management Unit (Only)	**903**	**242**	**581**	**348**	**283**	**175 Failed 88 Success 20 Unknown**	**322 Migrants; 115 Unpaired males; 42 Pairs; 191 Pairs w/ nests**	

1 When a single WIFL responded to the tape playback, and there was no evidence of pairing, it was considered to be an unpaired male. It is possible that some WIFLs counted as males may have been females, especially during the migration period.

2 A WIFL was considered to be a resident *Empidonax traillii extimus* if it was documented on or after June 10 and exhibited behavioral characteristics typical of a territorial WIFL or nesting activity could be confirmed.

3 A second brood occurs after a SWFL pair has had a successful nesting attempt (i.e., young are fledged). A re-nest commonly occurs after an unsuccessful first nesting attempt.

4 Belen Reach = From south boundary of Pueblo of Isleta, downstream to confluence of Rio Puerco and Rio Grande.

5 Sevilleta/La Joya Reach = From confluence of Rio Puerco and Rio Grande, downstream to San Acacia Diversion Dam

6 San Acacia Reach = From San Acacia Diversion Dam, downstream to Escondida Bridge

7 Escondida Reach = From Escondida Bridge, downstream to north boundary of Bosque del Apache NWR

[8] Bosque del Apache NWR Reach = From north boundary of NWR, downstream to southern boundary of NWR.
[9] Tioffany Reach = From south boundary of BDA NWR, downstream to railroad trestle.
[10] San Marcial Reach = From railroad trestle, downstream through the narrows to Elephant Butte Reservoir Pool (Monticello Bay)
[11] Lower Rio Grande = From Caballo Dam to the Mexican border

Migrant – any WIFL detected only during the period prior to June 10th, and where breeding was neither confirmed nor suspected.

Unpaired Male – a resident SWFL that was documented on or after June 10th and exhibited behavioral characteristics typical of a territorial flycatcher, however breeding was neither suspected nor confirmed

Pair – a SWFL territory where breeding was confirmed or behavioral evidence strongly suggested that pairing had occurred

Pair w/ nest – a SWFL territory where breeding was confirmed by the discovery of an active nest.