United States Department of the Interior

FISH AND WILDLIFE SERVICE

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December 2, 2016

Consultation Number 02ENNM00-2013-F-0033

Memorandum

To: Area Manager, Bureau of Reclamation, Albuquerque Area Office, Albuquerque, New Mexico (Attn: Jennifer Faler)

From: Field Supervisor, Fish and Wildlife Service, New Mexico Ecological Services Field Office (NMESFO), Albuquerque, New Mexico

WALLY MURPHY

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Subject: Final Biological and Conference Opinion for Bureau of Reclamation, Bureau of Indian Affairs, and Non-Federal Water Management and Maintenance Activities on the Middle Rio Grande, New Mexico

Thank you for your request for formal consultation dated February 22, 2013, with the U.S. Fish and Wildlife Service (Service) pursuant to section 7 of the Endangered Species Act of 1973 (16 USC 1531-1544), as amended (ESA). At issue are impacts that may result from the actions described in the Joint Biological Assessment (BA) for Bureau of Reclamation (Reclamation), Bureau of Indian Affairs (BIA), and non-Federal Water Management and Maintenance Activities located along the Middle Rio Grande (MRG), New Mexico (Proposed Action). You determined the Proposed Action may affect and is likely to adversely affect the Rio Grande Silvery Minnow (*Hybognathus amarus*; silvery minnow), the Southwestern Willow Flycatcher (*Empidonax traillii extimus*; flycatcher), the Yellow-billed Cuckoo (*Coccyzus americanus*; cuckoo) and proposed or designated critical habitat for each of the species.

You determined that the Proposed Action is not likely to adversely affect the New Mexico Meadow Jumping Mouse (*Zapus hudsonius luteus*), its designated critical habitat, the Pecos Sunflower (*Helianthus paradoxus*), and will have no effect on the Interior Least Tern (*Sternula antillarum athalassos*).

The Service concurs with the determination of may affect, but is not likely to adversely affect the New Mexico Meadow Jumping Mouse and its designated critical habitat based on the following proposed actions. Reclamation and the BA Partners will provide a minimum of 25 cubic feet per second (cfs) to the north boundary of Bosque del Apache National Wildlife Refuge (BDANWR) through the Socorro Riverside Drain and Low Flow Conveyance Channel (LFCC) from April 15 through September 30. Combined flows will not fall below 25 cfs for more than a total of 5 days annually, when water is available.

The Service concurs with the determination of may affect, but is not likely to adversely affect the Pecos Sunflower based on the following proposed actions:

- Reclamation and the BA Partners will continue actions that are beneficial; coordinate with the Service on river maintenance activities near occupied habitat including the area near the La Joya Drain; evaluate new areas to determine presence and avoid impacts to the Pecos Sunflower habitat.

- Reclamation and the BA Partners will work with the Service to develop a plan to avoid impacts; including water delivery, to the Pecos Sunflower populations in maintenance areas, including the La Joya Drain.

- Implementation of the Lower Reach Plan will include activities designed to improve Pecos Sunflower habitat.

This 15-year biological and conference opinion (BiOp) is based on information provided in the August 31, 2015 BA; March 23, 2016 BA errata; July 20, 2016, memorandum; other correspondences, telephone conversations, and field investigations; and other sources of information. A complete administrative record of this consultation is on file at the NMESFO.

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Final Biological and Conference Opinion for Bureau of Reclamation, Bureau of Indian Affairs, and Non-Federal Water Management and Maintenance Activities on the Middle Rio Grande, New Mexico

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EXECUTIVE SUMMARY

This biological opinion (BiOp) is issued in response to Reclamation's request for reinitiation of section 7 consultation on February 22, 2013. The Service began consulting under section 7 of the ESA with Rio Grande (River) water operations managers beginning in 1998. On March 17, 2003, the Service issued a jeopardy BiOp for Rio Grande Silvery Minnow (silvery minnow) and Southwestern Willow Flycatcher (flycatcher) that would direct certain water management operations in the MRG for a decade and a half. In the 2003 BiOp, the Service found that the Proposed Actions would continue to threaten the survival and recovery of the silvery minnow and flycatcher by reducing the quantity and quality of habitat through continuation and expansion of habitat degrading and destroying actions. The 2003 BiOp contained five Reasonable and Prudent Measures (RPMs) with nine Terms and Conditions, and one Reasonable and Prudent Alternative (RPA) with 32 elements. The RPA was designed to alleviate jeopardy to the silvery minnow and flycatcher, and avoid destruction or adverse modification of their designated critical habitats. Implementation of the RPAs in the 2003 BiOp would contribute to the Service's current understanding of effects of water operations on riparian ecology, river geomorphology, and the response of listed species. Specific elements included an increase in flows between April 15 and June 15 of each year, beneficial use of Reclamation's supplemental water, continuous river flows between November 16 and June 15, continuous flows of 100 cfs between Cochiti Dam and Isleta Diversion Dam, salvage and captive propagation of silvery minnows, and fish passage at Isleta and San Acacia Diversion Dams.

Reclamation and others have implemented various water management, habitat restoration, research, and monitoring activities, as prescribed in the 2003 BiOp. Under the MRG Endangered Species Collaborative Program (Collaborative Program), various agencies and organizations have contributed to implementing these activities. More than approximately $125 million has been spent to comply with the 2003 BiOp. In some areas, such as research, Federal and State agencies and the Collaborative Program contributed more than the minimum required by the 2003 BiOp. However several components of the 2003 BiOp were never implemented including fish passage at Isleta and San Acacia Diversion Dams and relocation of the San Marcial Railroad Bridge). It was determined that the Army Corps of Engineers (USACE) did not have the authority to relocate the bridge (USACE 2012a), therefore it was never relocated.

In the 2003 BiOp the Service concluded that it was important to address river drying through targeted flows, fish passages, habitat restoration, and increased channel capacity. In addition, programs for genetic management, captive propagation, and fish salvage were implemented. Since 2003, we have learned how water management can be used to benefit the species and their habitats. We found that elevated spring flows resulted in increased silvery minnow density during the fall; therefore, spring flow management is emphasized in this BiOp.

In 2013, the Service responded to extremely low silvery minnow numbers by developing the Hydrological Objective (now referred to as Hydrobiological Objectives). The Service then made the Hydrobiological Objectives available to MRG Water Managers [Reclamation, New Mexico Interstate Stream Commission (NMISC) and Middle Rio Grande Conservancy District (MRGCD)], to provide scientific information to help inform decisions on how they would conduct water management operations that would result in an increased silvery minnow density, which would promote survival and recovery.

Since 2013, the Service has continued to refine the Hydrobiological Objectives. Hydrobiology is the analysis and assessment of life (i.e., silvery minnow) in the water and their interconnection with the cycling of natural resources in a body of water. Our hydrobiological analysis is based on relationships between silvery minnow density and flows (Appendix A). The Service's Hydrobiological Objectives are comprised of potential water management strategies for silvery minnow production and survival. The Production Strategy fosters the production of young silvery minnows during spring. The Survival Strategy provides guidelines to manage for silvery minnow survival when spring and summer flows are low. These Hydrobiological Objectives and relationships provide a basis for supporting management decisions because they are based on 20 years of observations of the effects of actions on endangered species from several sites along the MRG under a variety of environmental conditions. Based on these observations, the Service has determined that there are additional conservation needs for the silvery minnow including: 1) restoration of river connectivity; 2) large-scale habitat restoration and enhancement; and, 3) conservation storage of water. The Hydrobiological Objectives and these three conservation needs are the Service's Silvery Minnow Survival and Recovery Strategy (Silvery Minnow SRS).

Flows are an important factor in determining river fish communities around the world. Annual variation in fish recruitment is often influenced by river flows and floodplain inundation levels. In low-gradient river floodplain systems (e.g., the Rio Grande), wet season high flows usually provide annual connectivity and inundation. Fish in river floodplain systems respond to rising water levels and floodplain inundation as cues for spawning. Inundated floodplain habitats provide food and complex cover for refuge from predation.

Dudley et al. (2016) found that prolonged high flows during spring were highly correlated with increased density of silvery minnows, and prolonged low flows during summer were correlated with decreased densities. Through the analysis in this BiOp, we have developed simple models that could be used to rapidly describe relationships between streamflow, channel hydraulics, and indices of silvery minnow abundance and distribution. This will also allow us to collect data so that water management options can be tested in an adaptive management framework as part of the River Integrated Operations (RIO).

The current status of the flycatcher within the Action Area is stable (flycatcher's management unit recovery goal is currently surpassed). Approximately 400 territories were detected in the MRG Management Unit in 2015. However, the trend in flycatcher nest success has been variable in recent years; and, the number of breeding territories is anticipated to decline due primarily to management in Elephant Butte Reservoir, climate change, decreases in prey base, habitat loss due to the saltcedar leaf beetle, and advanced succession stages of riparian vegetation.

The status of the cuckoo within the Action Area is also stable. In 2015, there were 110 cuckoo territories found from Isleta Diversion Dam to Elephant Butte Reservoir, in approximately 3,795 ha (9,378 acres) of suitable nesting habitat.

Reclamation, BIA, MRGCD, and NMISC propose a number of ongoing activities such as: continuation of ongoing water management; river maintenance (including habitat restoration); and, maintenance; and, restoration activities by the MRGCD and NMISC. It was determined that these activities have both adverse and beneficial effects to silvery minnow, flycatcher, cuckoo and their designated and proposed critical habitat (Reclamation 2015). Effects to listed species were analyzed using processes for identifying adverse and beneficial impacts to the river environment (i.e., hydrology, geomorphology, water quality, riparian vegetation dynamics, and other localized disturbances) and then assessing the effects of these impacts on listed species. This analytical framework is referred to as the Matrix of River System Impacts (MRSI). The framework for assessing the effects to the species is referred to as A System of Assessing Effects to Species (ASAETS). Methods for both MRSI and ASAETS are located in Appendix A.

Reclamation's BA contains a suite of offsetting and conservation measures designed to minimize the impacts of their operations and ongoing maintenance actions, and to contribute to the conservation of listed species. We considered all these measures to be Conservation Measures for the purpose of this BiOp, and identified whether the conservation measures addressed the four factors included in the Silvery Minnow SRS (i.e., Hydrobiological Objectives, restoration of river connectivity, large-scale habitat restoration and enhancement, and conservation storage of water). Utilizing an analytical framework we more specifically determined whether or not the conservation measures minimized adverse impacts to hydrology, geomorphology, water quality, riparian vegetation dynamics, or other localized disturbances.

The lack of river connectivity is an issue in the Action Area. To address the lack of river connectivity, Reclamation will ensure fish passage at the three diversion dams: Angostura, Isleta, and San Acacia. To address adverse geomorphic trends, Reclamation will implement large-scale habitat restoration in the Isleta and San Acacia Reaches. Examples of large-scale habitat restoration that Reclamation will implement include BDANWR river realignment and the Fort Craig to RM 60 projects (Reclamation 2015 Part III, Appendix B). To address the need for conservation storage, Reclamation will work with the Albuquerque Bernalillo County Water Utility Authority (ABCWUA), MRGCD, and USACE to develop Conservation Storage of 30,000-60,000 acre feet capacity in Abiquiu Reservoir.

Reclamation is proposing to use adaptive management principles that address species and water management needs termed the RIO. The RIO would include hypothesis testing to improve our understanding of how MRG hydrology can meet the conservation needs of the silvery minnow and other listed species. An example of the practical application of hypothesis testing will be to manage flows to promote silvery minnow production and survival.

The Service has commitments from Reclamation, BIA, and the BA Partners to accomplish these Conservation Measures. In addition to Reclamation's conservation measures, the Service has committed to providing funds and equipment for interim fish rescue/salvage efforts until fish passages are complete. The Service will also assist with coordination during adaptive management (RIO) reviews, provide guidance on listed species needs, support development of Safe Harbor Agreements that may be needed in the Cochiti Reach, and provide ESA permitting as needed.

Our analysis indicates that major impacts of the Proposed Action to spring, summer, and fall flows, lack of river connectivity, and adverse geomorphic trends in the MRG, will be minimized by the implementation of the Conservation Measure in the Proposed Action. Based on commitments to implement the Conservation Measures in the Proposed Action the Service believes there will be improvement in the status of the silvery minnow, flycatcher, and cuckoo. Our conclusion that the Proposed Action will not jeopardize the continued existence of the silvery minnow, flycatcher, and cuckoo, and will not destroy or adversely modify designated or proposed critical habitat, is based on full implementation of the Conservation Measures.

CONSULTATION HISTORY

- July 2006 – Start of discussions concerning reinitiation of consultation involving interagency consultation team meetings with Reclamation, U.S. Army Corps of Engineers (USACE) and the Service. Non-Federal agencies were also engaged in the reinitiation discussions.

- October 2008 to July 2012, the Service participated in 62 interagency consultation team meetings.

- May 7, 2012, the Service received a final joint BA for "Bureau of Reclamation and Non-Federal Water Management and Maintenance Activities on the Middle Rio Grande, New Mexico. Part I – Operations; Part II - Maintenance".

- June 8, 2012, the Service submitted comments to Reclamation on the Maintenance component (Part II) of the BA.

- June 26, 2012, the Service submitted comments to Reclamation on the Operations component (Part I) of the BA.

- July 31, 2012, the Service received a final joint BA for "Bureau of Reclamation and Non-Federal Water Management and Maintenance Activities on the Middle Rio Grande, New Mexico. Part I – Operations; Part I – Water Management Appendices; and, Part II - Maintenance" and request for formal consultation.

- August 1, 2012, the Service received Reclamation's updated version of "Bureau of Reclamation and Non-Federal Water Management and Maintenance Activities on the Middle Rio Grande, New Mexico. Part II – Maintenance."

- August 15, 2012, the Service received a supplement to Reclamation's BA from State of New Mexico agencies [Interstate Stream Commission (NMISC), Office of the State Engineer (NMOSE), and New Mexico Attorney General's Office] requesting that the information contained in the supplement be included in the formal consultation process.

- August 27, 2012, the Service received a revision to the State of New Mexico's August 17, 2012 supplement to Reclamation's BA.

- August 30, 2012, the Service issued a letter to Reclamation acknowledging their requests for formal consultation, identifying some missing or uncertain information critical to the consultation, and stating the Service's intention to issue a draft BiOp by November 16, 2012, provided that a number of key uncertainties would be satisfied.

- September 7, 2012, the Service received from Reclamation an updated version of section 6.3.3 of the BA addressing effects to Pecos sunflower.

- September 15, 2012, the Service received a supplement to Reclamation's BA that included a list of Conservation Measures to be implemented by State Agencies.

- January 15, 2013, Reclamation submitted a memorandum and attached amended and complete Biological Assessment to the Service for MRG Water Operations and River Maintenance.

- February 22, 2013, the Service reinitiated formal ESA consultation with Reclamation, BIA, and the BA Partners through a memorandum dated February 25, 2013.

- May 6, 2013, Service provided a draft Hydrologic Objective to Reclamation, BIA, and the BA Partners recommending strategies for seasonal water needed to support silvery minnow.

- May 31, 2013, the Service issued a memorandum to Reclamation supporting the implementation of emergency drought measures in the MRG during the 2013 irrigation season.

- August 8, 2013, Reclamation submitted additional information through a revision to the BA for Middle Rio Grande Water Operations and Maintenance.

- November 26, 2013, the USACE withdrew their BA and thereby terminated their re-initiation of formal consultation associate with their flood control operations.

- November and December 2013, Reclamation, and the BA Partners worked with the Service on a revised draft impact analysis for the BiOp.

- May and September 2014, Reclamation, and the BA Partners reviewed and commented on the Service's draft Hydrological Objectives and described potential refinements through a formalized Adaptive Management process. BIA joined the consultation. Reclamation, BIA, and the BA Partners identified a need to consider specific action impacts and offsets as well as integrated water management, habitat restoration, improvements to river dynamics and connectivity, and other actions that became part of a revised BA.

- August 31, 2015, Reclamation, BIA, MRGCD, NMISC and NMOSE submitted a final revision to the BA, including Part IV addressing Offsetting and Conservation Measures (as termed by the BA Partners) and additional analysis from MRGCD.

- Spring 2016, the Service participated in several meetings with Reclamation, BIA, MRGCD, and the State of New Mexico to discuss water management operations and authorities in the MRG basin as background and context to the ongoing consultation and to support the Service's efforts in writing the Biological Opinion.

- March 23, 2016, Reclamation submitted errata for table on San Juan-Chama (SJC) Project contracts.

- July 20, 2016, Reclamation submitted memorandum with a progress update on specific Conservation Measures that increase the reasonable certainty of their occurrence.

- August 23, 2016, Reclamation submitted a memorandum with an additional progress update to address river connectivity at Angostura Diversion Dam.
- September 12, 2016, the Service sent letters to the Pueblos extended the offer of government to government consultation on the draft BiOp.
- September 13, 2016, Service issued a draft BiOp.
- October 12, 2016, the Pueblo of Santa Clara requested clarification on the draft BiOp.
- October 14, 2016, Reclamation, BIA, and the BA Partners provided the Service with comments on the draft BiOp.
- October 25, 2016, the Service responded to the Pueblo of Santa Clara’s comments.
- November 9, 2016, the Pueblo of Santa Clara provided comment to the Service on the draft BiOp.
- November 14, 2016, BIA and Coalition of Six MRG Pueblos (six MRG Pueblos) provided the Service with comments on the draft BiOp.
- November 14, 2016, the Service responded to the Pueblo of Santa Clara’s comments on the draft BiOp.
- November 18, 2016, the Service met with Reclamation and the BA Partners to respond to their comments and describe changes made to the BiOp.
- November 18, 2016, the Service met with Reclamation, BIA and the six MRG Pueblos to respond to their comments and describe changes made to the BiOp.
- November 23, 2016, the Service received additional comments from the Pueblo of Santa Clara on the draft BiOp.
- November 28, 2016, the Service met with Reclamation and the BA Partners regarding comments on the draft BiOp.
- November 30, 2016, the Service responded to the additional comments from the Pueblo of Santa Clara on the draft BiOp.
- November 30, 2016, the Service participated in a conference call with representatives from the six MRG Pueblos regarding their comments and responded to comments.

BIOLOGICAL OPINION

DESCRIPTION OF THE PROPOSED ACTION

Action Area

The Action Area includes all areas to be affected directly or indirectly by the Proposed Action (see 50 CFR 402.02). The Action Area is defined as:

- the entire width of the 100-year floodplain of the Rio Grande basin and its tributaries from the Colorado/New Mexico state line to Elephant Butte Dam;
- to the extent present outside the boundary of the 100-year floodplain, the footprint of irrigation and flood control structures and facilities (canals, laterals, drains, dams, headings, gates, etc.) and immediately adjacent property between Cochiti Dam and the northern boundary of BDANWR where the MRGCD conducts maintenance activities;
- to the extent present outside the boundary of the 100-year floodplain, the footprint and immediately adjacent property of other facilities [Drain Unit 7, Drain Unit 7 Extension, La Joya Drain, San Francisco Drain, San Juan Drain, Elmendorf Drain, Escondida Drain, operation and maintenance (O&M), roads, levees, the LFCC, the LFCC Outfall];
- San Marcial Delta Water Conveyance Channel Project (Delta Channel) and access roads to the northern extent of the active reservoir pool; and
- Other localities not identified previously where the Proposed Action's Conservation Measures will occur.

The Service defines the Action Area to Elephant Butte Dam to include delivery of water and sediment to Elephant Butte Reservoir, as well as river maintenance (Figure 1). It is important to note that the portion of the Action Area within Elephant Butte Reservoir overlaps with the Action Area defined for the recent BiOp for the Rio Grande Project Operating Agreement and storage of SJC Project water (Service 2015). The difference between the two consultations, however, is that this BiOp provides coverage for river maintenance activities and water delivery. The BiOp for the Rio Grande Project Operating Agreement and storage of SJC Project water provides coverage for the storage and allocation of water (see Service 2015 for further detail). The actions within this BiOp that fall within this overlapping area include the LFCC Outfall and various other river maintenance activities which take place within the historically inundated portion of Elephant Butte Reservoir. In addition, the Proposed Action associated with the Delta Channel and access roads have a southern-most boundary of the "northern extent of the active reservoir pool," which is a fluctuating point that would extend no farther than Elephant Butte Dam.

The MRG between Cochiti Dam and Elephant Butte Reservoir is further divided into four reaches by the presence of two mainstem dams and three irrigation diversion dams. These reaches are defined as follows:

- *The Cochiti Reach* extends from Cochiti Dam to Angostura Diversion Dam. This reach is 35.9 kilometers (km) [22.3 miles (mi)] in length.
- The reach from Angostura Diversion Dam to Isleta Diversion Dam is the *Angostura Reach*. This reach is 65.0 km (40.4 mi) in length.
- The *Isleta Reach* is bounded upstream by Isleta Diversion Dam and downstream by San Acacia Diversion Dam. This reach is 85.5 km (53.1 mi) in length.
- The reach below San Acacia Diversion Dam to the northern extent of the Elephant Butte Reservoir pool is the *San Acacia Reach*. The length of the San Acacia Reach is dynamic, increasing and decreasing as the water surface elevation in Elephant Butte Reservoir rises and falls. This reach in 2012 was about 129.9 km (80.7 mi) in length. If the pool rises to its maximum, the reach would be approximately 87 km (54 mi) in length. If the pool falls to the historical minimum, the reach would be approximately 138 km (86 mi) in length.

Overview of Proposed Action

The Proposed Action is comprised of water operations, river infrastructure restoration, maintenance, and conservation activities. Nothing in this BiOp precludes any new depletion that results from the exercise of Native American water rights or other senior water right holders within the Action Area or modifies the obligation to store, release, and deliver water to the six MRG Pueblos to meet their statutorily recognized rights. Consequently, the Reclamation, BIA, and BA Partners assume the risk that the future development of senior water rights, including Indian Pueblo and Tribal water rights, may result in shortages of water to junior users.

The Proposed Action is a continuation of ongoing actions and newly proposed Conservation Measures. The past effects of those actions are included in the environmental baseline. Future effects of the Proposed Action are analyzed in this BiOp.

Water Operations

1. Reclamation proposes the following water management actions:
    a. Release of nonnative SJC Project water from Heron Reservoir for delivery to downstream users.
    b. Operate El Vado Dam and Reservoir to store and release water, including response to requests by the MRGCD and notification from BIA.

2. BIA proposes the following water management actions:
    a. Notify Reclamation of needs for storage and releases of water from El Vado to meet the Pueblos’ irrigation needs.
    b. Notify MRGCD of needs for delivery of water to the Pueblos to meet their statutorily recognized water rights.

3. MRGCD proposes the following water management actions:

    a. Operate the MRG Project diversion dams to deliver water to MRGCD lands to meet agricultural demand of lands with water rights, including the lands of the six MRG Pueblos.
    b. Operate drains and wasteways to re-divert for irrigation and to return water to the river, as appropriate.
    c. Request storage and release of water at El Vado to meet the irrigation needs of constituents.

4. The State proposes the following water management actions:

    a. Continue its Compact-related activities to administer relinquishment of New Mexico credit water and allocation of relinquished Compact credits.
    b. Continue to administer the surface water and groundwater resources to maintain hydrologic system balance by executing its statutory duties with respect to transfers of valid existing surface water rights and compliance with valid existing state water declarations, permit, licenses, and court adjudication.
    c. Continue to issue permits for small domestic, livestock, and temporary uses, as required by State of New Mexico statutes and regulations.

For a complete description of water management actions for Reclamation, BIA, MRGCD, and the State refer to the BA (Reclamation 2015, Part II; entire).

Through the Act of March 13, 1928 (1928 Act; 45 Stat. 312) and the Act of August 27, 1935 (49 Stat. 887), Congress protected the six MRG Pueblos' "prior and paramount" right to the water necessary to irrigate Pueblo lands and recognized the Pueblos' water rights for irrigation of additional Pueblo lands that would be newly reclaimed. The 1928 Act also recognized the prior and paramount status of "all water for the domestic purposes of the Indians and for their stock." Pursuant to the 1928 Act, the six MRG Pueblos have a recognized senior right on the river to divert the Rio Grande natural flow. Consequently, Reclamation and BIA currently work cooperatively to perform computations and operations to store and release water at El Vado as is needed to meet the six MRG Pueblos' prior and paramount water demand when natural flows of the Rio Grande are insufficient.

River Maintenance

For the purposes of this document, the term "river maintenance" refers to river and infrastructure maintenance and restoration actions.

1. Reclamation's programmatic strategy for river and infrastructure maintenance and restoration actions will:

a. Provide for effective transport of water and sediment to Elephant Butte Reservoir;

b. Conserve surface water within the MRG;

c. Protect riverside structures and facilities;

d. Reduce and eliminate excessive sediment deposition in the MRG;

e. Reduce the rate of channel degradation from Cochiti Dam downstream;

f. Restore natural river processes; and

g. Provide habitat improvement for the listed species within the Action Area.

2. Reclamation's maintenance activities for the LFCC and former State drains in coordination with the State.

3. Reclamation's maintenance of the Delta Channel, including the State cooperative agreement.

4. Reclamation's river maintenance support activities, including access roads, dust abatement, stockpiles and storage yards, borrow and quarry areas, and data collection activities.

5. MRGCD's continued maintenance activities for diversion dams and associated conveyance channels and facilities that are part of the MRG project.

6. The State's maintenance actions that include its cooperative agreement for river maintenance with Reclamation and also habitat restoration activities.

Reclamation lists the numbers used to derive total river maintenance acreage in BA Table III-13 (Reclamation 2015). For a complete description of river maintenance actions for Reclamation, BIA, MRGCD, and the State refer to Reclamation (2015, Part III).

Conservation Measures

Offsetting and conservation measures proposed in Reclamation's BA are combined in Table 1 as Conservation Measures. These measures are presented as directly or indirectly contributing to improving the overall management/habitat situation for listed species. The Service anticipates that the agency(s) will implement these measure(s) including meeting described timelines, and monetary commitments.

As part of their Proposed Action, Reclamation is implementing River Integrated Operations (RIO), which is an approach for river operations using adaptive management principles that address species and water management needs. Adaptive management is supported by Department of the Interior policy (Williams et al. 2009). Development of a defined adaptive management process for the MRG Project, integrated with ongoing decision-making efforts, will help to improve our collective understanding of how to achieve sustainable management of the

MRG. The RIO is an overarching adaptive management process that would take into account the four focus areas in Silvery Minnow SRS: 1) strategies for stabilizing, and eventually recovering, the silvery minnow (Hydrobiological Objectives, Appendix A); 2) river connectivity; 3) habitat restoration; and 4) conservation storage.

Silvery Minnow Survival and Recovery Strategy (Silvery Minnow SRS)

Implementing the Silvery Minnow SRS along with the Conservation Measures presented in Table 1 will result in a significant improvement in the status of the silvery minnow because they will increase survival and promote recovery. They do this by providing a mechanism for evaluating the component impacts of the Proposed Action and guidance on how to ameliorate impacts to silvery minnow production and survival. Reclamation, BIA, and the BA Partners will implement the Silvery Minnow SRS through the adaptive management process. RIO is the component of the overarching adaptive management process that addresses Part One, as described in BA Part IV (Reclamation 2015). The Silvery Minnow SRS contains four parts.

Part One of the Silvery Minnow SRS contains strategies and decision points for silvery minnow production and survival known as the Hydrobiological Objectives:

Generally, the Production Strategy and Survival Strategy work together to first ensure that silvery minnow successfully spawn in the spring and survive through the summer to spawn the following year. In years when there is not enough water to ensure a successful spring spawn, the Survival Strategy works to ensure that silvery minnow, that are already in the river, survive so that they can spawn the following spring.

Production Strategy

The Production Strategy is management of the magnitude, duration, and timing of spring flows. It is important because it promotes successful spawning. Silvery minnow spawning is timed to high flow events that occur in the MRG with the inflow from spring snow melt during May or June. High spring flow events are crucial to triggering spawning and providing nursery habitat for recruitment (production), as described in the Status of the Species section below. High flow events occur when the winter snowpack is sufficient to create the water timing, volume, and duration to trigger and support spawning. If spawning and recruitment occurs in the spring, then it is more likely that silvery minnow recovery goals will be met. Native flows are those flows in the Rio Grande that are not imported to the Rio Grande watershed. When native flows are forecasted to be insufficient to produce high flow events, Reclamation, BIA, and the BA Partners will work through the RIO to pursue the Production Strategy and determine how sufficient spring water flow, timing, and duration could be accomplished with available water. Such sources of available water include native Rio Grande water and SJC Project water which can be leased, purchased, or stored. If the spring water flow, timing, and duration are not sufficient to produce high flow events, then Reclamation, BIA, and the BA Partners will move to implementation of the Survival Strategy. The Conservation Measures that address this component are described in Table 1 (also see Reclamation 2015, Part IV).

Survival Strategy

The Survival Strategy is management of water to reduce the length and duration of river drying. It is important because it promotes survival of silvery minnow. Silvery minnow survival from one year to the next is an important aspect of ensuring a successful spawn the next year and continued existence of the species. Recovery of the silvery minnow depends on successful spawning in spring (May and June). However, historically there have been years of low snowpack and low spring flows. Evidence indicates that silvery minnow can survive without high spring flows for a limited time (approximately 2 years) depending on the extent of drying (Archdeacon 2016). In years when spring flows are insufficient to ensure successful spawning, then fish from the prior years need to survive through the summer to spawn the following spring. In wet years [as described in Reclamation (2015, Part II)], river drying will be minimized by natural flows through the end of the irrigation season (October), thus ensuring silvery minnow survival so that they can spawn the following year. The goal for the Survival Strategy is to maximize recruitment of silvery minnows into the reproductive population for the next spring spawn by supporting wetted river from May and June through October. In years with sufficient water, reducing river drying from May and June through October can be accomplished by natural flows after a successful spring spawn. In years that are very dry [as described in Reclamation (2015, Part II)], available water will be used to keep silvery minnow habitat wet during the summer in order to maximize silvery minnow survival into the next spring. Leased water is either SJC Project water that is added to the MRG system, or water that is purchased from native water rights owners. The water is purchased by Reclamation or other parties and is managed with the help of the MRGCD to augment summer flows to keep silvery minnow habitat wet at key locations in the MRG - specifically the Isleta and San Acacia Reaches. Purchases and leases of water for the aforementioned purposes have been ongoing since 1997 (Service 2003b). The Conservation Measures that address this component are listed below, described in Table 1, and Reclamation (2015, Part IV).

Part Two of the Silvery Minnow SRS involves restoring river connectivity.

Angostura, Isleta, and San Acacia Diversion Dams disconnect reaches of the MRG. This disconnection precludes the movement of silvery minnows between reaches of the river. The goal of reconnecting the river is to enhance the chances for silvery minnow survival by allowing fish movement between reaches. This movement is important to the survival of the species because it provides access to additional suitable habitat and genetic connectivity for the species. Connectivity can be accomplished using fish passages. Fish passages are any methods allowing fish to swim or be transported around or through barriers (i.e., diversion dams). Constructing fish passages around the Angostura, Isleta, and San Acacia Diversion Dams will allow silvery minnows to move more naturally from areas in the river channel that are experiencing drying or degradation of water quality to more suitable habitat above and below these diversion structures. Fish passages may reduce or remove the need to rescue or salvage fish as the river begins to dry. They will also provide for genetic connectivity throughout the occupied reaches of the MRG. The Conservation Measures that address this component are described in Table 1 [see also Reclamation (2015, 2016b)].

Part Three of the Silvery Minnow SRS involves large-scale habitat restoration and enhancement in the Isleta and San Acacia Reaches.

The goal of this part of the Silvery Minnow SRS is multifaceted. Habitat restoration and enhancement in the Isleta and San Acacia Reaches will target restoration of floodplain function so that overbanking can occur at lower flows. These actions will reduce the total volume of water required for successful silvery minnow spawning because more spawning and survival habitat will be available at lower volumes. Another important goal of habitat restoration is to increase the length of perennially wetted river in these two important reaches. This goal is important because it promotes survival and recovery. See habitat restoration section below for details.

Part Four of the Silvery Minnow SRS involves the establishment of Conservation Storage.

Conservation storage is the creation of storage capacity for available water in upstream reservoirs. Conservation storage is important because it can be used to augment flows to promote survival and recovery of listed species. The goal of conservation storage is to create space for approximately 30,000 to 60,000 acre-feet (ft) of capacity. Stored water will provide opportunity to augment flows for the purpose of sustaining silvery minnow, cuckoo, and flycatcher habitat. Reclamation, BIA, and the BA Partners will use stored water during dry years to augment flows. The Conservation Measures describe how storage will be accomplished over the next 15 years [see details in Reclamation (2015, Part IV)].

Agency Specific Conservation Measures

The specific Conservation Measures developed to minimize and avoid anticipated adverse effects of the Proposed Action, committed to by Reclamation, BIA, MRGCD, and the State, are listed in Table 1 and include the following:

1. Reclamation's Conservation Measures:

   Reclamation will use adaptive management through the RIO to manage the river. Reclamation will continue leasing water, as part of its Supplemental Water Program, and use SJC Project waivers of mandatory release dates from Heron Reservoir to ensure the implementation of Conservation Measures, such as keeping the river wet from May and June through October and increasing flows during silvery minnow spawning season. In addition, Reclamation will coordinate with other parties to establish water storage capacity when water becomes available. Conservation storage will be used to provide water to sustain silvery minnow, cuckoo, and flycatcher populations. Finally, Reclamation will work with other parties to modify operations and adjust timing of storage at El Vado Reservoir, within current authorizations. These actions will be used to augment the spring flows (Production Strategy) and summer and fall flows (Survival Strategy).

Reclamation will monitor listed species and habitat and implement silvery minnow captive propagation, genetic management, and salvage (Reclamation 2015, Table IV-2).

2. BIA's Conservation Measures:

   BIA will work with interested Pueblos who wish to participate to assist them with the development of species habitat, facilitate exchange actions for management of Prior and Paramount stored water [water stored in El Vado Reservoir, even under storage restrictions imposed by the Rio Grande Compact (Mann 2007)], and assess conditions of irrigation facilities on Pueblo lands to identify ways to increase efficiency of the irrigation infrastructure. Nothing in the Compact shall be construed as affecting the obligations of the United States of America to Mexico under existing treaties, or to the Indian Tribes, or as impairing the rights of the Indian Tribes. Additional BIA commitments to ensure the accomplishment of Conservation Measures are described in Reclamation (2016a, b).

3. MRGCD's Conservation Measures:

   MRGCD will work with other water management entities (Reclamation, USACE, ABCWUA, etc.) to ensure the development of conservation storage in upstream reservoirs, modify reservoir operations, and continue to adjust timing of water storage and exchanges, and other measures. Additional MRGCD commitments to ensure the accomplishment of Conservation Measures are described in Reclamation (2016a, b).

4. The State's Conservation Measures:

   The State will provide relinquishment credit for storage and later release of water to benefit listed species (Table 1). Relinquishment credits are generated when water delivery to Texas is above Compact delivery requirements. These credits can be stored in reservoirs. The State will provide senior consumptive use rights from the Strategic Water Reserve to offset the depletion impacts of specific habitat projects (NMISC 2008). Senior consumptive use rights are water rights held by senior water rights holders. Conservation Measures for which these water rights could be used include habitat restoration and spring flow augmentation. The State will maintain existing overbank habitat constructed by the State. Additional State commitments to ensure the accomplishment of Conservation Measures are described in Reclamation (2016a, b).

The specific Conservation Measures developed to address multiple species and the River system, which are committed to by Reclamation, BIA, MRGCD, and the State include the following categories:

1. RIO using Adaptive Management: Tools to meet RIO needs and goals, including some that are outside of existing authorities.

2. Restoration of River Connectivity: Measures to improve river connectivity at diversion dams.
3. Habitat Restoration: Measures to improve and create habitat for the needs of listed species.

Adaptive Management and Conservation

MRG water managers have previously used decision support tools that incorporate adaptive management (Murray et al. 2011). The need for adaptive management in the MRG was identified in the 2003 BiOp (Service 2003b). We expect the use of adaptive management will allow Reclamation, BIA, and the BA Partners to maximize conservation benefits under varying river conditions, and still provide for the needs of the MRG Water Managers. An example of this would be implementation of the RIO, as described below.

RIO (Reclamation 2015, Part IV)

Reclamation is proposing an approach for river operations termed the RIO, which will address species and water management needs and be based on adaptive management principles. Adaptive management is a systematic approach for improving resource management by learning from past management outcomes (Williams et al. 2009). Adaptive management will be used by MRG Water Managers to learn which Conservation Measures are most effective, and to test water management, species, and habitat relationship hypotheses in the Hydrobiological Objectives over time. The RIO would use hypothesis testing to improve understanding of how to manipulate MRG hydrology in order to meet the conservation needs of the silvery minnow and other listed species in the MRG over time. The RIO is Reclamation's plan for integrating the Hydrobiological Objectives (Appendix A) into river operations. A draft RIO decision tree has been developed (Gensler 2016a; Figure 2). The draft decision tree explains the alternatives the RIO may take under the two strategies in the Hydrobiological Objectives (Production and Survival). A final decision tree will be developed by Reclamation, BIA, and the BA Partners in early 2017. Further commitments to implementation of the RIO can be found in Reclamation (2016a). The Service recognizes the Reclamation, BIA, and the BA Partners need to consult when considering water management actions that may affect Indian Pueblos or Tribes.

5-year Adaptive Management Review (Reclamation 2015, Part IV)

Reclamation will implement a defined adaptive management process over the duration of the BiOp to allow for evaluation and adjustment of Conservation Measures at 5-year intervals. This adaptive management review will allow for lessons learned to be applied to the prioritization of Conservation Measures to improve resource benefits to listed species. The Conservation Measures would be reviewed, adjusted, and incorporated into milestones related to 5-year performance elements.

Best Management Practices (BMP)

BMPs minimize impacts to the River system from Project activities. The following is a list of actions for which there are BMPs that will be implemented by Reclamation, BIA, and the BA Partners (Reclamation 2015, Part III).

1. Rangeline Clearing [Reclamation 2015, III-31]
2. Timing of the Proposed Action [Reclamation 2015, III-32]
3. Water Quality [Reclamation 2015, III-32]
4. Equipment and Operations [Reclamation 2015, III-34]
5. Access and Staging [Reclamation 2015, III-35]
6. Vegetation Replanting and Control [Reclamation 2015, III-35]
7. Herbicide and Pesticide Use [Reclamation 2015, III-36]
8. Dust Abatement [Reclamation 2015, III-37]
9. Other Measures [Reclamation 2015, III-37]

STATUS OF THE SPECIES

Rio Grande Silvery Minnow

The silvery minnow was federally listed as endangered under the ESA in 1994 (Service 1994). The silvery minnow is known to occur only in the Rio Grande in a 280-km (174-mi) stretch of river that runs from Cochiti Dam to the headwaters of Elephant Butte Reservoir (Bestgen and Platania 1991; Dudley and Platania 2002). This includes a small portion of the lower Jemez River, a tributary to the Rio Grande north of Albuquerque (Service 2010a). Its current habitat is limited to about seven percent of its former range, and is split by three dams into four reaches.

In December 2008, silvery minnows were introduced into the Rio Grande near Big Bend, Texas as a nonessential, experimental population under section 10(j) of the ESA (Service 2008). Surveys through 2012 found the silvery minnow from near Presidio downstream through the Lower Canyon in the Big Bend area (Edwards and Garrett 2013). This indicates not only survival of the introduced population, but also both upstream and downstream dispersion. Reproduction may be limited as optimal conditions for reproduction do not occur with regularity, and further stocking efforts may be needed (Edwards and Garrett 2013).

The silvery minnow is reported to live from 2 to 3 years (Horwitz et al. 2011). Adults in the wild generally spawn during an approximate 1-month period in late spring to early summer (May to June) in association with spring runoff when water temperatures are between 18 and 24 °C (64 and 75 °F) (Platania and Dudley 2006; Turner et al. 2010). Silvery minnow is a pelagic spawner that produces thousands of semi-buoyant, non-adhesive eggs that passively drift while developing (Platania and Altenbach 1998). Silvery minnow egg and larvae downstream transportation was, historically, beneficial to silvery minnow populations because it allowed silvery minnow to recolonize downstream reaches impacted during periods of natural drought (Dudley and Platania 1997). Silvery minnow larvae are most abundant in habitats with little or no flow and relatively high water temperature (Pease et al. 2006). Additionally, prolonged and elevated spring flows resulting in overbank flooding of vegetated areas and formation of inundated habitats, combined with the delayed onset of low flows, appear to ensure successful recruitment of silvery minnow larvae (Dudley et al. 2016). The preference for a narrower range of physical habitat conditions by silvery minnow early life stages means that individuals are congregated into a smaller subset of areas within the river. These conditions most commonly occur in backwaters and secondary channel pools that are not directly associated with the main channel. Main channel habitats that have shallow and slow-velocity water are along the shoreline in areas where stream edges are not eroded (Dudley and Platania 2007).

Increases in spring discharge can increase the abundance of Age 0 and subsequently adults (Age 1 and older) and decreases (or poor runoff) in spring discharge can result in declines in the population (Archdeacon 2016). High spring runoff and multiple drying events within a year generally result in local extirpation of adult silvery minnow (Archdeacon 2016). Declines in silvery minnow diversity (including declines in mitochondrial DNA and microsatellite diversity) coincides with extensive drying in the MRG (Turner and Osborne 2007; Osborne et al. 2012). Inconsistent spring runoffs can result in unpredictable hydrologic connectivity and result in variation in the amount of suitable habitat for silvery minnow. Maintaining pelagic spawning species, such as silvery minnow, requires maintaining long, unfragmented river reaches (Perkin and Gido 2012). Reaches less than 100 km (62 mi) in length cannot support long-term self-sustaining populations of silvery minnow (Dudley and Platania 2007). Construction of fish passages will reconnect the four reaches. This reconnection will result in a continuous reach that is approximately 277 km (172 mi) long so it will be capable of supporting long-term, self-sustaining populations of silvery minnow.

Critical habitat for the silvery minnow was designated in 2003 (Service 2003a). Designated critical habitat extends 252 km (157 mi) from the Cochiti Dam downstream to RM 62.1, just north of Elephant Butte Reservoir, which equates to approximately 11,630 hectares (ha) (28,738 acres) (Figure 1). The silvery minnow has been extirpated upstream of Cochiti Reservoir (Service 2003a). The width of the critical habitat is defined as the area bound by existing levees; or, where no levees are present, as 91 m (300 ft) of riparian zone adjacent to each side of the bankfull stage of the river channel. The Pueblo lands of Santo Domingo, Santa Ana, Sandia, and Isleta found within this area were excluded from this designation (Service 2003a).

The primary constituent elements (PCEs) of the silvery minnow critical habitat are those elements of the physical or biological features in an area that provide for life-history processes and are essential to the conservation of the silvery minnow. The PCEs listed in the critical habitat designation for the silvery minnow are:

1. A hydrologic regime that provides sufficient flowing water with low to moderate currents capable of forming and maintaining a diversity of aquatic habitats, such as, but not limited to, the following: backwaters (a body of water connected to the main channel, but with no appreciable flow), shallow side channels, pools (that portion of the river that is deep with relatively little velocity compared to the rest of the

channel), 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 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 dissolved oxygen, increased pH).

For more detailed information on the silvery minnow's biology, status of the species, and critical habitat, see the Recovery Plan (Service 2010a), designation of critical habitat (Service 2003a), and recent BiOps that discuss current status of the species within the Angostura and San Acacia Reaches (Service 2015, 2016b). See the Environmental Baseline below for more details on the life history and demographics of the silvery minnow in the Action Area.

Southwestern Willow Flycatcher

The flycatcher was federally listed as endangered in 1995, without critical habitat (Service 1995). The flycatcher is a small, insect-eating generalist, neotropical migrant bird (Service 2002). It grows to about 15 centimeters (cm) [5.8 inches (in)] in length. It eats a wide range of invertebrate prey including flying, and ground- and vegetation-dwelling insects of terrestrial and aquatic origins (Drost et al. 2003). The flycatcher spends the winter in locations such as southern Mexico, Central and South America (Paxton et al. 2011).

Flycatchers use riparian habitats that are generally dense, shrubby, moist, and that have abundant flying insects (Service 2002). Riparian habitat is used throughout the flycatcher's range for breeding and stop-over habitat during their long-distance migration. Breeding habitat is largely associated with perennial (persistent) streamflow that can support the expanse of vegetation characteristics needed by breeding flycatchers. The hydrologic regime and supply of surface and subsurface water is a driving factor in the long-term maintenance, growth, recycling, and regeneration of flycatcher habitat (Service 2002).

At the end of 2007, 1,299 flycatcher breeding territories were estimated to occur throughout southern California, southern Nevada, southern Utah, southern Colorado, Arizona, and New Mexico (Durst et al. 2008). Some of the flycatcher breeding sites having the highest number of territories are found along the MRG and upper Gila River in New Mexico, and Roosevelt Lake and the San Pedro and Gila River confluence area in central Arizona.

Critical habitat was first designated in 1997, but was recently redesignated in 2013 (Service 1997, 2013a). San Ildefonso, Santa Clara, and Ohkay Owingeh Pueblo lands are excluded from designated critical habitat (Service 2013a). Range wide there are 84,568 ha (208,973 acres) of designated critical habitat.

The PCEs of flycatcher critical habitat are those elements of the physical or biological features in an area that provide for life-history processes and are essential to the conservation of the flycatcher. The PCEs listed in the critical habitat for the flycatcher are:

1. Riparian vegetation. Riparian habitat along a dynamic river or lakeside, in a 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 (*Salix exigua*), Geyer’s willow (*Salix geyeriana*), arroyo willow (*Salix lasiolepis*), red willow (*Salix laevigata*), yewleaf willow (*Salix taxifolia*), pacific willow (*Salix lucida*), boxelder (*Acer negundo*), tamarisk (*Tamarix* spp.), Russian olive (*Eleagnus angustifolia*), buttonbush (*Cephalanthus* spp.), cottonwood (*Populus* spp.), stinging nettle (*Urtica dioica*), alder (*Alnus* spp.), velvet ash (*Fraxinus velutina*), poison hemlock (*Conium maculatum*), blackberry (*Rubus* spp.), seep willow (*Baccharis salicifolia*), oak (*Quercus* spp.), rose (*Rosa* spp.), sycamore (*Platanus* spp.), false indigo (*Baptisia australis*), Pacific poison ivy (*Toxicodendron diversilobum*), grape (*Vitis* spp.), Virginia creeper (*Parthenocissus quinquefolia*), Siberian elm (*Ulmus pumila*), and walnut (*Juglans* spp.) and some combination of:

    a. Dense riparian vegetation with thickets of trees and shrubs that can range in height from about 2 to 30 m (about 6 to 98 ft). Lower-stature thickets [2 to 4 m (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;

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

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

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

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

For more detailed information on the flycatcher's biology, status of the species and critical habitat, see the Recovery Plan (Service 2002), designation of critical habitat (Service 2013a), 5-year review (Service 2014a), and recent BiOp (Service 2015). See the Environmental Baseline below for more details on the life history and demographics of the flycatcher.

Yellow-billed Cuckoo

The cuckoo was listed as threatened in 2014 (Service 2014b) and critical habitat was proposed (Service 2014c). Currently there is no recovery plan for the cuckoo. The western population of cuckoo is considered a "distinct population segment" (DPS) as opposed to a subspecies (Service 2014b). The cuckoo is a neotropical migrant bird that winters in South America and breeds in North America (Service 2014b). The cuckoo is typically a secretive and hard-to-detect bird with a distinct vocalization. In the Southwest, the cuckoo usually occurs in association with large areas of mature riparian cottonwood-willow woodlands and dense mesquite associations. However, recent survey efforts in Madrean oak and pine-oak woodland, juniper woodland, and dense Sonoran desert scrub have documented cuckoo breeding in these atypical vegetation types. This DPS is historically known from 12 states including: Washington, Oregon, California, Idaho, Nevada, Utah, Arizona, and parts of Montana, Wyoming, Colorado, New Mexico, and Texas. The estimated cuckoo population was summarized by the Service (2013a) and is provided in Table 2. Northwestern Mexico and Arizona are believed to have the largest populations of cuckoos, range wide (Table 2). New Mexico also contains important breeding habitat for cuckoos with approximately 15 percent of the estimated population found in this area.

Cuckoos generally arrive at their breeding grounds in mid-June with nesting starting between late June and late July. Nest clutch size is typically between two and four eggs (Halterman et al. 2016). Nesting may continue into September, but along the Rio Grande, nesting activity is typically concluded by mid to late August (Sechrist et al. 2009, 2012; Carstensen et al. 2015; Halterman et al. 2016). Both adults will tend to the nest, eggs, and young. Nest heights range from 1.3 to 13 m (4 to 43 ft) and the nesting cycle is extremely rapid, taking 17 days from egg laying to chicks fledging (Carstensen et al. 2015; Halterman et al. 2016). Cuckoos typically have one brood per year (Ehrlich et al. 1988); however, in circumstances where an abundance of prey is available; cuckoos can have up to three broods (Halterman et al. 2016). Fledglings are dependent on the adults for up to 4 weeks, and have shorter tails and paler coloration. Little is known about cuckoo survivorship or nesting success, but telemetry and banding evidence from the lower Colorado River suggests they could live at least 3 years (Laymon 1998), and that pesticides are suspected of causing reproductive failure (Gaines and Laymon 1984).

The PCEs of cuckoo proposed critical habitat are those elements of the physical or biological features in an area that provide for life-history processes and are essential to the conservation of the cuckoo. The PCEs listed in the 2014 proposed rule for the cuckoo (Service 2014c) are:

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

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

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

For more detailed information on the biology, status of the species and critical habitat, see the final listing and proposed designation of critical habitat rules (Service 2014b, 2014c), and recent BiOp (Service 2015). See the Environmental Baseline below for more details on the life history and demographics of the cuckoo.

ENVIRONMENTAL BASELINE

Regulations implementing the Act (50 CFR 402.02) define the environmental baseline as the past and present impacts of all Federal, State, or private actions and other human activities in the Action Area. Also included in the environmental baseline are the anticipated impacts of all proposed Federal projects in the Action Area that have undergone section 7 consultation, and the impacts of State and private actions which are contemporaneous with the consultation in progress. Included within the surface water and groundwater uses for the Action Area are the water uses of 18 federally-recognized Indian Pueblos (Taos, Picuris, Ohkay Owingeh, Santa Clara, San Ildefonso, Pojoaque, Nambe, Tesuque, Jemez, Zia, Acoma, Laguna, Cochiti, Santo Domingo, San Felipe, Santa Ana, Sandia, and Isleta) recognized and protected under Federal law, including but not limited to aboriginal, time immemorial water rights. These Federal Indian water rights in the Action Area are part of the environmental baseline and are not: 1) impaired by the Compact; 2) subject to State law restrictions; or 3) administered by the State.

Nothing in this BiOp precludes any new depletion that results from the exercise of senior Native American water rights within the Action Area and the Reclamation, BIA, and the BA Partners assume the risk that the future development of these water rights may result in increased depletions and/or shortages of water to junior users. Consistent with Article XVI of the Compact water is stored in El Vado each year regardless of Article VII restrictions to ensure that water can be provided to meet the demand of the six MRG Pueblos.

Rio Grande Silvery Minnow

The silvery minnow population in the Action Area is restricted to the 280 km (174 mi) between Cochiti Dam and the headwaters of Elephant Butte Reservoir. The occupied range is fragmented by dams into four discrete reaches: Cochiti Reach [35.9 km (22.3 mi)], Angostura Reach [65 km (40.4 mi)], Isleta Reach [85.5 km (53.1 mi)], and San Acacia Reach [93.7 km (58.2 mi) or more depending on the Elephant Butte Reservoir water level] (Service 2010a; Figure 1). Sampling studies documented the species in all four reaches (Cochiti, Angostura, Isleta, and San Acacia) at the time of listing in 1994. However, because of limits to Tribal land access, the silvery minnow has not been documented in the Cochiti Reach since 1994 and its status is currently unknown in this reach (Platania 1995; Buntjer and Remshardt 2005; Torres et al. 2008). Overall, the average area of adult silvery minnow habitat (Figure 3) within all reaches has generally remained the same over time, with the highest amounts in the Isleta Reach (after Bui 2016).

Silvery minnow habitat in the Action Area is fragmented so it restricts upstream movement of silvery minnows. This means fish movement is restricted by existing diversion dams and regulated flows separating the population into three occupied reaches. This fragmentation of silvery minnow habitat has limited the silvery minnow's movement and distribution in the upstream direction. Habitat fragmentation is a factor in the extirpation and persistence of "pelagic-spawning" fish species (Perkin and Guido 2010; Hoagstrom et al. 2011; Hoagstrom 2015).

The population of silvery minnow in the MRG is a mixture of wild fish, marked fish of hatchery origin, and the progeny of hatchery or wild fish (Atkins 2016). Reclamation has funded annual, as well as nearly monthly, seining efforts to sample small-bodied fishes in the MRG (between Angostura Diversion Dam and Elephant Butte Reservoir) and to estimate catch-per-unit effort (CPUE). For 23 years, the Rio Grande Silvery Minnow Population Monitoring Program (Silvery Minnow PMP) has systematically monitored the status and trends of the silvery minnow population in response to environmental phenomena and management actions (Dudley et al. 2016). The results of the Silvery Minnow PMP provide the best available scientific information upon which to evaluate and measure the long-term demographic trends of silvery minnow in the MRG.

The Silvery Minnow PMP uses a statistical model that considers the variability associated with CPUE in aquatic habitats to estimate the October density. This model is used to estimate silvery minnow density from the CPUE data (Atkins 2016). The October density is used for annual assessments because base flows at that time are relatively stable in most years (Atkins 2016). In this BiOp, we used the October density to:

- evaluate the recovery criteria (Service 2007a, 2010a);
- evaluate genetic and other criteria (Appendix A);
- assess the effects of the Proposed Action;
- formulate recommendations; and
- develop the Incidental Take Statement (ITS).

The long-term monitoring of silvery minnows has recorded fluctuations in the population of silvery minnow in the MRG. Silvery minnow population is highly correlated with hydrologic conditions, particularly the magnitude, timing, and duration of the spring runoff (Dudley and Platania 2009; Dudley et al. 2016). The capacity of the species to respond to good hydrologic years is dependent on a variety of factors including the previous year's survivorship and number of adults available to reproduce (Dudley et al. 2005; Dudley and Platania 2007). The highest collections of silvery minnow eggs in the MRG have occurred during mid-to-late May, with lower frequencies of eggs being collected in late May and June (Smith 1999; Platania and Dudley 2001, 2003). These data suggest there may be multiple silvery minnow spawning events during the spring and early summer, perhaps concurrent with multiple flow spikes; however, multiple cohorts and recruitment from late spawning have not been documented.

Population numbers are estimated in the fall (October) because this is the best representation of the population status. This period avoids the spike in the number of individuals from the spring spawning and the large mortality due to the summer drying. The fall sampling results are the best estimate of the more stable population that will be part of the breeding population the next spring season (Dudley et al. 2016). Fall silvery minnow numbers have fluctuated widely over the past two decades (1993 to 2015) (Figure 4). Dudley et al. (2016) found that numbers of silvery minnow were highest in 2005 (44.8 fish per 100 m^2), but silvery minnow was not detected in 2012 and 2014. While estimated densities of silvery minnow were notably lower from 2010 to 2014 as compared with 2007 to 2009, there was an increase in numbers in 2015 (0.16 fish per 100 m^2) (Dudley et al. 2016).

The available evidence suggests that silvery minnow have occupied reaches throughout the Action Area, that they are capable of long distance movement (silvery minnow can swim up to 125 km (77 mi) in about 73 hours), and that these movements have been documented (Platania et al. 2003; Bestgen et al. 2010; Archdeacon and Remshardt 2012a,b). Dams are barriers that prevent upstream movements of silvery minnow both to spawn and access wet reaches necessary for survival and recovery. The existence of barriers to silvery minnow movements adversely affects survival and recovery by restricting access to suitable habitat. Dams contribute to fragmentation of suitable habitat having negative effects on silvery minnow genetics. The genetic consequences of dams blocking silvery minnow movements are described in more detail by Alo and Turner (2005).

Abundance of silvery minnows in recent years has approached levels similar to those observed at the time of listing in the mid 1990's. For the past 14 years, population monitoring during the summer (post-spawn) showed yearly increases in silvery minnow densities in 9 of 13 years (no summer data was collected in 2009), but no increase in 2002, 2006, 2012, or 2014, indicating that little recruitment occurred in those years (Dudley et al. 2016). Decreases in the October silvery minnow densities from 2001 to 2002, 2005 to 2006, 2011 to 2012, and 2013 to 2014, were attributed to reductions in spawning and low recruitment during these years (Dudley et al. 2016). During standard population monitoring conducted in October 2012 and 2014, no silvery minnow were detected. These were the lowest October results since comprehensive monitoring began (Dudley et al. 2016). Dudley et al. (2016) found low spring flows have negative effects on abundance during the subsequent fall, while late season low flows could negatively affect downstream reach abundance, depending upon how early or late in the season these decreased flows occur.

Occupancy (how much area is occupied by silvery minnow) is also related to flow conditions. Analyzing silvery minnow occupancy is important because it is a criterion within the Recovery Plan and represents their distribution in the MRG. Silvery minnow distribution is important because if the fish are congregated in a small area they are vulnerable to harm caused by stochastic events. From 2006 through 2011, the Collaborative Program funded a study to investigate methods for estimating population size for the silvery minnow (Dudley et al. 2012). This study was structured to estimate the population of silvery minnow based on data collected from 20 sampling units in the Action Area. In 2008 October density counts, when there was high spring flow, silvery minnows occurred at all 20 sampling sites (Dudley and Platania 2008) (Table 3). In 2009, there was again high fall occupancy, with silvery minnows present at 19 of the 20 sampling sites (Dudley and Platania 2009). Monitoring data indicated there was approximately a 10 percent decline in silvery minnow occupancy per year from 2005 through 2015 (Table 3). A distribution in less than 50 percent of the habitat in the fall increases the risk of extirpation and lowers the likelihood of having a minimum viable population of silvery minnows (Appendix A).

The 2003 BiOp identified the need for captive propagation, augmentation, and research to help maintain the viability of the silvery minnow in the MRG. To address these needs, the Service, Reclamation, and the BA Partners developed a genetics management and captive propagation program at the Southwestern Native Aquatic Resources and Recovery Center (Southwestern ARRC), the Albuquerque BioPark Aquarium Aquatic Conservation Facility (BioPark), and the Los Lunas Silvery Minnow Refugium (LLSMR) (City of Albuquerque et al. 2013). The Southwestern ARRC maintains a captive brood stock, propagates fish for augmentation, conducts fish health monitoring and research, and provides public education. Activities at the BioPark include egg collection, captive propagation, augmentation, research, and outreach. The LLSMR conducts research, captive propagation, augmentation, and provides public education.

Due to the variation in the silvery minnow population, augmentation of the MRG with silvery minnows raised in a hatchery is a management action that has been taken to prevent extinction of the species; however, it may have negative genetic consequences if less diverse animals are stocked in excess. A thorough and detailed description of the augmentation program is described in the silvery minnow Recovery Plan (Service 2010a). The augmentation program follows a formal genetic management and propagation plan (City of Albuquerque et al. 2013). In 2016, a peer review of the augmentation program was conducted. The Service is addressing peer review recommendations (AMEC Foster Wheeler 2016). Augmentation of the wild population of silvery minnow with hatchery raised fish is expected to continue for the duration of this BiOp, but depends on annual silvery minnow density.

Since 2002, approximately 2.5 million hatchery-raised silvery minnows have been released in the MRG (Figure 5). Augmentation releases generally occur in the fall or early winter, although spring stocking may be done with overwintered fish under favorable conditions (Remshardt 2012a). Stocking rates for each reach are based upon the September capture rates at the monitoring stations (Remshardt 2012a). Augmentation has sustained the silvery minnow population throughout the Action Area as evidenced by the higher proportion of hatchery-reared silvery minnows in the river during years of low recruitment.

From 2002 to 2007, the Angostura Reach was the focus of testing augmentation efforts. Numbers of silvery minnow released prior to 2008 (before the protocol was initiated) varied greatly and may have been related more to production numbers and less on a specific target silvery minnow density in the Rio Grande. From 2008 to 2012, the Service did not augment the Angostura Reach (Remshardt 2012a). If the overall catch rate for the Angostura Reach dropped below 0.1 fish per 100 m^2 during fall (October) monitoring, augmentation would have been implemented in this Reach during that year as well (Remshardt 2012a). During this period, catch rates in Angostura Reach remained above the 0.1 fish per 100 m^2 threshold (Remshardt 2012a) and did not trigger the need for augmentation. Thus we concluded that no augmentation is necessary in this Reach if flow conditions maintain a continuous wetted river. However, in 2012 all reaches were augmented as estimated densities were below 0.1 (Archdeacon et al. 2016).

In addition to augmentation, salvage activities also take place in the MRG. During river drying, a salvage crew collects and relocates silvery minnow from isolated pools within disconnected reaches. Salvage activities are conducted according to a protocol developed by the Service (Archdeacon et al. 2014). From 2000 through 2015, approximately 751,078 silvery minnows were salvaged and relocated to wet portions of the reaches (Table 4) (Archdeacon et al. 2016). The numbers of salvaged silvery minnows were lowest during 2001, 2003, and 2014, which were years of intense drought (Table 4). These low numbers are due to poor spring spawning and subsequent poor recruitment during low flows. That is, a section (an area smaller than a reach) of river may stay dry during a drought year and never rewet and re-dry, resulting in that section needing to be salvaged only once. Repeated drying and rewetting episodes reduce the local abundance and distribution of silvery minnow. More than two drying occurrences in a given year greatly reduces the number of silvery minnows salvaged (Archdeacon 2016).

River sections susceptible to drying occur in the Isleta Reach, a 8 km (5 mi) section near Tome (RM 150-155), a 8 km (5 mi) section near the U.S. Highway 60 Bridge (RM 127-132), and in the San Acacia Reach on an extended 58 km (36 mi) section from near Brown’s Arroyo (downstream of Socorro) to Elephant Butte Reservoir (Service 2010a). Extensive fish kills, including silvery minnows, have occurred in these sections when the river has dried (Archdeacon 2016). Although it is possible to find dead silvery minnows it is impossible to accurately count every dead minnow in any given year because of delayed mortalities, predation by birds in isolated pools, small body size, and other factors (Smith 2003; Service 2010a). From 1996 to 2007, an average of 51 km (32 mi) has dried each year, mostly in the San Acacia Reach. The most extensive drying occurred in 2003 and 2004 when 96 and 109 km (60 and 68 mi), respectively, were dry. Most documented drying events lasted an average of two weeks before flows returned. In contrast, 2008 was considered a wet year, with above average runoff and at least an average monsoon season. As a result, there was no river intermittency or drying, and no silvery minnow salvage was conducted that year, which is the first time there has been no river drying since this information has been recorded (1996). In 2010, the majority of silvery minnow salvaged (70 percent) were from the San Acacia Reach (Remshardt 2012b). All of those silvery minnows were released into the wettest portion of the same reach in which they were salvaged (Remshardt and Archdeacon 2012). The majority of silvery minnows salvaged (60 percent) were again from San Acacia reach in 2011 (Remshardt 2012a) and 2012 (60 percent) (Archdeacon and Remshardt 2012c), although total numbers salvaged decreased for each of these years. This outcome reflects the greater number of drying and rewetting events that occurred in the San Acacia Reach during these 3 years (Table 4). In 2012 the river exhibited the greatest amount of drying since 2004, with approximately 82 km (51 mi) dried in the Isleta [30.9 km (9.2 mi)] and San Acacia [51.2 km (31.8 mi)] Reaches (Figure 6). The maximum duration of intermittency was approximately 15 weeks in the Isleta Reach and 6 weeks in the San Acacia Reach.

Any river impact that results in an adverse effect on the silvery minnow can result in a physiological stress response in individuals. Causes of the stress response in fish can be numerous and include natural life history functions (such as spawning), water properties (e.g., temperature, hypoxia, pH, salinity), suspended sediment, pollutants (chemical and noise pollution), pathogens, parasites, inadequate oxygen (hypoxia or exposure to air), environmental extremes, reduction of food resources, interruption of nutrient cycles, physical disturbance, swimming, and capture (e.g., netting), confinement, and handling by humans (Service 2003a, 2010a). Stress can cause changes in energy allocations with individuals from development, movement, feeding, reproduction, maintenance and growth to maintaining optimal conditions within the body of the individual. Silvery minnow physiological stress has been observed including parasites, skin ulcers, fin erosion, tumors, enlarged or reduced organs, organ discoloration, nodules, and other deformities (Lusk et al. 2012). Components of the Proposed Action that results in river system impacts such as mechanical activities, disturbance and water quality alterations may result in adverse effects to the silvery minnow and contribute towards or cause physiological stress response and altered energetic requirements.

Implementation of various RPA elements of the 2003 BiOp has not resulted in a change in the status of the silvery minnow in the Action Area. The status of the silvery minnow has not improved because sufficient water was not available during consecutive drought years. Because of drought conditions recent spring peak flows have not been adequate to maintain sufficient production and survival of silvery minnows.

Southwestern Willow Flycatcher

The Rio Grande Recovery Unit for the flycatcher encompasses the San Luis Valley, Upper, Middle, and Lower Rio Grande Management Units (Service 2002, 2011a, 2011b). Increases in the number of territories have occurred within this Recovery Unit, primarily due to increasing numbers within the MRG Management Unit (Albuquerque to Elephant Butte Reservoir). In 2002, a total of 197 territories were known to occur within the Recovery Unit, mostly along the mainstem Rio Grande (Sogge et al. 2003), representing 17 percent of the territories rangewide. By 2007, this number had increased to an estimated 230 territories (Durst et al. 2008). There were 344 territories detected in the MRG Management Unit in 2015 (Moore and Ahlers 2016). Since 1999, most territories within the MRG Management Unit (81 percent) have been located within the lower San Marcial Reach near Elephant Butte Reservoir (Moore and Ahlers 2016). In the MRG Management Unit, the numerical recovery goal is 100 territories, which has been far surpassed in most recent years (Moore and Ahlers 2016). The only other unit with large numbers of territories is the Gila Recovery Unit in southwestern New Mexico which had 659 (50 percent) of the rangewide total in 2007 (Durst et al. 2008). The amount of habitat available to flycatchers varies by reach. Table 5 estimates suitable habitat for flycatchers in the Action Area (Ahlers 2009; Siegle et al. 2013; Reclamation 2015).

Nest success has been on a downward trend in the Action Area in recent years. Since 1999, the overall nest success rate has been as high as 45 percent (Moore and Ahlers 2016). In 2014, the lowest nest success rate (28 percent) in the history of the monitoring effort was recorded, but rebounded to 40 percent in 2015 (Moore and Ahlers 2016). The periodically flooded upper portion of Elephant Butte Reservoir has proved to be the most productive area of the MRG Management Unit with 251 nests detected in 2015, approximately 80 percent of the total territories found within the Unit (Moore and Ahlers 2016). For the Rio Grande Basin, a total of 310 nests were monitored in 2015, producing an estimated 309 flycatcher young (Moore and Ahlers 2016).

Current status of the flycatcher within the Action Area is stable (management unit goal for flycatcher is currently surpassed). The trend in flycatcher nest success has been quite variable in recent years and the number of breeding territories is anticipated to decline due primarily to climate change impacts to habitat and prey base; habitat loss due to the saltcedar leaf beetle; and succession of riparian vegetation to an unsuitable state for flycatchers. However, at this time we cannot quantify this anticipated decline due to a lack of information. Reclamation will monitor flycatchers for the duration of this BiOp.

Yellow-billed Cuckoo

Formal cuckoo surveys in the Action Area were started in 2006. From Isleta Pueblo to Elephant Butte Reservoir, the population has ranged from a low of 73 territories in 2011 to a high of 121 territories in 2012 (Carstensen et al. 2015). There were 110 cuckoo territories found during the 2015 breeding season (Ahlers et al. 2016). Of the 110 territories, 59 (54 percent) were located in the lower San Acacia Reach, with 13 territories found along the LFCC Outfall. Habitat suitable for nesting activity ("suitable" or "moderately" suitable habitat) within the Action Area is estimated to be 3,795 ha (9,378 acres) [calculated from data in Reclamation (2015 Part III), and Siegle et al. (2013)]. The status of the cuckoo within the Action Area is currently stable.

Because there is no cuckoo suitable habitat model, we used areas of suitable or moderately suitable habitat derived from the Flycatcher Habitat Suitability Model (Siegle et al. 2013). We found similarities between the two species including the use of dense riparian, mainly native, vegetation with successional age classes of vegetation for nesting activity (or multilayered structure). Cuckoos have large territories, extending an additional 72 ha (178 acres) in less suitable habitat past the minimum of 5 ha (12 acres) of core nesting areas (Halterman et al. 2016). Though cuckoos occupy larger patch sizes than the flycatcher, the size of the habitat patch is not the determining factor of habitat suitability from the flycatcher model. Instead, the structure, density, and species composition are the contributing factors (Siegle et al. 2013). A cuckoo specific habitat suitability model is anticipated to be created and quantified within the next 5 years. Once the additional analyses are complete, data for cuckoo will be reevaluated. The PCEs of designated flycatcher critical habitat and proposed cuckoo critical habitat are similar. Both require dynamic riparian environment with successional age classes of vegetation, consisting of similar species and structure. Therefore, we assume the habitat suitable for the flycatchers can be used as a surrogate for cuckoo habitat as the two species have similar habitat requirements at this spatial scale (Service 2013a, 2014b).

Factors affecting species environment within the Action Area

The effects of human activities and environmental conditions have contributed to the current status of the silvery minnow, flycatcher, and the cuckoo, as well as the condition of their habitats in the Action Area, and potentially affect the survival and recovery of these species. Specifically, these factors are:

- Hydrology
- Geomorphology
- Habitat restoration
- Collaborative Program Activities Implementation
- Past Federal Projects (i.e., projects with a Federal nexus)
- Water Quality
- Riparian Vegetation Dynamics
- Other

Hydrology

Effects to hydrology in the Action Area are summarized (more specific descriptions are found below) by the following:

- Natural snowpack, upstream water use, rain events, and air temperatures/evaporative losses define the quantity of water available to the MRG.

- The Compact, which apportions flows and provides for upstream states to deplete their apportionment, further defines the quantity of water available to the MRG.

- Demand for water exceeds supply of water; the MRG is a fully appropriated river system.

- The magnitude, duration, and timing of spring runoff have been altered by natural and human changes to the system. The river ecosystem and the life histories of the native species depend upon the amount and timing of spring runoff.

- Surface water is removed from the MRG through diversions, aquifer recharge, evaporation, and evapotranspiration.

- Surface water is added/supplemented to the MRG by water storage in upstream reservoirs, which can be released during summer and through nonnative SJC Project flows, the quantities of which are limited by Federal authorization and by supply.

- Use of groundwater can supplement or deplete surface water, and can contribute to river intermittency. Past pumping can have continuing impacts on the river.

- The MRG experiences low flows, flow intermittency, and river drying during parts of the hottest time of the year when water demands are highest (e.g., evapotranspiration, irrigation, etc.).

- Sublethal impacts of various chemicals contribute to the overall conditions of environmental stress in the MRG.

- Seasonal and diurnal variation of water temperatures downstream of Cochiti Dam are impacted by releases from Cochiti Reservoir (USACE et al. 2007). Based on these releases, the downstream water temperatures can be warmer during winter and summer, and colder during spring and fall (USACE 2013a).

- Overall, the current hydrology of the MRG system has resulted in a degradation of silvery minnow habitat, with potential adverse consequences on species viability.

Rio Grande Compact

Compliance with the Compact is mandated by law (Public Act No. 96, 1939), and therefore the Compact has a definite role in quantification of the MRG water supply [Littlefield 1999; S.S. Papadopulos and Associates (SSPA 2004)]. The States of Colorado, New Mexico, and Texas agreed upon the Compact for “the purpose of effecting an equitable apportionment of water in the Rio Grande.” The specified percentage of flow in the Rio Grande delivered to the next lower state is complicated by accounting methods, storage, credits, debits, and spills (Wolfe et al. 2016). The percentage increases on a sliding scale in correlation with the Rio Grande and tributary flows. Depending on the year’s flow, Colorado must send between 35 and 75 percent of water downstream and New Mexico must send between 57 to 86 percent downstream to Texas (Coleman 2013; SSPA 2004). The percentage that New Mexico must deliver to Texas is based on the amount of inflow in the Rio Grande as measured in the Rio Grande at Otowi gage (USGS 08313000), with adjustments for SJC Project water. The amount of surface water available for consumption in the MRG therefore, is the difference between the native inflow and the State’s delivery obligation of water to Texas, surface or groundwater inflow between Otowi and Elephant Butte Reservoir, and the SJC Project water (SSPA 2004). The Compact provides incentives for New Mexico to minimize transport losses of water. Pursuant to Article XVI, nothing in the Compact shall be construed as affecting the obligations to or impairing the rights of Indian Tribes (Rio Grande Compact Commission 1939). Consistent with Article XVI of the Compact, water is stored in El Vado each year regardless of Article VII restrictions to ensure that water can be provided to meet the demand for the six MRG Pueblos.

MRG Water Use

The water supply of the MRG includes surface water from the Rio Grande and Rio Chama originating in Colorado and Northern New Mexico (native flow), surface water from the Colorado River system delivered through the SJC Project (imported water), tributary surface water flowing to the Rio Grande from perennial and ephemeral tributaries between the Otowi gage and Elephant Butte Dam (native flows), and groundwater of the Albuquerque Basin, Socorro Basin, and other aquifers that are connected to the Rio Grande (SSPA 2004). The surface waters of the Rio Grande have been considered fully appropriated (Turner 2000).

Surface Water

<u>Peak flows</u>

Peak flows in the spring occur in the MRG from snow melt runoff. Snow melt depends on the available snowpack in the spring. One of the major ecological consequences of climate change is a shift from spring peak flows to earlier peak runoff events in snowmelt-dominated regions (Frederick and Gleick 1999; Poff et al. 2002; Reclamation 2011, 2013b, 2016c). The timing of spring streamflow in the Rio Grande during the last 5 decades has advanced so that peak flow now arrives 1 to 4 weeks earlier, resulting in less flow in the summer (Stewart et al. 2004; Bui 2011; Krabbenhoft 2012). Earlier peak runoff has substantial impacts on water resources management including irrigation, geomorphology, recreation, flood control, and instream flow for fish (Reclamation 2011). These changes in the timing of peak flows have affected the reproductive success of the silvery minnow (Platania and Hoagstrom 1996; Magana 2009; Krabbenhoft et al. 2014).

<u>Volume</u>

Volume is the amount of water, typically measured in acre-ft, which flows in the river over a given period of time. Total annual volumes fluctuate greatly from year to year because of differences in annual snowpack, groundwater levels, soil moisture, spring temperatures, precipitation, drought, riparian evapotranspiration, drains, and water diversions. Silvery minnow density has been found in Service analyses to be directly related to the annual volume in the MRG, with high silvery minnow densities in the fall associated with high spring volumes (Table 6). Volume decline can also result in river drying.

<u>Storage</u>

There are five water storage reservoirs, Heron, El Vado, Abiquiu, Cochiti, and Elephant Butte, in the Action Area. Cochiti and Elephant Butte Reservoirs are on the River mainstem. The operation of these reservoirs affects the timing of water availability in the MRG. Storage in these reservoirs allows delivery of water during strategic times for the silvery minnow, but improper timing of the releases can have a negative effect on the silvery minnow.

Groundwater

Withdrawal

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 riparian habitat (Briggs 1996; Reclamation 2004). Depletion of groundwater in the MRG results in loss of water from the river into the groundwater system which would normally replenish the water that has been removed (SSPA 2005). Groundwater withdrawals not only reduce flow volumes, but may also contribute to river drying, either locally and intermittently, or across long reaches for significant periods of time. In addition, decreased alluvial groundwater levels may result in mortality of riparian vegetation. Lower groundwater levels may reduce soil moisture that is important for flycatcher and cuckoo nesting conditions and abundant prey populations (Service 2002, 2014).

The historical rate of groundwater pumping within the Albuquerque reach has been reduced due to the use of SJC Project water. In 1999, it was estimated (Bartolini and Cole 2002) that 170,000 acre-ft per year were pumped from the river-connected aquifer in the MRG, up to 110,000 acre-ft of which were pumped by the Albuquerque-Bernalillo County Water Utility Authority (ABCWUA) for use in the Albuquerque metropolitan area (ABCWUA 2010).

Currently, ABCWUA expects that approximately 58 percent of its demand will be met with groundwater (ABCWUA 2013). Ultimately, the water pumped is made up for by seepage from the river into the groundwater system. Wilcox (2003) identified large water losses to aquifer recharge in the San Acacia Reach averaging 55 percent of surface flow. Groundwater recharge throughout the MRG was estimated in 1999 to total 295,000 acre-ft per year (SSPA 2004).

Groundwater pumping causes dewatering of both shallow and deep aquifers, resulting in a steady loss of water from the river (SSPA 2004). ABCWUA makes a substantial contribution to river flow downstream of Albuquerque from pumped groundwater and treated drinking water returned through its wastewater treatment plant (WWTP).

Water Depletion

Passell et al. (2003) divided surface water depletions into four broad classes: open-water evaporation, evapotranspiration from riparian vegetation, agricultural evapotranspiration, and municipal consumption.

The MRG Water Supply Study Phase 3 (SSPA 2004) reports consumption (depletions) as distributed in the following proportions:

- Riparian evapotranspiration (37 percent)
- Reservoir evaporation (25 percent)
- Agriculture (26 percent)
- Open water evaporation (9 percent)
- Municipal (3 percent)

The effects of water loss in the MRG can be measured by the difference in flow at the Albuquerque, San Acacia, and San Marcial Gages, which illustrates general upstream to downstream differences. Water depletion in the MRG reduces overall river flows for silvery minnow spawning, decreases the amount of overbanking that supports silvery minnow nursery habitats, reduces riparian vegetation available for flycatcher and cuckoo, and increases intermittency and river drying.

Low Flows and River Drying

Prior to measurable human influence on the system, up to the 14th century, the Rio Grande was an intermittent, aggrading river with a shifting sand substrate (Biella and Chapman 1977). Historically river drying occurred during droughts (Scurlock 1998). River drying occurred more frequently as humans exerted greater influence on the river through increased irrigation. Increased irrigation, especially during drought conditions, resulted in significant reduction of river flows and increased drying in the MRG (Scurlock 1998).

The amount and duration of drying has varied over the years, reflecting regional drought conditions and channel morphology (Scurlock 1998). River sections (areas smaller than reaches) particularly susceptible to drying occur in the Isleta Reach near Tomé (8 km (5 mi) RM 150 to 155), near the U.S. Highway 60 Bridge (8 km (5 mi) RM 127 to 132), and in the San Acacia Reach from near Brown Arroyo (downstream of Socorro) to Elephant Butte Reservoir (48-58 km (30-36 mi) RM 74 to 105)(Archdeacon 2013b).

From 2001 to 2015, an average of 53 km (33 mi) of the Rio Grande has dried each year, mostly in the San Acacia Reach (Table 6). The most extensive drying occurred during the drought years of 2003 and 2004, when 113 and 110 km (70 and 68 mi), respectively, dried. In 2012, 82 km (51 mi) or approximately 31 percent of the critical habitat, experienced drying (see Table 6). The longest duration drying has occurred within the very recent history with approximately 117 days of drying in 2012.

Availability of sufficient summertime flows is of particular importance for survival of silvery minnow, and to regeneration and maintenance of flycatcher and cuckoo habitat in the MRG. When groundwater levels decline intermittency and river drying may increase. These changes can result in mortality of the native trees and shrubs in which flycatcher and cuckoo nest, and may cause a narrowing or contraction of the riparian corridor or may increase soil salinity (Parametrix 2008). Smaller reductions in streamflow or fluctuations in groundwater levels by as little as 1 m (3 ft) during the growing season can cause plants to undergo physiological stress and lose productivity, with possible adverse implications for riparian habitat (U.S. Department of Agriculture 2003). Even short-term loss of surface flows may reduce productivity and biomass, and degrade habitat quality by stressing insects with aquatic larval forms that serve as food for certain migratory birds, including flycatcher and cuckoo.

Low flows occur as part of the natural hydrograph in the MRG, and silvery minnow populations can generally persist through unfavorable conditions (Goodman 2012). However, at some levels and duration, genetic loss has occurred to silvery minnow (Alo and Turner 2005; Osborne et al. 2012). As the distribution of silvery minnows is reduced, the probability that stochastic events or river drying can extirpate the fish increases (Norris et al. 2008; Miller 2012; Dudley et al. 2016).

Infrastructure

This section provides an overview of some of the major environmental effects of MRG water resources infrastructure. Infrastructure has impacted the intensity of flows, geomorphology, water quality, and persistence of riparian vegetation within the Action Area (Appendix C).

- Dams fragment the river, restrict sediment movement, and create barriers to fish movement.

- LFCC intercepts groundwater and recaptures draining water from the river, which is then returned to the river downstream and helps support flycatcher habitat.

- Levees confine the river channel and limit floodplain functionality.

- Ditches, drains, canals, and laterals occupy parts of the historical floodplain including designated flycatcher or proposed cuckoo critical habitat.

The dams constructed on the Rio Grande and its tributaries alter magnitude, timing and duration of peak flows. Dams also capture and store sediment over time in reservoirs, reducing the supply to downstream reaches of the MRG (Lagasse 1980). The dams also fragment the naturally continuous river channel. Historically, it is known that silvery minnow were found as far north as Velarde, New Mexico (Sublette et al. 1990). Thus, Cochiti Dam fragments the historical range of the silvery minnow and Angostura, Isleta and San Acacia diversion dams fragment currently occupied habitat. By changing the flow, sediment, nutrients, energy, and biota, these dams and reservoirs interrupt and alter some of a river's important ecological processes (Ligon et al. 1995) and the ability of the silvery minnow to meet its life history requirements.

Upstream of dams, previous floodplain and river channel habitats are often inundated, either permanently or periodically, so that the riparian habitat associated with them is lost (Graf et al. 2002). Dams have played a role in the decline of riparian cottonwood and willow forests throughout the western U.S. (Rood and Mahoney 1990; Braatne et al. 1996). The impoundment of water and sediment upstream from dams causes changes in the fluvial hydrology and geomorphology of the river because of inundation and the change in stream gradient as the streamflow enters the reservoir area. The upstream portion, where the stream enters the reservoir, is a dynamic zone where deposition of sediment creates a delta because the reservoir pool reduces the energy gradient of flow. The delta surface offers moist sand deposits suitable for vegetation growth. If reservoir levels are stable for 3 to 5 years, substantial riparian vegetation may develop, only to be destroyed by changes in reservoir elevation at a later time. If the new levels remain relatively unchanged [that is, water levels do not fluctuate more than about 6 meters (m) (20 feet) for another 3 to 5 years], new deposition and riparian vegetation growth will develop (Graf et al. 2002). The Lower San Acacia Reach provides habitat for the largest population of flycatchers rangewide (Moore and Ahlers 2015), and a substantial cuckoo population. However, if the water levels remain unchanged for a prolonged period of time (15-20 years) vegetation will eventually over mature and lose suitability for flycatcher and cuckoo.

The 113-km (70-mi) LFCC, a deep narrow artificial channel designed to receive Rio Grande flows, was constructed alongside the Rio Grande between San Acacia and Elephant Butte in 1951, and diversions from the Rio Grande at San Acacia also began in 1959 (Gorbach 1999). The LFCC conveyed a majority of Rio Grande flows in the 1960's through the 1970's (Gorbach 1999). The LFCC reduced flows in the river channel by diverting up to 2,000 cfs from the late 1950s through the early 1970s. The LFCC caused attenuation of peak flow spikes in the lower portion of the Action Area, which resulted in some of the lowest peak flows recorded. In 1985, diversions at San Acacia to the LFCC were suspended.

Although Rio Grande water is no longer actively diverted to the LFCC, it continues to carry seepage flows and irrigation returns to Elephant Butte (Gorbach 1999). The LFCC creates a barrier that intercepts water seeping from the river and prevents that water from raising the valley's water table (Reclamation 2000). In addition, the LFCC serves as the primary drain for the agricultural lands of the Socorro Valley, is used by the MRGCD to provide water to Socorro irrigators, and to support wildlife habitat and farming practices at BDANWR. Pumps have been installed at sites along the LFCC to pump some of the water that has accumulated in the LFCC to the river during drying periods. Other sections of the LFCC and LFCC Outfall support wide expanses of riparian habitat for large populations of nesting flycatchers and cuckoos. Levee maintenance (raising and reinforcing) contributes to the prevention of levee breaches and the natural flooding process into portions of the LFCC.

Based on the information above, the Service has determined that the volume of water in the LFCC is an indirect effect of the Proposed Action (including river maintenance, levee maintenance, LFCC maintenance, MRGCD irrigation delivery, irrigation water return, pumping operations, habitat restoration, credit relinquishment water, etc.). The volume of water in the LFCC is an indirect effect because it is caused by or results from the Proposed Action, it will occur later in time, and it is reasonably certain to occur because the LFCC is never dry and is predominately river water (Newton 2004).

The lateral extent of the floodplain from Cochiti Dam to Elephant Butte Reservoir is generally defined by levees with their associated riverside drains. There are approximately 377 km (234 mi) of levees in the Action Area. Levees create lateral confinement of the floodplain and limit channel migration. Lateral confinement results in severe disruption of natural fluvial processes throughout the floodplain (USACE 2012a; Service 2013b). The sinuosity and braiding in the Rio Grande dropped between 1949 and 1962 due in part to channelization activities, erosion control, levee construction, and decreased flow and sediment (Massong et al. 2008; Makar and AuBuchon 2012). These activities generally continue to limit lateral channel migration and reduce the functional areas of the floodplain. The limited functional floodplain reduces suitable habitat for the silvery minnow, flycatcher, and cuckoo.

There are also approximately 1,930 km (1,200 mi) of ditches, drains, canals, and laterals in the Action Area (SSPA 2004). Some of this infrastructure is located in areas that previously supported riparian habitat occupied by flycatcher and cuckoo (Service 2013a, 2014c). These structures provide water sources for riparian vegetation in areas where groundwater levels have declined to the point that riparian vegetation is not supported.

Geomorphology

Channel conditions and dynamics that make up geomorphology can be summarized as follows (details regarding channel conditions and dynamics follow this summary):

- Important factors that control geomorphology include flow frequency, magnitude, and duration, sediment supply, and anthropogenic factors.
- The channel and floodplain have been altered by dams, levees, and erosion control structures. In addition, the floodplain has been further modified by canals, ditches, drains, and development.
- The exclusion of upstream sediment supply by Cochiti Dam has led to rapid downstream river channel narrowing and coarsening of the river bed substrate. Cochiti Dam and Reservoir continue to modify peak flows and store sediment.
- The effects of river regulation and water operations result in a continuation of the above-listed geomorphic trends.
- The current floodplain and channel conditions are not beneficial to habitat requirements of silvery minnow, flycatcher, and cuckoo. These detrimental geomorphic trends have had unfavorable consequences on species viability.
- The major geomorphic trends observed on the MRG include (Makar and AuBuchon 2012):
  - Channel narrowing
  - Channel incision
  - Channel aggradation, or sediment plugging
  - Increased channel uniformity
  - Vegetation encroachment
  - Bank erosion
  - Floodplain aggradation
  - Coarsening of bed material

The historical MRG channel was an aggrading river system with a wide, sandy, braided river channel with an extensive floodplain and wetland system inundated during high flows (Crawford et al. 1993; Scurlock 1998; Stoltz 2000; Service 2002; Massong et al. 2006; Makar 2010).

Human induced changes in water and sediment inputs have resulted in major adjustments to the MRG channel (Lagasse 1980; Shafike 2002; Julien et al. 2005; Makar 2010; Swanson 2012; Julien and Rainwater 2014). Reductions in peak discharges, changes in sediment delivery, river engineering, and vegetation encroachment played varying roles in shaping the geomorphology, bed texture, and topography of the MRG channel over time (Makar 2010; Swanson 2012; Julien and Rainwater 2014).

Flood control and channel stabilization measures were implemented from the 1920s to 1960s, including the installation of jetty jacks to trap sediment and direct flow; dredging to produce narrower; deeper channels; and construction of tributary dams to capture sediment (Swanson 2012). Cochiti Dam began operations in 1973 for flood control and sediment retention. This reduction in sediment supply resulted in channel narrowing and incision in the Cochiti and Angostura Reaches that continues today (Lagrasse 1980; Julien et al. 2005; Schmidt and Wilcock 2008; Swanson 2012).

Channel narrowing has occurred throughout the MRG due to decreased peak flows, changes in sediment supply, increased bank stability, increased floodplain confinement, and decreased floodplain connectivity. Irrigation and drainage ditches that remove water from the active channel, and diversion dams that trap sediment and attenuate floods have also help reduce channel widths (Ward and Stanford 1995; Swanson 2012). Levees and jetty jacks were often placed within the active channel, as well as the floodplain, directly contributing to channel narrowing.

Once flood control and erosion control measures were implemented, the river channel narrowed through vegetation encroachment on bars and islands that were no longer cleared by flooding. Current hydrology and flood control operations for safe channel capacity make a flood event large enough to destabilize the current vegetation unlikely.

Channel incision has occurred from Cochiti Dam to Isleta Diversion Dam because sediment supply is reduced from upstream reservoirs. The low water elevation at Elephant Butte Reservoir is one of the causes of channel incision in the San Acacia Reach from the southern boundary of BDANWR to the Reservoir pool level (Reclamation 2013a). This has disconnected the channel from the surrounding floodplain in some areas. However this is a trend that is expected to reverse itself once water surface elevation in Elephant Butte Reservoir rises again.

One physical change on the MRG is the loss of sand on the channel bed resulting in a gravel-dominated bed (Massong et al. 2008). This coarsening of bed material associated with Cochiti Dam operations has slowly progressed downstream to the Angostura Reach (Massong et al. 2008). Silvery minnows prefer sand substrates and their absence in the Cochiti Reach may be due to the change to a gravel-dominated channel bed (Dudley and Platania 1997; Torres et al. 2008).

Floodplain aggradation (floodplain elevation increases due to sediment accumulation) in the San Acacia Reach is likely the result of the combination of high sediment supply, reduced flow velocities, increased bank stability, higher Elephant Butte Reservoir pool base level, channel constriction (San Marcial Railroad Bridge), and increased floodplain lateral confinement (Makar and AuBuchon 2012). Levee construction in the MRG is known to restrict floodplain width (USACE 2012b). The constrained floodplain impairs the functionality of the river ecosystem and has negative effects on silvery minnow, flycatcher, and cuckoo.

The historical floodplain has been reduced by levees paralleling much of the river. Aggradation can cause the floodplain within the levees to become perched (elevated above the adjacent area outside the levees). Where floodplain elevation is higher than the adjacent drain canals, the river channel can lose water (SWCA 2013). Therefore, perched channel conditions contribute to intermittency by removing water from the river channel.

Floodplain and river channel area from Cochiti Dam downstream to Elephant Butte Reservoir has declined 52 percent since 1935 (Crawford et al. 1993). This has resulted in less habitat area for silvery minnow, cuckoo, and flycatcher.

Habitat Restoration

In 2004, a framework habitat restoration plan for the MRG was developed to serve as a guide for implementing restoration activities throughout the silvery minnow and flycatcher's occupied range (Tetra Tech 2004). This ongoing restoration plan outlines a "suite of actions" and habitat requirements that will be needed in order for habitat restoration efforts to be successful for the silvery minnow and flycatcher and is applicable to the cuckoo.

The habitat restoration plan includes the following habitat restoration actions for the silvery minnow:

- Maintain flows to promote populations of wild silvery minnow
- Maintain spring flow peak to stimulate spawning
- Establish conditions that reduce downstream displacement of eggs and larvae
- Establish a sustainable population of silvery minnow in the Angostura Reach
- Establish suitable feeding and cover habitat for juveniles and adults
- Reduce fragmentation associated with irrigation diversion dams

The plan also includes habitat restoration requirements for the flycatcher, which the Service anticipates could also have benefits for the cuckoo:

- Vegetation stands that are preferably 0.6 ha (1.5 acres) or larger
- Dense vegetation or dense patches interspersed with openings containing water or shorter stature/sparser vegetation
- Thickets of trees and shrubs ranging in height from about 2 to 30 m (6 to 98 ft), with dense vegetation occurring mostly within the first 3 to 4 m (10 to 13 ft).

Tetra Tech (2004) and Baird and Makar (2011) also describe some of the specific restoration techniques for future silvery minnow and flycatcher habitat restoration projects. These include the following techniques:

- Passive restoration
- Terrace and bank lowering
- High-flow, ephemeral side channels
- High-flow, bank-line embayments
- Arroyo connectivity
- Main channel widening

- Removal of lateral confinements
- River bar and island enhancement
- Destabilization of islands and bars
- Gradient-control structures
- Woody debris enhancement
- Sediment management
- Fish passage
- Removal and control of exotic vegetation
- Passive restoration of riparian vegetation
- Active restoration of riparian vegetation
- Hydromodification
- Wetland enhancement

Numerous habitat restoration projects have been completed in the MRG. Projects have been funded by many organizations including City of Albuquerque, Reclamation, NMISC, six MRG Pueblos, Service, and USACE. Examples of ongoing and completed projects include the following:

Cochiti Reach

- The Santo Domingo Pueblo completed a restoration project. This project totaled approximately 4 ha (9 acres) and involved the reconstruction of a historical side channel.

Angostura Reach

- BOR has completed work on sediment spoil pile removal. This work totaled approximately 8 ha (20 acres) of overbank improvements.

- The Pueblo of Santa Ana currently maintains 595 ha (1,470 acres) of bosque and historical floodplain along the Rio Grande for wildlife habitat. To date, 585 ha (1,445 acres) have been treated for saltcedar, Russian olive, and Siberian elm. Each year, the Pueblo revegetates 10 to 20 ha (25 to 50 acres) using native trees and shrubs as either live root or as poles. Past restoration work within the 19 km (6 mi) of the channel include three gradient restoration facilities designed to stop incision and allow for fish to pass, three backwaters, and numerous streambank stabilizations including bioengineering. In addition, 22 ha (55 acres) of dry river bar were lowered to allow for inundation at lower flows. The Pueblo completed further work on 8 ha (20 acres) of these river bar by creating ephemeral channels for aquatic habitat for larval and juvenile silvery minnows. An additional 28 ha (70 acres) of river bar restoration is planned for the next few years.

- BOR completed a restoration project on the Pueblo of Sandia. This project totaled approximately 14 ha (35 acres) and involved the construction of bendway weirs and placement of root wads.

- The Pueblo of Sandia completed a restoration project at 11 locations. This project totaled approximately 12 ha (30 acres) and involved the creation of backwater embayments, bankline benches, modifications to river islands and bars, placement of large woody debris, and seeding with native vegetation.

- The Pueblo of Sandia, in cooperation with the Service's Management of Exotics for Endangered Species Recovery program, cleared and revegetated 12 ha (29 acres) of bosque and completed in-channel modifications to an adjacent 4 ha (10 acres) island bar.

- The Pueblo of Sandia created a high-flow side channel approximately 610 m (2000 ft) in length [1 ha (2 acres) of area] along with 12 ha (30 acres) of nonnative removal and 8 ha (20 acres) of seeding. The entrance and exit of the channel were subsequently lowered to create floodplain habitat and the channel widened to allow wetland vegetation to spread [additional 1 ha (2 acres)].

- At the Rio Grande Nature Center, the USACE created a high-flow side channel [1.2 ha (3 acres)] that reconnects the Rio Grande with the bosque, and 4 ha (10 acres) of exotic vegetation removal and native shrub plantings.

- The NMISC has completed several habitat restoration projects in the Angostura Reach. These projects total approximately 64 ha (157 acres) and include such features as backwaters, embayments, scoured and terraced bank lines, modified islands, ephemeral channels, lateral constraint removal (e.g., jetty jacks), placement of large woody debris to create scour flows, and floodplain vegetation management.

- The City of Albuquerque completed a riverine and bosque habitat restoration project on approximately 23 ha (58 acres) of land managed by the City and the MRGCD. The project used techniques such as passive restoration, modification of islands and bars, construction of ephemeral channels, backwater channels and embayments, removal of lateral confinements, placement of woody debris, and active restoration of riparian vegetation.

- The USACE has completed a 49 ha (121 acre) bosque restoration project in the Angostura Reach. This project included the removal of jetty jacks and nonnative vegetation, the creation of three high flow channels, the enhancement of an outfall wetland, the creation of willow swales and planting of native vegetation.

- The New Mexico State Land Office, funded by the U.S. Forest Service, has begun work on a 9 ha (22 acres) riverine restoration project in the Angostura Reach that will involve riverbank terracing, placement of large woody debris, the creation of ephemeral and backwater channels, jetty jack removal, the removal and treatment of exotic species, and planting of native vegetation.

- The USACE has begun work on a bosque restoration project involving approximately 370 ha (916 acres) along 42 km (26 mi) of River. The project aims to improve hydrologic functions through the construction of high flow channels, willow swales and wetlands, and also to restore native vegetation and habitat through jetty jack removal, thinning of exotic species and revegetation with native species.

- The ABCWUA has proposed restoration of riparian habitat involving approximately 65 km (161 acres) in the Angostura Reach. The project will include nonnative vegetation clearing, floodplain expansion through jetty jack removal, channel widening and destabilization, terrace lowering to reestablish floodplain hydraulic connectivity, and construction of ephemeral (high flow) side channels. This project addresses mitigation requirements of the City of Albuquerque Drinking Water Project.

Isleta Reach

- The Los Lunas Habitat Restoration Project involved removing jetty jacks along 1.8 km (1.1 mi) of river bank, lowering 20 ha (50 acres) of river bank, contouring to integrate floodplain functions, and construction of side channels, wetlands, and other features.

- The MRGCD has completed three woody debris installation projects in the Isleta Reach to encourage the development of pools and wintering habitat.

- The NMISC and BOR have completed several habitat restoration projects in the Isleta Reach. These projects total approximately 40 ha (125 acres) and include such features as backwaters, embayments, scoured and terraced bank lines, modified islands, ephemeral channels, lateral constraint removal (e.g., jetty jacks), placement of large woody debris to create scour flows, and floodplain vegetation management.

San Acacia Reach

- BOR has completed work setting back lateral constraints to allow more freedom to the river to self-adjust.

- At BDANWR has restored approximately 1,335 ha (3,300 acres) of riparian forest and low lying emergent wetland habitat. Most of this effort (90 percent) focused on saltcedar removal and willow/cottonwood restoration efforts which benefit the flycatcher. Some improvements in backwater habitat for silvery minnow were included as well. Approximately 194 ha (480 acres) of potentially suitable habitat for the flycatcher have been created by this effort.

- Inlets were added to the River Widening Project at BDANWR for silvery minnow habitat.

Most of the above restoration projects have focused on the creation and improvement of silvery minnow habitat, and to a lesser extent flycatcher habitat. Many included an objective of providing additional low velocity habitats during floodplain inundation. These projects provided spawning and rearing habitat for the silvery minnow (Gonzales et al. 2012; Magana 2012, 2013) and nesting habitat for cuckoo and flycatchers. The historical floodplain provided additional low velocity shallow water for egg retention and nursery habitats when flooded in spring. The Los Lunas habitat restoration project was excavated and provided more inundated water used by larval silvery minnow for nursery habitat (Magana and Horner 2005).

Collaborative Program Activities Implementation

To date, approximately 405 ha (1,000 acres) of habitat along the MRG have been improved through habitat restoration projects supported by the Collaborative Program. Currently, restoration projects are monitored individually without standardized objectives, protocols or parameters for data collection and determining effectiveness. The lack of systematic evaluation of habitat restoration in the MRG has led the Collaborative Program to begin development of an effectiveness monitoring program that can relate habitat restoration project performance to the population status of listed species. Since 2010, Collaborative Program participants have implemented a pilot monitoring program and have collected vegetation, hydrology, geomorphology, and fisheries data. Anticipated beneficial effects of habitat restoration projects for flycatchers have not yet been demonstrated (SWCA 2014). As of the 2012 season, no flycatcher territories have been established on any of the habitat restoration sites constructed by the Collaborative Program. The silvery minnow habitat constructed to date provides suitable habitat at certain discharges and silvery minnow have been detected using constructed habitats, but no increase in density can be specifically attributed to the restoration.

Past Federal Actions (projects with a Federal nexus)

The Service has conducted section 7 consultations that authorized incidental take of silvery minnow, flycatcher, and cuckoo resulting from past projects in the MRG. There have been 54 formal consultations (Appendix B). The projects encompassed activities such as water management, river maintenance, levee-building, habitat restoration, safe harbor agreements, and stormwater discharge. Notable water management formal consultations have included Reclamation's consultation for the City of Albuquerque's Drinking Water Project (Service 2004), the Forest Service's consultation for the Buckman Water Diversion Project (Service 2007b), and the joint consultations conducted with Reclamation and the USACE regarding MRG water management (operations, flood control, and river maintenance) (Service 2003b). The Service issued a jeopardy BiOp in 2003 on MRG water management (Service 2003b).

2003 Biological Opinion

In 2003 the Service issued a jeopardy BiOp containing five Reasonable and Prudent Measures (RPMs) with nine Terms and Conditions, and one Reasonable and Prudent Alternative (RPA) with 32 elements. These nondiscretionary requirements set forth a flow regime in the MRG and described habitat improvements, monitoring, research, and other activities necessary to alleviate jeopardy to both the silvery minnow and flycatcher. Most elements have been or continue to be achieved; however, progress on some key elements including relocating the San Marcial Railroad Bridge, providing fish passage around diversion dams, and avoiding river intermittency have not been implemented. The only one of these elements not being addressed in the current Proposed Action is the San Marcial Railroad Bridge relocation due to lack of authority (USACE 2012a).

The 2003 BiOp also contains 25 conservation recommendations which are discretionary measures intended to benefit the silvery minnow or flycatcher. Most of these have been completed or are underway; however, some recommendations that would potentially provide additional or secure water for listed species have not been completed or initiated or have not resulted in documented benefits.

Reclamation and others have implemented various water management, habitat restoration, research, and monitoring activities as prescribed in 2003 as part of the RPA to alleviate jeopardy to the silvery minnow and flycatcher, and avoid destruction or adverse modification of their designated critical habitats. Under the Collaborative Program, other agencies and organizations contributed to implementing these activities. Between 2001 and 2012 a total of approximately $125 million has been spent to comply with previous BiOps. In some areas, such as research, the Federal and State agencies and the Collaborative Program contributed more than the minimum required by the 2003 BiOp. Other organizations (Save Our Bosque Task Force), programs (Service's Partners Program), and individuals also implement activities that directly or indirectly benefit the listed species in the Action Area.

Research Permits

The Service has issued permits authorizing take of silvery minnow for scientific research and enhancement purposes under ESA section 10(a)(1)(A). Applicants for 10(a)(1)(A) permits must also acquire a permit from the New Mexico Department of Game and Fish (NMDGF) to "take" or collect silvery minnows. The section 10 permits issued by the Service for the silvery minnow have covered a range of activities and average 15,000 juvenile and adult silvery minnows per year with an average of 25,000 silvery minnow eggs per year. These include approximately 17 active 10(a)(1)(A) permits that authorize the following types of silvery minnow activities: presence/absence surveys (including population monitoring, population estimate, and habitat restoration effectiveness monitoring); reproduction monitoring (including egg and spawning monitoring); tagging (using VIE (visible implant elastomer) and PIT (passive integrated transponder) tags; salvage of silvery minnows (in response to river drying or chemical spills/degraded water quality); collection of eggs and larvae for captive propagation purposes, rearing or breeding for augmentation purposes; the collection and use of specimens for education; a variety of scientific studies (toxicity, genetic, feeding, swimming, behavioral, age/growth, movement and other life history studies) to further our knowledge about the species and how best to conserve the silvery minnow. As a result of the population declines, the Service has reduced the amount of take permitted for spawning adults during April through June in the wild.

The Service has issued approximately 44 permits in New Mexico for scientific research and enhancement purposes under ESA section 10(a)(1)(A) authorizing surveys for flycatchers using vocalization tape playback. Eighteen of these permit holders are also authorized to conduct flycatcher nest searches and nest monitoring activities. Applicants for 10(a)(1)(A) permits must also acquire a permit from the NMDGF to monitor flycatcher nests.

The Service has issued approximately 40 permits in New Mexico for scientific research and enhancement purposes under ESA section 10(a)(1)(A) authorizing presence/absence surveys for cuckoos in the State. Six permit holders are authorized to either conduct nest searches or telemetry studies.

Water Quality

Water quality in the MRG is characterized by relatively high turbidity and slight to moderate alkalinity (Abeyta and Lusk 2004b; Scholle 2015). Average total suspended and total dissolved solids concentrations in the Action Area are about 7,000 milligrams per liter (mg/l) and 250 mg/l, respectively (Crawford et al. 1993). Water quality in the MRG 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). Year-round water quality conditions in the MRG above Alameda, including the Rio Chama, are generally good (Langman and Nolan 2005). Low flow conditions in the MRG below Alameda, though, can concentrate pollutants and other components, including nutrients such as organic carbon, nitrates and phosphates through evaporation. This generally will result in higher pollutant concentrations further downstream, in areas experiencing low flow conditions and isolated pools (Zeglin and Dahm 2006; Hatch et al. 2008). Pollutant concentration generally does not occur in areas of irrigation diversion, which removes most of the nutrient compounds from the river channel (Van Horn and Dahm 2008).

Factors that are known to cause poor fish habitat include temperature changes, sedimentation, organic loading, reduced oxygen content, high salinity, pesticides, and an array of other toxic or hazardous substances. Both point source pollution (e.g., pollution discharges from a pipe or other discrete conveyances) and non-point source pollution (i.e., from diffuse sources such as stormwater runoff) affect the MRG (New Mexico Environmental Department (NMED) 2007, 2009, 2010). Major point sources include discharges from WWTPs, irrigation channel return flows, and feedlots. Major nonpoint sources include agricultural activities (e.g., fertilizer and pesticide application, livestock grazing), urban stormwater runoff, atmospheric deposition, and mining activities (Ellis et al. 1993).
Fish kills resulting from spills along roadways and railways within the MRG occur once every 48 years on average, based upon the number of crossings and miles of roadway and railway exposed to the river (Tetra Tech 2008). The potential for a catastrophic event causing a discharge into the MRG from roadway or railway spills is considered to be highest overall in the San Acacia Reach, followed by the Albuquerque section of the Angostura Reach (Tetra Tech 2008).

Dissolved Oxygen

Dissolved oxygen is critical to the biological community and for the breakdown of organic matter. It is essential to not only keeping fish and other aquatic organisms alive, but also for sustaining their reproduction, development, vigor, immune capacity, behavior, movement, and predator response actions (Hughes 1973; Kramer 1987; Breitburg 1992; Portner and Peck 2010). Fish can attempt to compensate for low dissolved oxygen conditions through behavioral responses, such as increased use of aquatic surface respiration, changes in activity level or habitat use, and avoidance behavior, though these activities are known to come at a higher energy cost (Kramer 1987; British Columbia Ministry of the Environment (BCME) 1997]. Below a specific oxygen saturation threshold, fish will be expending excess energy to maintain stable physiological processes and stress will occur (Heath 1995). Eventually fish suffocate at critically low dissolved oxygen concentrations and begin to die. Additionally, low dissolved oxygen conditions may also cause a wide range of chronic effects and behavior responses in fish

(Downing and Merkens 1957; Kramer 1987; Breitburg 1992). Stormwater runoff has been observed to cause sudden declines in dissolved oxygen in the MRG within the Angostura Reach. Daniel B. Stephens & Associates Inc. (DBS&A 2009) reported low dissolved oxygen within the North Diversion Channel stormwater outfall contributed to low dissolved oxygen condition within the MRG when high stormwater runoff pushed stagnant water at the outfall into the River. This can decrease dissolved oxygen in the River as far as 33 km (20 mi) downstream (Van Horn 2008; DBS&A 2009; Dahm and Candelaria-Ley 2012).

In the MRG, increased water temperatures can cause lower dissolved oxygen levels during low flow events (Crawford et al. 1993). Low flows isolate fish in pools, with higher temperatures and lower dissolved oxygen than is found in the adjacent flowing channel. Lethal conditions can occur under these conditions through impaired swimming and eventually lead to suffocation (Dahlberg et al. 1968). Low flow conditions that create isolated pools in the Isleta and San Acacia Reaches have resulted in low dissolved oxygen measurements (Hatch et al. 2008, p.29).

Poor water quality conditions can also occur in the MRG as a result of high flow conditions. Bexfield (2010) reported that groundwater near the river channel tended to have low dissolved oxygen after a high flow event. In floodplains that were infrequently flooded, inundation of the forest resulted in widespread low dissolved oxygen in the floodwaters capable of affecting fish that use backwater areas such as the silvery minnow (Valett et al. 2005). A fish kill due to low dissolved oxygen from such an event was reported in a large stagnant floodplain pool (Abeyta and Lusk 2004a). These low dissolved oxygen conditions in stagnant floodwaters can also enter the channel and decrease the dissolved oxygen content downstream.

Salinity

Salinity, the amounts of salts in the water, can be very high in the downstream reaches of dams or intensive agricultural areas in the west. The primary sources of salinity are irrigation waters and reservoir evaporation (Briggs and Cornelius 1998). Besides input from irrigation water return, natural sources of salt from geological formations (Phillips et al. 2003; Phillips et al. 2006) and tributary input (Zeglin and Dahm 2006) can contribute to salinity levels, in the Action Area. Salinity levels in the river channel increase downstream due to evaporation (Zeglin and Dahm 2006).

Salinity increases can be biologically significant to vegetation. Salts from the water are deposited on the floodplain through evaporation and evapotranspiration. Most native vegetation (e.g., willows and cottonwoods) are relatively intolerant of salt (Jackson et al. 1990; Shafroth et al. 1995). In contrast, saltcedar germination increases with salinity. Water operations to minimize flooding increases sediment salt content by not allowing flushing of the salts from floodplain.

Although salinity is not as high in the MRG as compared to other western rivers, decreased flows increase salinity through concentration of natural and agriculturally introduced total dissolved solids (Yuan and Miyamoto 2005). Salt build up in agricultural soils during drier years can be flushed into the River during the first wet year causing a spike in salinity (Yuan and Miyamato 2004). High salinity spikes can have adverse effects on silvery minnows.

Turbidity and Suspended Sediment Concentrations

Sediment movement is a natural occurrence; however, land-use changes can result in an alteration of the quantity and timing of sediment delivery to the River. Stream sediments come from the channel bed and tributaries (Wood and Armitage 1997). Fine sediments increase with land-cover alteration and riparian disturbance (Kaufmann et al. 2009). Turbidity is primarily caused by sediment suspended in the water. It varies by season and reach. The lowest turbidity values occur between November and February; the highest values occur during summer months when runoff from storm events can rapidly increase runoff and river flow. Reservoirs, such as Cochiti, have an influence on turbidity by allowing fine sediments to settle out and preventing their movement downstream. Suspended sediments are a source of contamination (Harwood 1995). A number of pollutants, such as heavy metals, semivolatile organic compounds, and organochloride pesticides are associated with suspended sediments (Newcombe and MacDonald 1991).

Sediment Oxygen Demand

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 water at shallow depths below and near the channel tends to have low dissolved oxygen due to sediment oxygen demand (SOD). SOD is 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). Precipitation events of sufficient intensity outside of the spring peak pulse can increase oxygen demanding substances in the sediment (Huggins and Anderson 2005). Additionally, when tributaries are scoured by stormwater runoff sediments redistributed to the River increases SOD (Huggins and Anderson 2005; Bixby and Burdett 2009). Another consequence of SOD is that ammonia can be released, reducing the habitat quality for fish and their prey (Merkens and Downing 1957; Fillos and Molof 1972; Thurston et al. 1981; Caldwell and Doyle 1995).

Pollutants

WWTPs effluents can contain pollutants that may affect the water quality of the River. In the Action Area, the largest WWTP discharges are from Albuquerque (80 cfs mean annual discharge), two Rio Rancho discharges (2.5 and 0.9 cfs), and Bernalillo (0.7 cfs) (Bartolino and Cole 2002). The City of Albuquerque WWTP effluent is a primary contributor to perennial flow in the lower portion of the Angostura Reach. For that reason, the water quality of effluent discharges is extremely important. These WWTP sources contribute a greater load of contaminants to the Angostura and Isleta Reaches than are found in the San Acacia Reach, where there are fewer WWTPs or other sources to contribute to the contaminant load (Zeglin and Dahm 2006). Since 1989, chlorine and ammonia have been discharged unintentionally into the Angostura Reach at concentrations that exceed protective levels for the silvery minnow (Passell et al. 2007), as recently as 2011 (Chwirka 2011; Lusk 2011). In addition to chlorine and ammonia, WWTP effluents may also include cyanide, chloroform, organophosphate pesticides, semivolatile compounds, volatile compounds, heavy metals, and pharmaceuticals and their derivatives, which all can pose a health risk to silvery minnows when discharged in concentrations that exceed the protective water quality criteria (Lusk 2003; NMED 2010). Additionally, even if the concentration of a single chemical compound is not harmful by itself, chemical mixtures may be synergistic in their toxicity to silvery minnows (Buhl 2002). Marcus et al. (2010) described the concentrations of chemicals in the MRG that may affect fish health or produce localized mortalities. However, the long-term effects and population-level impacts of toxic chemical discharge in the MRG on the silvery minnow are not fully known.

Large precipitation events wash sediment and pollutants into the river from surrounding lands through storm drains and tributaries. Constituents of concern that are commonly found in stormwater include petroleum hydrocarbons; the metals aluminum, cadmium, lead, nickel, copper, chromium, mercury, and zinc; nutrients; pesticides; solid waste; sediments, and salts; toxics such as polychlorinated biphenyls (PCBs); the industrial solvents trichloroethene and tetrachloroethene (TCE); and the gasoline additive methyl tert-butyl ether (USGS 2001; Service 2003b; NMED 2010). Stormwater contributions of dissolved lead, zinc, and aluminum from the Albuquerque North Diversion Channel to the Angostura Reach were found to be elevated (Harwood 1995; Service 2014d). Ambient stormwater water quality for Albuquerque was evaluated in 2010 and reported lead, zinc, bacteria, and cold temperature exceeded applicable water quality standards (USEPA 2010). USEPA (2010) reviewed the accumulation of lead and zinc in fish tissue and sediment and required no additional controls for these metals because of the lack of acute toxicity reported. NMED (2010) confirmed that lead and zinc were below levels of concern in the Rio Grande during monitoring from 2007 to 2009.

Ong et al. (1991) reported the concentrations of heavy metals in suspended sediment and bed sediment samples collected from the MRG. These data were compared to sediment quality criteria for aquatic life [probable effects criteria (PEC)] proposed by MacDonald et al. (2000). According to MacDonald et al. (2000) most of the PECs provide an accurate basis for predicting sediment toxicity to aquatic life and a reliable basis for assessing sediment quality in freshwater ecosystems.

Polycyclic aromatic hydrocarbons (PAHs), phenols, and phthalate esters have been analyzed in bed sediment (Levings et al. 1998). These compounds are abundant in the environment, are toxic and often carcinogenic to organisms, and could represent a long-term source of contamination. The PAH analysis showed one or more compounds were detected at 14 sites along the MRG with the highest concentrations found below Albuquerque (Levings et al. 1998). PAHs and other semivolatile compounds affect the sediment quality of the MRG and may affect silvery minnow behavior, habitat, feeding, and health.

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, riverside drain return flows, and wind-blown processes contribute pesticides to the MRG. Multiple sources have reported pesticides in MRG water or sediment samples (Ong et al. 1991; Anderholm et al. 1995; Abeyta and Lusk 2004b; Langman and Nolan 2005; NMED 2009; Marcus et al. 2010). Roy et al. (1992) reported that dichlorodiphenyldichloroethylene (DDE), a degradation product of dichlorodiphenyltrichloroethane (DDT), was detected in fish collected throughout the MRG. Lusk (2012) found DDT residues in silvery minnow collected in the MRG but not above concentrations of concern for adult lethality. Sublethal effects of DDT residues at the levels observed could occur to silvery minnow eggs (Beckvar and Lotufo 2011), or other fish and those that consume them (Schmitt et al. 2004; Beckvar and Lotufu 2011; Lusk 2012).

For flycatchers and cuckoos, pesticide drift from adjacent agricultural fields can decrease the abundance of large insects and their larva in riparian areas (White 2007). This can be particularly problematic during migration and breeding seasons when high energy demands are required (Service 2002).

Stormwater runoff has also been correlated with *Escherichia coli* concentrations, an indicator of potential pathogens, in the MRG. These concentrations rise significantly in direct relation to the intensity and volume of stormwater runoff during individual events (Shoemaker et al. 2013). A significant portion of this *E. coli* load has been traced to input from birds and domestic dog waste (NMED 2009) which can be managed through BMPs implementation to control input of *E. coli* from urban areas (Shoemaker et al. 2013).

PCBs have been detected in River samples in the Albuquerque area following storm events (Yanicak 2006; NMED 2010). PCB concentrations in some of these stormwater samples exceeded New Mexico's water quality criteria for the protection of wildlife as well as human health criteria (NMED 2010). PCBs in suspended sediments were 90 times the values for stormwater indicates that stormwater is the likely source of the PCBs (NMED 2010). This suggests that management techniques that reduce suspended sediment in stormwater may reduce PCBs in the MRG.

Fish tissue PCBs followed similar patterns to sediment PCBs (Yanicak 2006; NMED 2010). All fish collected from the MRG contained detectable PCBs (NMED 2009). Fish consumption advisories were issued in 2010 to protect the public from PCB ingestion due to health concerns in the Action Area. Lusk (2012) reported that all silvery minnow samples tested had detectable PCB concentrations.

Fire Effects on Water Quality

Forest fires within the Rio Grande watershed can have significant impacts on water quality. Following the Cerro Grande Fire in 2000, water quality was greatly impacted from increased sediment transported into the river during storm runoff. Up to 25 percent of water volume post-fire was debris and sediment (Gallaher and Koch 2005). Elevated concentrations of the radionuclides cesium-137, plutonium-239, 240 and strontium-90, as well as cyanide, heavy metals and nutrients, were detected during storm runoff events in the first year after the fire. Suspended sediment concentrations continued to be found up to 4 years after this fire, although most concentrations of the aforementioned contaminants fell to near pre-fire levels within 2 to 3 years (Gallaher and Koch 2005).

Similar impacts were recorded in the Rio Grande following the Las Conchas Fire in 2011. Most of the impact resulted from ash and other fire debris being transported into the Rio Grande from flood events in 2011 (Dahm and Candelaria-Ley 2012, p. 12). Decreases in dissolved oxygen and concurrent increases in salinity were recorded in the Angostura Reach. Numerous fish kills were reported in this Reach during these low dissolved oxygen events. High turbidity levels also resulted in lowered primary productivity (Dahm and Candelaria-Ley 2012, p.33).

Riparian Vegetation Dynamics

The area of riparian vegetation in the MRG has declined over time (Hink and Ohmart 1984). Riparian vegetation and its dynamics in the MRG are affected by geomorphology and hydrology of the system. Alterations in the magnitude and availability of flow, plus removal of water for consumptive uses, have resulted in river drying; reduced magnitude, frequency, and duration of peak-flow events; increased magnitude, frequency, and duration of low-flow events; and altered riparian plant community. These major influences have been previously described in detail (hydrology and geomorphology).

Native vegetation can be lost under conditions of stress, where natural processes are not allowed to proceed (Shafroth et al. 2002). Riparian habitat in the Action Area has historically been dynamic, and without flooding the diversity and productivity of the habitat 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. Through water operations and infrastructure development many of these dynamics of the MRG have been eliminated.

Overbanking the channel and flooding the floodplain are required to develop a healthy riparian ecosystem. As peak flow increases the chance of overbanking increases and area flooded increases (USACE 2010). The flow level necessary to overbank floodplain and area inundated can be found in Table 7.

Riparian Vegetation Restoration

Restoration of riparian vegetation within the MRG has included nonnative species removal and willow-cottonwood restoration efforts which benefit flycatcher and cuckoo (see Habitat Restoration Section above).

Invasive Species

The alterations to the MRG system provide conditions favorable for the development of nonnative vegetation. Conditions that place cottonwoods and willows under stress such as drought, high salinity, flow alteration, livestock presence, and recurring fire, allow invasive plants to become established (Horton 1977; Smith et al. 1998). Many nonnatives have broad tolerance ranges for stress.

Saltcedar are physiologically adapted to salt levels that would stress or kill most native willows (Shafroth et al. 1995). They also have high water-use efficiency, root deeply, and tolerate prolonged drought (Busch and Smith 1995; Smith et al. 1998). Cottonwood and willows thrive where groundwater is less than 3 m (10 ft) deep, but saltcedar persist where groundwater is up to 7 to 10 m (23 to 33 ft) below the surface (Graf 1982; Stromberg 1998). Saltcedar thus can dominate where diversions or groundwater pumping have lowered the water table and salt levels are high. Anderson (1995) provides data showing that for many rivers in the Southwest, water tables have become too deep and soils too salty to allow native cottonwood and willows to survive, contributing to replacement by stress-tolerant saltcedar. As floods have decreased, fire disturbance has increased, providing additional opportunity for species that resprout, such as saltcedar. In areas where geomorphology no longer allows for native species regeneration, saltcedar does provide structure and cover to accommodate flycatcher nesting and cuckoo foraging activities, although not a preferred alternative.

Russian olive also has wide drought tolerance range. Relative to cottonwoods and willows, Russian olive is drought tolerant at both the seedling and adult stages. Although not as salt-tolerant as saltcedar, Russian olive is more salt tolerant than many cottonwoods and willows (Carman and Brotherson 1982; Shafroth et al. 1995). Russian olive similarly may be benefitting from flood suppression. Unlike the native willows and cottonwoods, and similar to saltcedar, it does not depend on spring flooding for establishment. Russian olive exhibits some traits typical of late-successional species, such as larger seed size. This enables it to establish in the understory of tree species such as cottonwood, and allows regeneration to be decoupled from flood disturbance. Together with saltcedar, Russian olive has spread and replaced cottonwoods-willows on spring-flood suppressed rivers including the Rio Grande (Howe and Knopf 1991; Everitt 1998).

Traditional methods, including mechanical removal, herbicide treatment, and burning, have not always been effective at restoring riparian areas to native vegetation. These methods often result in other nonnative species expanding into an area, unless other measures are implemented to restore native species (Harms and Hiebert 2006). Resource limitations often make it difficult to conduct monitoring and continue treatment to prevent the reemergence. For this reason, biocontrol methods have been implemented in an effort to better control saltcedar.

Saltcedar Leaf Beetle

Although there are negative impacts from the continued spread of tamarisk along the Rio Grande, the introduced saltcedar leaf beetles (*Diorahbda* spp.) are now a threat to flycatcher breeding habitat and cuckoo foraging habitat. In 2012, more than 50 percent of flycatcher nests in the MRG were found in saltcedar-dominated patches. Biocontrol efforts against saltcedar using the saltcedar leaf beetle have created a new challenge to the recovery of the flycatcher. Saltcedar leaf beetles actively impact saltcedar during the flycatcher and cuckoo breeding season. This can cause vegetation mortality containing flycatcher nests and surrounding territory vegetation, resulting in nest failure (Paxton et al. 2011). Vegetation mortality may also reduce prey base for cuckoo foraging habitat.

The U.S. Department of Agriculture began actively releasing saltcedar leaf beetles in Colorado and Utah in 1999. Saltcedar leaf beetles were first reported in the MRG near Santa Ana Pueblo (Tamarisk Coalition 2012). As of 2015, saltcedar leaf beetles have been confirmed throughout the Action Area (Tamarisk Coalition 2015).

Beetle defoliation of saltcedar occurs during the summer at the time of peak breeding for many migratory bird species. By mid-summer, the beetle-infested saltcedar becomes defoliated and is no longer suitable. This results in decreased nesting success and even mortality through nest abandonment, increased nest parasitism and increased predation (Paxton et al. 2011). Beetle-infested saltcedar can take up to 5 years to die. This can result in multiple years of reduced nest success or localized extirpation. It is anticipated that 50 percent of the flycatcher population known to occupy saltcedar habitat could be affected (Service 2014a). Cuckoos also can be found in saltcedar and defoliation could impact the cuckoo prey base (Ahlers et al. 2016).

The spread of saltcedar leaf beetles has historically been monitored and reported by the Tamarisk Coalition (Bosque Ecosystem Monitoring Program 2015; Tamarisk Coalition 2015). Reclamation, BIA, and the BA Partners have also been planning maintenance and restoration activities to allow for natural native vegetation recruitment by creating more favorable geomorphology and hydrologic conditions (Reclamation 2012).

Nonnative Fish Species

The MRG has experienced a large shift in fish community structure as has been seen in many river systems of the western U.S. (Miller et al. 1989). Rivers in the Southwest naturally have smaller native fish faunas. Species endemism is also much higher with species adapted to the highly fluctuating flow conditions (Rinne 2004, p.194-195).

Competition and predation by introduced species is considered to have contributed to the decline of the silvery minnow throughout its historical range (Service 2010a). In the MRG, the impact from predation by nonnative fish is considered low, since few of the nonnative species are predators (Remshardt 2012c). Competition for resources necessary for survival from these nonnative species is of greater concern. Most species native to the MRG have adapted to its historically dynamic hydrological pattern of floods and droughts. Some native species that have gone extinct, like the phantom shiner (*Notropis orca*), may not have been able to tolerate the stable flow conditions of a regulated river, while many nonnative species flourished under these conditions (Miller et al. 1989; Hoagstrom et al. 2010). Species such as the common carp (*Cyprinus carpio)* and white sucker (*Catostomus commersonii)* spawn earlier than silvery minnow and, as a result, could dominate nursery habitat that the silvery minnow use (Hoagstrom et al. 2010). The dominance of nonnative species which are better adapted than native species to local conditions could lead to competitive displacement. This has been demonstrated in the Pecos River in New Mexico, where the introduced plains minnow (*Hybognathus placitus*) has apparently displaced the silvery minnow (Bestgen and Platania 1991) and the lower Colorado River Basin where introduced red shiner (*Cyprinella lutrensis*) have displaced native spikedace (*Meda fulgida*) (Douglas et al. 1994).

Other

Population Growth, Urbanization, Recreation and Human Disturbance

The availability of relatively flat land, rich soils, high water tables, and water for flood irrigation has fostered human development in the MRG floodplain. Levee construction that laterally confined the floodplain has led to development in the floodplain for agriculture, housing, and other human development. Land conversion to agricultural use has reduced native vegetation. These areas often contained riparian and wetland vegetation (Stotz 2000). 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 flycatcher breeding habitat. Agricultural seepage and return flows support riparian vegetation that provides flycatcher and cuckoo habitat.

The MRG is rapidly changing from predominately agricultural to urban in nature. This has led to measurable changes in both water availability and water quality in the river. The increase in urban population has led to increased floodplain development, more domestic water wells, and water rights transfer (USACE 2013b). Continued growth is placing a great demand on water use leading to changes in regional land use planning that will affect future water management (USACE 2013b).

In the MRG counties of Sandoval, Bernalillo and Valencia, there has been a 21 percent increase in population since 1993. This rate of urban growth and associated water demand has also resulted in an increased demand for groundwater that exceeds the aquifer recharge rate.

Total water use in the major population center (Santa Fe, Bernalillo, and Valencia Counties) has exceeded renewable supplies by 55,000 acre-ft per year (Mid-Region Council of Governments 2004). Similarly, in Socorro and Sierra Counties, current deficits are at about 78,000 acre-ft per year with the potential of reaching 194,000 acre-ft per year in drought years (Reclamation 2016c).

Due to water demands, Albuquerque and Santa Fe installed surface water diversions in the MRG. In the past, unused SJC Project water was often used by Reclamation to meet endangered species needs. Increased municipal use reduces water available for endangered species purposes (Reclamation 2016c).

Urban development also increases recreational use of aquatic and riparian habitats and the demand to use natural areas will likely increase. Outdoor recreation activities involve more than 25 percent of the country's population. Wildlife can be affected by recreation in a variety of ways: 1) direct mortality, 2) indirect mortality, 3) lowered productivity, 4) reduced use of habitat, 5) reduced use of preferred habitat, and 6) aberrant behavior/stress that in turn results in reduced reproductive or survival rates (Pomerantz et al. 1988; Cole and Landres 1995). Birding, hiking, backpacking, downhill skiing, and primitive camping were the five fastest growing activities in the country in terms of percentage change in number of participants between 1983 and 1995 (Service 2002). All of which occur in the Action Area.

As human populations grow, the effects from recreational activities are likely to increase. 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; exotic species invasion; solid waste, pollution, increases in predators and scavengers due to discarded food and solid waste; increases in brood parasitism by cowbirds; and noise disturbance. Recreational development also promotes an increased need for river access including trails and roads, and support structures that fragment native habitat.

Fire

The effect of forest fires on water quality has been previously described. Fire can also cause direct loss of MRG riparian forest habitat. The probability of fire is enhanced by the vegetation accumulation on regulated, flood-suppressed rivers (Busch 1995). Fire was virtually unknown in naturally functioning, riparian ecosystems of the Southwest (Busch and Smith 1993). However, fuel accumulations coupled with human-caused ignitions have introduced fire as a major disturbance mechanism in the riparian ecosystem (Stuever 2009). While cottonwood is highly susceptible to fire-induced mortality, saltcedar re-sprout vigorously following fire (Busch and Smith 1993; Busch 1995). Post-fire soils typically have significantly higher salinity than unburned soils areas, which may allow establishment of saltcedar (Busch and Smith 1993).

EFFECTS OF THE ACTION

Regulations implementing the ESA (50 CFR 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 action under consideration. Effects of the action are considered along with the environmental baseline and the predicted cumulative effects to determine the overall effects to the species for purposes of preparing a BiOp on the Proposed Action (50 CFR 402.02).

Effects to the silvery minnow, flycatcher, and cuckoo resulting from the Proposed Action were analyzed using processes for identifying impacts and benefits to the river environment (i.e., hydrology, geomorphology, water quality, riparian vegetation dynamics, and other localized disturbances) and then assessing these impacts and benefits for effects on the species. The analytical framework for identifying impacts and benefits to the river environment is referred to as the Matrix of River System Impacts (MRSI). The framework for assessing the impacts and benefits and the resultant effects on the species is referred to as A System of Assessing Effects to Species (ASAETS). The methods for both MRSI and ASAETS are located in Appendix A and Figure 7.

Rio Grande Silvery Minnow

Hydrology

Hydrology refers to the magnitude, timing, and duration of flows within the Action Area. Based on the Service's review and analysis of the Proposed Action as summarized in the MRSI (Appendix C), the following activities are anticipated to negatively affect river hydrology:

- Water storage (amount and timing)
- Agricultural demand (diversion and depletion)
- LFCC
- State's new water rights permits

The activities listed above will contribute to hydrologic alterations within the Action Area, specifically, changes to May and June and July through October flow volumes. If these alterations occur within, or affect, occupied or suitable silvery minnow habitat within the Action Area they may adversely affect silvery minnow and its critical habitat as described in the analysis below.

In reviewing the scientific literature on the effects of flows on fish communities we found that the annual variation in fish recruitment is often influenced by river flows and floodplain inundation levels (DiCenzo and Duval 2002; Janac et al. 2010; Dutterer et al. 2013; Dudley et al. 2016). Variable flows influence the structure of river communities and indirectly affect stream fishes by changing habitat and food availability, or create suboptimal conditions that decrease survival (Stalnaker 1981; Fisher et al. 1982; Balcombe et al. 2005; Rogers et al. 2005; Dudley et al. 2009; Dutterer et al. 2013). In low-gradient river floodplain systems (e.g., the Rio Grande), wet season high flows usually provide annual connectivity and inundation of the floodplain (Dutterer et al. 2013). Commonly, fish in river floodplain systems respond to rising water levels and floodplain inundation as cues for spawning (Agostinho et al. 2004; Dudley and Platania 2015). As spawning and nursery habitat for river fish assemblages, inundated floodplain habitats provide food and complex cover for refuge from predation (Dudley and Platania 1997; Pease et al. 2006; Porter and Massong 2006; Arthington and Balcombe 2011; Dudley and Platania 2015; Dudley et al. 2016).

The Service's analysis of flows on silvery minnow is based in part on mathematically derived models which include key assumptions. The assumptions, methods, models, and raw data used in developing this analysis are described in detail in Appendix A.

May and June Flows (Production Strategy of the Hydrobiological Objectives)

We analyzed alterations to May and June flow volumes by evaluating the depletions of water (i.e., diversions for agriculture or storage, issuance of water rights permits, LFCC demands) that would be expected to occur from the Proposed Action for three hydrologic scenarios (very wet year, average year, and very dry year) (Table 8).

We compared water depletions that will occur each year over the next 15 years to factors that compose the environmental baseline. These environmental baseline factors include: 1) water lost from the system due to riparian vegetation evapotranspiration, 2) open water evaporation, 3) groundwater withdrawal, 4) water lost through infiltration in the river bed and banks, and 5) water demand associated with other ongoing projects.

Implementation of the Proposed Action will result in May and June river depletions each year that are in addition to the environmental baseline. Proposed Action impacts include: water temporarily stored and not available downstream due to storage (i.e., El Vado Reservoir), agricultural diversions and consumption, LFCC removals, and new activities by the State of New Mexico (issuance of permits to water rights owners, the transfer of senior water rights, and contingency depletions).

We used the Upper Rio Grande Water Operations Model (URGWOM) and Flow Models to calculate to estimates of the water volumes that would be depleted from the River during May and June. The estimates are shown in Table 8. During May and June we anticipate that implementation of the Proposed Action would result in the loss of approximately 113,150 to 179,010 acre-ft of water depending on whether it is a very dry, average, or very wet year for the system as a whole (Table 8).

Adequate flows during spring (May and June) are essential for a successful annual silvery minnow spawn and the long-term survival and recovery of the species (Service 2010a). We were able to use the results by Dudley et al. (2016) and additional modeling (see Appendix A for a detailed discussion of methods), to estimate the changes in densities of silvery minnows that could occur within the Action Area based upon the May and June flow volumes that are anticipated to occur with implementation of the Proposed Action (Figure 8).

Our analysis shows that a decrease in May and June flows will result in a decrease in the October densities and percent occupancy (i.e., percentage of sites with silvery minnow out of 20 sites distributed throughout the MRG) of silvery minnows within the Action Area (Figure 8). To evaluate the effects of May and June flow volumes on the survival and potential for recovery of the species we compared the information provided in Figure 8 to the survival and recovery goals in the Hydrobiological Objectives (Appendix A), as well as the goals identified in the silvery minnow draft Recovery Plan (Service 2007a).

Based on production and survival goals in the Hydrobiological Objectives, as well as goals identified in the draft Recovery Plan, densities must be greater than or equal to 1.0 fish per 100 m^2 to maintain a self-sustaining population within the MRG (Service 2007a, Archdeacon and Remshardt 2013). Based on modeling done by Reclamation (2016c), we anticipate spring flows will be sufficient to support a self-sustaining population in 10 out of 15 years. In addition, densities must be greater than or equal to 0.3 fish per 100 m^2 to maintain genetic diversity (Appendix A).

Silvery minnow require shallow-water, low-velocity habitats, such as inundated floodplain habitats and channel braids and backwaters, which occur during high May and June flow volumes, magnitudes and durations, for survival and recruitment of larval and juvenile silvery minnows (Pease et al. 2006). We found that as May and June flows at the Albuquerque Gage decrease there is a decrease in the area of low-velocity, shallow-water habitat (i.e., inundated floodplain habitat, channel braids and backwaters) within the Action Area (Figure 9).

Based on information presented in Dudley et al. (2016), we determined that well-timed, sustained, and increased May and June flows, which result in the inundation of the river channel and floodplain for a duration of over 3 weeks, may maximize availability of habitats necessary for survival and recruitment resulting in higher densities of silvery minnows in the fall. Based on the information in Table 8 we anticipate that the loss of May and June flows will result in a decrease of inundated habitat as a result of the Proposed Action. As the area of inundated channel and floodplain (including channel braids and backwaters) habitat decreases, the densities of silvery minnows in the fall also decrease (Figure 10).

Production Strategy Conservation Measures

To minimize adverse effects to the silvery minnow associated with project-related May and June flow volume reductions (Table 8), Reclamation will implement the Proposed Action that includes conservation measures such as the Silvery Minnow SRS. Pursuant to the Silvery Minnow SRS, MRG Water Managers will meet annually to evaluate upcoming hydrologic conditions to determine if there is a need for modified operations at El Vado Dam/Reservoir, or other operations, to provide May and June flows for silvery minnow spawning (Production Strategy) and to meet the fall silvery minnow density target (i.e., greater than or equal to 1.0 fish per 100 m^2). Modified operations at El Vado that could be implemented pursuant to the Silvery Minnow SRS include: 1) using supplemental SJC water to increase flow; 2) continue adjusting the timing of water storage during the spring; and 3) using diversion structures to aid in providing spawning conditions (Conservation Measures 1 through 5 and 32 through 44).

To minimize the effects of diversions on silvery minnow during spawning MRGCD will use the diversion system to deliver supplemental water (i.e., native or purchased water) to specific habitat areas within the river to assist with spawning habitat during low water years (Conservation Measure 8) and will work with the Service and egg monitoring teams to adjust diversions to minimize entrainment of eggs during spawning events (Conservation Measure 16).

To minimize the effects of reduced overbank habitat on silvery minnow survival and recruitment, the State will maintain existing overbank habitat constructed by the State since 2006 in the Angostura and Isleta reaches for at least 15 years (Conservation Measure 23). In addition, Reclamation will implement a large-scale habitat restoration project in the Isleta and San Acacia reaches of the MRG (Conservation Measures 70 through 76). Reclamation will take up to 1.5 years to develop a lower river restoration and enhancement plan (Lower Reach Plan). This Plan will be reviewed and approved by the Service prior to implementation. This Plan will outline project opportunities, costs, timeframes, responsible parties, and an implementation schedule. Once completed, this Plan will be active for the life of this BiOp. The goal of this Plan is to reverse the ongoing adverse effects through habitat restoration that will increase floodplain inundation, and increase the wetted river length.

July through October Flows (Survival Strategy of the Hydrobiological Objectives)

Alterations to July through October flow volumes were analyzed by evaluating the depletions of water (i.e., diversions for agriculture or storage, issuance of water rights permits, LFCC removals from the channel via seepage) from the Rio Grande that would be expected to occur with the proposed Action. We also considered the addition of water to the system due to releases of stored water for conservation purposes (i.e., El Vado and supplemental water releases), during July through October for three hydrologic scenarios (very wet year, average year, and very dry year) (Table 9).

We compared water depletions that will occur each year over the next 15 years with factors that compose the environmental baseline. These environmental baseline factors include: 1) water lost from the system due to riparian vegetation evapotranspiration, 2) open water evaporation, 3) groundwater withdrawal, 4) water lost through infiltration in the river bed and banks, and 5) water demand associated with other ongoing projects.

Implementation of the Proposed Action would result in July through October water depletions from the Rio Grande each year (Proposed Action impacts) that are in addition to the above-described environmental baseline. Proposed action impacts include: 1) water temporarily stored and not available downstream due to storage (i.e., El Vado): 2) agricultural diversions; 3) LFCC removals; and 4) new activities by the State of New Mexico (issuance of permits to water rights owners, the transfer of senior water rights, and contingency depletions). In addition, the Proposed Action includes the beneficial impact of releases of stored water for conservation purposes (i.e., El Vado into the River during July through October).

We used the URGWOM model and Flow Models to calculate estimates of the water volumes that would be depleted from, and released into, the River, (see Appendix A for detailed discussion). The estimates are shown below in Table 9. Estimates of depletions are shown as positive numbers and releases or conservation purposes are shown as negative numbers.

As shown in Table 9, during July through October we anticipate that implementation of the Proposed Action would result in the loss of approximately 104,560 to 124,390 acre-ft of water from the Rio Grande depending on whether it is a very wet, average, or very dry year for the system as a whole.

As a result of depletions, we determined that the Proposed Action will result in a decrease in the amount of wetted habitat (i.e., increased drying/intermittency) within the River in July through October (Figure 11), thereby adversely affecting the survival of newly spawned silvery minnows and silvery minnows from the previous years within the Action Area through increased mortalities and decreased genetic diversity due to habitat fragmentation.

River drying will result in silvery minnow mortalities as isolated pools dry and as water quality degrades (Caldwell et al. 2010). In addition, as water levels in the channel drop, water recedes from backwaters and side channels used by adult and juvenile silvery minnow (Bailey 2004). As wetted habitat decreases, silvery minnow can become stranded (Extence 1981; Stanley et al. 1994) or trapped in drying pools and die (e.g., Iversen et al. 1978; Lake 2003). The maintenance of diversion dams within the Action Area prevents silvery minnows from moving from drying habitats upstream or downstream to more perennially wet reaches (Service 2010a) decreasing their ability to survive periods of drying.

In addition to causing silvery minnow mortalities, river drying and intermittency can adversely affect silvery minnow genetic diversity, resulting in genetic bottlenecks and inbreeding depression. These effects were observed in silvery minnows within the Action Area after extensive drying events in 1996, 2002, and 2013 (Turner and Osborne 2004; Osborne et al. 2012, 2015). These effects will occur if fall silvery minnow densities drop below 0.3 fish per 100 m^2 (Appendix A).

Decreased genetic diversity can adversely affect silvery minnow reproduction by reducing birth rates, reproductive lifespan, recruitment into breeding life stage, and variation in reproductive success. In addition, decreased genetic diversity can increase mortalities of silvery minnows by reducing individuals' resilience to stressors.

Without the Conservation Measures, we expect that intermittency or river drying in the Angostura, Isleta, and San Acacia Reaches to continue with the Proposed Action (Reclamation 2015). With the Conservation Measures we anticipate the amount of intermittency or river drying will be reduced (Table 1). The number of silvery minnows that could be adversely affected by the anticipated drying/intermittency is anticipated to be proportional to their average annual density and is therefore difficult to quantify.

Survival Strategy Conservation Measures

To minimize adverse effects to the silvery minnow associated with project-related July through October flow volume reductions (Table 9), Reclamation will implement the Silvery Minnow SRS (as described in the Conservation Measures). MRG Water Managers will meet annually to evaluate upcoming hydrologic conditions within the Action Area and to determine if there is a need for additional water during July through October to ensure that newly spawned silvery minnows and fish from prior years survive through the summer (Survival Strategy). The goal for this survival strategy is to maximize recruitment of silvery minnows into the reproductive population for the next spring spawn by increasing the amount of wetted river through the summer and fall. In years with sufficient water, this is accomplished by native flows after a successful spring spawn. In years that are very dry and the water is projected not to be sufficient, available native and purchased water will be used to primarily ensure survival (Conservation Measures 7 through 12, and 31 through 45).
In addition, MRGCD will maintain selected drain and wasteway outfalls (e.g., Peralta Drain, etc.), to more effectively collect unused water at drains and transfer the water through the wasteways to the river channel. This maintenance is anticipated to support up to 16 km (10 mi) of additional wetted river, primarily in the Isleta Reach and will improve survival of Age 1 silvery minnows (Conservation Measure 14).

To further minimize adverse effects to silvery minnow resulting from reduced July through October flows, and potential increases in the length of river drying/intermittency, the Service has committed to an interim measure of providing funds and equipment for fish rescue efforts to be conducted by the New Mexico Fish and Wildlife Conservation Office (NMFWCO). The Service has committed to providing a hatchery style truck to transport silvery minnows from the lower river reaches to wetted areas within the Albuquerque area of the Angostura Reach during drying events. This support will be provided before fish passages are completed (see below) and will continue as needed into the future. The fish rescue program will be developed and commence in 2017.

In addition to fish rescue efforts by the Service, Reclamation will ensure fish passage at the three diversion dams within the Action Area (San Acacia, Angostura, and Isleta) beginning at San Acacia within 5 years of the issuance of this BiOp and completing all three within 10 years of issuance (Conservation Measures 17, 18, 48, and 59). This will be accomplished with coordination with Pueblos and the Service using adaptive management (Reclamation 2016b).

Fish passages around the San Acacia, Angostura, and Isleta Diversion Dams will provide connectivity between the three reaches, and allow silvery minnows to move between reaches to find refugia upstream or downstream in case of drying due to extremely low flow conditions. Genetic connectivity and interchange would also be reconnected reducing the risk of further genetic bottlenecking affecting the population. Allowing silvery minnow to naturally find refugia would reduce the need to salvage individuals and reduce associated impacts from the capture, transport and release of these individuals.

The delivery of SJC water contributes to continuous flows in Cochiti Reach. Construction of fish passage at the Angostura Diversion Dam will provide silvery minnow access, through upstream movement, to the unoccupied Cochiti Reach. Therefore, fish passage will provide refugia for silvery minnows during low flows. It is anticipated that this will provide silvery minnow access to an additional 32 km (20 mi) of wetted river.

To minimize the effects of increased drying/intermittency, the State will maintain existing overbank habitat constructed by the State since 2006 in the Angostura and Isleta reaches for at least 15 years (Conservation Measure 23). In addition, Reclamation will implement a large-scale habitat restoration project in the Isleta and San Acacia reaches of the MRG (Conservation Measures 68 through 74). Reclamation will take up to 1.5 years to develop a lower river restoration and enhancement plan (Lower Reach Plan). This Plan will be reviewed and approved by the Service prior to implementation. This Plan will outline project opportunities, costs, timeframes, responsible parties, and an implementation schedule. Once completed, this Plan will be active for the life of this BiOp. The goal of this Plan is to reverse the ongoing adverse effects through habitat restoration that will increase floodplain inundation, and increase the wetted river length.

Geomorphology

Geomorphology refers to the physical properties of the river channel (i.e., width, depth, whether it is channelized or meanders). Based on the Service's review and analysis of the Proposed Action as summarized in the MRSI (Appendix C), the following activities are anticipated to affect River geomorphology:

- Storage and release of water
- Agricultural demand (diversion and depletion)
- Maintenance activities at river facilities, dams, and levees including the LFCC
- Delta Channel maintenance
- River maintenance projects

Geomorphic alterations that occur within suitable or occupied silvery minnow habitat adversely affect silvery minnow habitat availability, health and survival, and feeding. Geomorphic alterations to the River, associated with the activities listed above, will occur within the Action Area as a result of the hydrological changes and mechanical alterations to the channel. These geomorphic alterations include channel incision, floodplain aggradation, sediment plugging, and substrate changes. These types of geomorphic alterations can result in higher and more uniform water velocities, reduced and altered patterns of floodplain inundations, reduced connectivity between the channel and floodplain, a loss of low velocity habitats, and river intermittency.

Habitat Availability

Geomorphic alterations associated with activities in the Proposed Action, such as channel incision and sediment plugging, can adversely affect silvery minnow habitat within the Action Area. Increased channel incision and floodplain aggradation may result in reduced connectivity between the channel and floodplain, as well as reduced frequency of floodplain inundation. This would reduce the amount of available spawning and rearing habitat available to silvery minnow, resulting in loss or reduction in young-of-year silvery minnows and recruitment to the breeding population. Channel sediment plugging can result in reduced flow and increased intermittency within sections of the River. Loss of suitable habitat due to river drying will cause a decline in silvery minnow abundance.

In addition, channel incision, floodplain aggradation, and sediment plugging can adversely affect connectivity between silvery minnow habitats. Channel incision results in high water velocities that reduce the ability of silvery minnows to colonize new areas. Floodplain aggradation results in increased floodplain elevation, thereby reducing silvery minnow spawning and rearing habitat. Channel plugging may create a physical barrier to silvery minnow movement. In addition, geomorphic alterations (substrate changes) may prevent localized colonization of a particular area for feeding or cover.

Silvery Minnow Health and Survival

Increased water velocities resulting from channel incision within occupied and potential silvery minnow habitat will adversely affect individual growth, health and survival. Higher water velocities will result in increased swimming/activity rates, increased stress, and reduce individual growth. Reduced growth can adversely affect silvery minnow swimming speed and endurance, vulnerability as prey, success with food or space competitors, health and fitness, rates of survival, maximum age, and reproductive success (e.g., sexual maturity, number of spawning individuals, number of gametes per individual, and quality of ova). Increased stress may result in reduced immune response, increased risk of disease, and increased susceptibility to parasites in silvery minnows within the Action Area.

Feeding

Increased water velocities resulting from channel incision and substrate changes can also adversely affect the amount and quality of food available for silvery minnow within the Action Area. Adult and larval silvery minnows feed mainly on algae/diatoms and feed by filtering detritus from the river bottom substrate, primarily sand and silt (Sublette et al. 1990; Magana 2007; Service 2010a). High water velocities can result in increased scouring and decreased suitable substrate (sand/silt) availability for algal/diatom growth. In addition, increased water velocities will result in increased turbidity, thereby lowering the amount of light available for algal/diatom growth. Reductions in the abundance or quality of food can adversely affect growth, and fitness of the silvery minnow. Consequently, fewer, or smaller eggs may be produced.

Geomorphology Conservation Measures

To minimize impacts to river channel geomorphology, Reclamation will implement habitat restoration projects, including the Delta Channel Maintenance project and large-scale habitat restoration in the Isleta and San Acacia reaches of the MRG. Maintenance of the Delta Channel (Conservation Measure 59) will facilitate the development of a more natural river channel. In addition, the Delta Channel maintenance schedule will allow breaches to occur, providing inundated floodplain and backwater habitat for use by silvery minnow.

To address the geomorphology issues in the San Acacia Reach specifically, Reclamation will engineer a 13 km (8 mi) realignment of the River at BDANWR (Conservation Measure 70). The goal of the realignment is to increase wetted habitat and decrease the frequency of sediment plugging (Reclamation 2016a). This realignment will widen the River, provide areas for overbanking, and reverse the narrowing and incising conditions within this reach. Reclamation has committed to completing planning for the river realignment in 1.5 years, with an estimated construction start date in 2021 to 2022 (Reclamation 2016a). Implementation of this river realignment will help by decreasing the amount of sediment plugging, which has historically been remedied by dredging a pilot channel through the plugged portion of the River and will return this portion back to a more natural channel bed.

In addition, Reclamation will implement a large-scale habitat restoration project in the Isleta and San Acacia Reaches of the MRG (Conservation Measures 68-74). The Service anticipates that Reclamation will take up to 1.5 years to develop a lower river restoration and enhancement plan (Lower Reach Plan). This Plan will be reviewed and approved by the Service prior to implementation. This Plan will outline project opportunities, costs, timeframes, responsible parties, and an implementation schedule. Once completed, this Plan will be active for the life of this BiOp. The goal of this Plan is to reverse the ongoing adverse effects through habitat restoration that will increase floodplain inundation, and increase the wetted river length.

Water Quality

Based on the Service's review and analysis of the Proposed Action as summarized in the MRSI (Appendix C), the following activities are anticipated to affect river water quality:

- Agricultural demand (diversion and depletion)
- Maintenance activities at river facilities, dams, and levees including the LFCC
- Delta Channel maintenance
- River maintenance projects

Implementation of the first three activities listed above will result in water depletions from the River each year that are in addition to the environmental baseline impacts, all of which are described in the Hydrology section, above. Water depletions in addition to environmental baseline impacts result in reduction of water in the River, increased river drying, and the formation of isolated pools. It is anticipated that the reduction in water quantity will impact water quality in the River by 1) increasing water temperature; 2) decreasing dissolved oxygen content; and 3) altering pH, conductivity, and the rate of chemical reactions (Michaud 1991).

The silvery minnow evolved in a highly variable ecosystem, and is likely more tolerant of elevated temperatures and low dissolved oxygen concentrations for short periods than other nonnative species (Service 2003a). Still, degraded water quality can significantly affect the silvery minnow directly by reaching tolerance limits, or indirectly by affecting physiological processes and increasing stress levels, ultimately leading to impaired ability to carry out life functions or death. In the laboratory, lethal temperatures were related to the age of the fish and the duration of exposure (Buhl 2011b). In tests with juveniles and adults, most of the mortalities occurred during the first 24 h of exposure and lethal temperatures for adult silvery minnow were between 1.9 to 4.4 °C (3.4 to 7.9 °F) lower than those for the other life stages, indicating that the adults were the least tolerant (Buhl 2011b). The tolerance of larvae to elevated temperatures decreased between 24 and 96 h of exposure. The “no acute lethal level” (the highest time-weighted mean temperature with less than or equal to 10 percent mortality of the fish) for silvery minnows ranged from 29.9 ºC (52 ºF) for adults to 36.1 ºC (64.9 ºF) for 30-day juveniles.

Silvery minnow become stranded in isolated pools thus concentrating silvery minnow and other fish in pools. Water quality in isolated pools continues to degrade without the input of fresh water. Furthermore, when water quality conditions degrade, stress increases, and fish generally die (e.g., Matthews and Maness 1979; Ostrand and Wilde 2001). It is believed that during periods of low flow or no flow, Great Plains fishes (i.e., including silvery minnow) seek refugia in large isolated pools, backwater areas, or adjoining tributaries (Deacon and Minckley 1974; Matthews and Maness 1979). Fish in these refugia are adapted to survive until suitable flow conditions return and these areas reconnect with the main river channel. This pattern of retraction and recolonization of occupied areas in response to flow and other habitat conditions is typical of fishes that endure harsh conditions of Great Plains rivers and streams (Deacon and Minckley 1974; Matthews and Maness 1979). However, prolonged exposure to contracted habitat, such as isolated pools, can result in overcrowding and increased exposure and susceptibility to disease, resulting in increased physiological stress levels and potentially death.

River maintenance will result in sediment disturbance. This disturbance may affect water quality causing localized increases in turbidity and suspended sediments and lowering dissolved oxygen due to sediment. Effects from excess suspended sediments and reduced dissolved oxygen on fish have included alarm reactions, abandonment of cover, avoidance responses, reduced feeding rates, increased respiration, gill damage, physiological stress, reduced growth, increased susceptibility to disease and other stressors, or mortality (Fillos and Molof 1972; Davis 1975; Kreutzberger et al. 1980; Wang 1980; Walker and Snodgrass 1986; Kramer 1987; Veenstra and Nolen 1991; Caldwell and Doyle 1995; Newcombe and Jensen 1996; BCME 1997; Buhl 2008, 2011a).

Changes in water quality resulting from construction and maintenance activities are expected to be temporary in nature, and silvery minnows that may be in the vicinity are expected to flee any water quality alterations that occur until those conditions return to baseline levels. However, indirect effects from sediment mobilization are possible, including potential smothering of silvery minnow prey such as algae and aquatic invertebrates, or oxygen stress, which can result in depressed rates of growth, and reduced physiological function.

Under unusual conditions, low dissolved oxygen may also cause a wide range of additional chronic effects and behavior responses in fish (Downing and Merkens 1957; Kramer 1987; Breitburg 1992), which are averse to silvery minnow (Lusk et al. 2012; Service 2013, 2014d). However, it is not known what sublethal effects, if any, occur to silvery minnows as a result of exposures to increased turbidity, suspended sediments, and lower dissolved oxygen associated with these activities.

Water Quality Conservation Measures

To minimize impacts to silvery minnow as a result of water quality changes Reclamation will implement several BMPs associated with river and drain maintenance projects (Conservation Measures 51 through 61).

In addition, Reclamation will implement habitat restoration projects. Focusing restoration projects on gaining reaches will increase the length of wetted river. These projects should improve water quality by maintaining flows.

Maintenance of the Delta Channel (Conservation Measure 59) will facilitate the development of a more natural river channel. In addition, Delta Channel maintenance will allow breaches to occur, providing inundated floodplain and backwater habitat for use by silvery minnow.

To address the issues of water quality in the San Acacia Reach specifically, Reclamation will engineer a 13 km (8 mi) realignment of the River at BDANWR (Conservation Measures 68 to 74). The goal of the realignment is to increase wetted habitat (Reclamation 2016a). This realignment will widen the River, provide areas for overbanking. Reclamation has committed to completing planning for the river realignment in 1.5 years, with an estimated construction start date by 2018 (Reclamation 2016a). The river realignment will increase the length of wetted river, and promote floodplain inundation. Increasing the length of wetted river will improve water quality by maintaining flows.

Localized Disturbances

Based on the Service's review and analysis of the Proposed Action as summarized in the MRSI (Appendix C), the following activities are anticipated to have impacts in addition to those described above, but on a short-term and localized level:

- Infrastructure construction and maintenance activities in the River and at dams and levees, including the LFCC
- River channel maintenance projects
- Delta channel maintenance

The following are beneficial activities for silvery minnow that may also have localized impacts:

- Maintenance of existing habitat restoration projects
- Pumping water from the LFCC to the river bed

During the next 15 years, the Proposed Action will include activities within the MRG for infrastructure construction and maintenance projects, river channel maintenance activities, Delta Channel maintenance, maintenance of habitat restoration projects and pumping water from the LFCC to the river channel. These activities are primarily related to small-scale construction or maintenance projects. The purpose of these projects can be to maintain and improve water conveyance, storage, recapture, delivery or protection of existing infrastructure. In addition, several activities that are proposed to minimize silvery minnow impacts as part of the Proposed Action, or are from ongoing conservation commitments, can have similar localized impacts on silvery minnow. The effects on silvery minnow from the activities are discussed below. Maintenance and restoration projects are programmatically covered under this BiOp; however, project-specific consultation may be required to determine the anticipated level of incidental take and provide project specific incidental take authorization.

Construction and Maintenance Activities

Heavy equipment will be used in river channel maintenance, construction and maintenance of water delivery structures and conveyance channels, and Delta Channel maintenance. The use of heavy equipment in the wetted channel will result in noise and vibrations, as well as physical disturbance of the water column and bottom sediments, which will impact the silvery minnow. Water quality issues are addressed in the prior section. In this section we will address the impacts of noise, vibration, and physical presence of equipment in the river channel.

Noise and vibration is likely to result in disturbance of silvery minnow within the construction zone and the water column immediately adjacent. Silvery minnow will exhibit an avoidance behavior, as they flee from the noise and vibrations associated with heavy equipment. This change from normal behaviors could result in increased energy expenditures and physiological stress, but because of the quick return to normal behavior exhibited by silvery minnow it is unlikely to result in death or injury for the majority of individuals or in population level effects. While moving position to avoid this disturbance, some level of increased exposure to predation may occur as silvery minnows seek alternative cover. There is also the potential for a small portion of the silvery minnows in the vicinity of the heavy equipment, to become disoriented and be buried in the sediment being moved or crushed under the equipment.

River maintenance activities include dredging, placement of fill material, bank stabilization structures, and revegetation. Dredging may result in local loss of sediment where it naturally accumulates. The net result is likely to be the movement of sediment which may enhance silvery minnow habitats downstream. Fill material is typically placed above the high water mark and to protect the bank from erosion. This can cause a temporary decrease in water quality and transport of fine sediments.

The use of bank stabilization structures and revegetation helps to maintain channel integrity, but will result in temporal loss of habitat. Weirs and riprap also involve the use of heavy construction equipment, dredging, and fill placement as described above. The placement of gabions that hold fill material will have minor adverse impacts. The presence of bank stabilization structures will reduce bank erosion and sediment loading. Vegetated banks will provide low velocity habitats at high water and allow for more natural rates of sediment movement and deposition. This should help to induce natural river meander and diversity in available silvery minnow habitats. Depending on where these vegetated banks occur, at higher river flows they may provide lateral connectivity from the river channel to low-velocity spawning habitat.

Maintenance activities, such as dust abatement on roads and levee structures, require the pumping of water from nearby ditches or the River. Entrainment in the ditches, as well as direct mortality, could occur if water was being pumped from the River and onto these roads and ditch embankments, adversely affecting silvery minnows.

Delta Channel Maintenance

The Delta Channel maintenance project will cover a large area approximately 32 km (20 mi)(RM 57.8 to 38.0), but channel maintenance will occur in a limited area at any one time.

The impacts from the use of heavy equipment, noise and vibration, water quality, and fill placement are all described above. The Delta Channel maintenance does not occur during high flow periods, and the breaching of the sides or overtopping at high flows allows shallow braided channels that could provide low-velocity spawning and rearing habitat. As water recedes from Elephant Butte Reservoir the maintenance activities help to maintain a wetted channel that provides suitable habitat for silvery minnow. The Delta Channel maintenance will assist the State in recovering water for downstream delivery. However, due to the mobility of the substrate in the river banks and floodplain adjacent to the Delta Channel, these habitat features are fairly dynamic and long-term habitat stability in this river section is unlikely. The short-term impact of the Delta Channel maintenance activities is offset by the creation of low velocity habitats in a braided channel.

Localized Disturbances Conservation Measures

To minimize impacts to silvery minnow as a result of localized disturbances Reclamation will implement several BMPs associated with river and drain maintenance projects (Conservation Measures 51 through 61, 64).

To reduce the likelihood of impacts to silvery minnow related to drain and LFCC channel maintenance projects Reclamation will install exclusion zones where necessary and will remove silvery minnows from within the impact area prior to beginning activities (Conservation Measure 62).

To reduce the likelihood of impacts to silvery minnows associated with pumping water from the river channel or other occupied habitat within the Action Area, screens will be installed at intakes to prevent silvery minnows from being sucked into pumps (Conservation Measure 60).

Effects of Action on Silvery Minnow Recovery

The Recovery Plan identifies demographic and threat-based criteria to recover the silvery minnow (Service 2010a). The MRG provides important spawning, feeding, sheltering, and designated critical habitat for the silvery minnow (Service 1994, 2003a). The Recovery Plan identifies the need to prevent the extinction and maintain a stable population of the silvery minnow in the MRG (Service 2010a).

The Proposed Action meets the following recovery goals and criteria (Service 2010a). The Proposed Action prevents extinction by conducting genetics management and captive propagation. The Proposed Action implements standard monitoring of the silvery minnow population and its reproduction (eggs). The Proposed Action increases the overall carrying capacity of the MRG for silvery minnow by connecting habitat and improves the quality and quantity of occupied habitat through river maintenance and implementation of future actions pursuant to the Lower Reach Plan, which we expect to improve survival rates, and contribute to recovery. The Proposed Action may alter the timing of recruitment flows to improve population growth rates. The Proposed Action implements an adaptive management program (RIO) so that appropriate research and management activities are implemented in a timely manner to help achieve recovery. Implementation of the Lower Reach Plan will improve water quality which is a recovery goal.

The Proposed Action does not prevent the attainment of the demographic goals for recovery (greater than 5 fish per 100 m^2), nor prevent the establishment of two additional populations of silvery minnow outside the MRG as called for in the Recovery Plan (Service 2010a). While the Proposed Action will have adverse effects to silvery minnow, the net effect along with the Conservation Measures will prevent extinction, stabilize or improve the population abundance, and increase survival of silvery minnow in the MRG. Thus, implementation of the Proposed Action will not preclude the recovery of silvery minnow.

Effects of the Action on Silvery Minnow Designated Critical Habitat

The Action Area includes all designated critical habitat for the silvery minnow, and equates to approximately 11,629 ha (28,738 acres) of designated silvery minnow habitat within the MRG critical habitat unit. Critical habitat within the Action Area includes the following habitat areas: active channel; areas of channel inundation at bankfull flows; and areas of overbanking in the floodplain within the levees, or in areas without levees, a lateral distance of 91.4 m (300 ft) from the edge of the bankfull channel. The biological requirements of the silvery minnow relevant to the PCEs are summarized in the Status of the Species section above.

Based on our analyses described in the Hydrology and Geomorphology sections, we conclude that the following activities included in the Proposed Action would adversely affect silvery minnow designated critical habitat (PCEs 1 and 2):

- Diversions of spring runoff into El Vado Reservoir for storage.
- Water storage (amount and timing).
- Agricultural demand (diversion and depletion).
- Maintenance activities at river facilities, dams, and levees including the LFCC.
- Delta Channel maintenance.
- River maintenance projects.

These activities are anticipated to reduce the amount of inundated habitat within the Action Area by decreasing flow volumes in May and June (USACE 2010). The inundated area is not directly equivalent to the PCEs of silvery minnow designated critical habitat. However, the magnitude, duration, and frequency of critical habitat inundation are important for silvery minnow.

Any reduction in inundated channel and floodplain is anticipated to reduce the availability, extent, or duration of slow [less than 0.3 m/s (0.1 ft/s)] velocity habitat indices, which will reduce habitat described in PCEs 1 and 2, specifically, the amount of spawning and rearing habitat. In addition to reducing the amount of spawning and rearing habitat during May and June as a result of reduced channel and floodplain inundation, the Proposed Action would result in a loss of low-velocity silvery minnow habitat (i.e., pools and backwaters) during July through October due to increases in river drying and intermittency.

Activities that contribute to channel incision or floodplain aggradation would adversely affect the physical and biological features of silvery minnow critical habitat PCE 1 and 2. This occurs by deepening the channel and separating the channel from lateral connection to the floodplain. Less water on the floodplain results in a reduction in the diversity of aquatic habitats. The slow increase of sediment deposition and increased elevation of terraces in the floodplain is anticipated to occur below Highway 380 (USACE 2012a, 2012b) due to levee maintenance which results in a lateral confinement of flows. We estimate up to 95 ha (235 acres) of potential overbanking within designated critical habitat is negatively impacted by sediment accumulations which continue due to levee maintenance practices (see flycatcher Hydrology section).

The Hydrology section describes how the Proposed Action will affect the hydrologic regime within the Action Area, including specified habitat features described in PCE 3. Based on our analyses described in the Hydrology section, we conclude that the Proposed Action's impacts on channel incision will adversely affect the physical and biological features of silvery minnow critical habitat PCE 3 due to reductions of sediment supply, and increased channel velocities that result in continued coarsening of substrates. Substrate coarsening will continue to increase in the MRG (mainly in the Cochiti and Angostura Reaches) (Richard 2001; Julien et al. 2005; Makar and Aubuchon 2012; Reclamation 2013a; USACE 2013b), thereby negatively affecting critical habitat (Service 2003a) and reducing the qualities of larval, juvenile and feeding habitat.

The adverse effects to water quality (PCE 4) are described in the Water Quality section above. For example, river maintenance activities can temporarily reduce dissolved oxygen in silvery minnow habitat. Alterations in hydrology that lead to less water in the MRG, reduce habitat connectivity, and form isolated pools, resulting in degraded water quality, which adversely affects PCE 4.

Silvery Minnow Designated Critical Habitat Conservation Measures

To minimize adverse effects to the silvery minnow critical habitat associated with project-related May and June flow volume reductions (Table 8), Reclamation will implement the Silvery Minnow SRS (as described in the Description of the Proposed Actions, Conservation Measures). MRG Water Managers will meet annually to evaluate the hydrologic conditions within the Action Area and to determine if there is a need for modified operations at El Vado Dam/Reservoir, or other operations. Modified operations at El Vado include: using supplemental SJC water to increase flow, continue adjusting the timing of water storage during the spring (i.e., storing early to minimize impacts on spring flows), and using diversion structures to aid in providing spawning habitat (Conservation Measures 1 through 5 and 32 through 44). In addition, the RIO will determine if there is a need for additional water during July through

October to increase the amount of wetted river through the summer. In years that are very dry and the water is projected not to be sufficient, the available water (native and purchased water) will be used to increase the amount of wetted river through the summer (Conservation Measures 7 through12 and 31 through 45). These Conservation Measures address PCE 1 through 4 by providing flows that result in an increase in habitat diversity and length of wetted river.

To further minimize impacts to silvery minnow critical habitat, Reclamation will implement habitat restoration projects, including the Delta Channel Maintenance project and large-scale habitat restoration in the Isleta and San Acacia reaches. Maintenance of the Delta Channel (Conservation Measure 59) will facilitate the development of a more natural river channel. In addition, Delta Channel maintenance will allow breaches to occur, providing inundated floodplain and backwater habitat. This Conservation Measure addresses PCE 1 and 2 by enhancing habitat and providing flows that result in an increase in habitat diversity.

Within the San Acacia Reach, Reclamation will engineer a 13-km (8-mi) channel realignment at BDANWR (Conservation Measure 70). The goal of the realignment is to increase wetted habitat and reduce the frequency of need to remove the sediment plug (Reclamation 2016a). This realignment will widen the channel and provide areas for overbanking (Holste 2015). Reclamation has committed to completing planning for the realignment in 1.5 years, with an estimated construction start date by 2018 (Reclamation 2016a). This Conservation Measure addresses PCE 1 through 4 by providing flows that result in an increase in habitat diversity.

In addition, Reclamation will implement the large-scale habitat restoration project in the Isleta and San Acacia Reaches of the MRG (Conservation Measures 68-74). The Service anticipates that Reclamation will take up to 1.5 years to develop a lower river restoration and enhancement plan (Lower Reach Plan). This Plan will be reviewed and approved by the Service prior to implementation. This Plan will outline project opportunities, costs, timeframes, responsible parties, and an implementation schedule. Once completed, this Plan will be active for the life of this BiOp. The goal of this Plan is to reverse the ongoing adverse effects through habitat restoration that will increase floodplain inundation, and increase the wetted river length. These Conservation Measures address PCE 1 through 4 by providing flows that result in an increase in habitat diversity and length of wetted river.

Summary of Effects to Silvery Minnow and Critical Habitat

Long-term survival and eventual recovery of silvery minnow is dependent upon maintaining adequate fall densities (fish per 100 m^2) of silvery minnows within the MRG by maintaining adequate May and June flows (volume, velocity, and duration) and habitat to support successful spawning, as well as July through October flow volumes and habitat to support survival and genetic exchange.

As a result of project-related impacts to flows and habitat suitability, resulting from alterations to hydrology, geomorphology, and water quality within the Action Area, as well as localized disturbances, we anticipate that silvery minnow densities and critical habitat will be adversely affected by the Proposed Action as follows: 1) increased depletions of water from the River during May and June and July through October resulting in reduced flows and increased river drying; 2) geomorphological changes to the channel including channel incision, sediment plugging and substrate changes resulting in the loss of spawning and rearing habitat, increased drying, and decreased food availability; 3) water quality degradation, including decreased dissolved oxygen, increased turbidity, and pH changes, resulting in increased physical stress and mortality; and 4) localized disturbances resulting in noise and vibration, loss of suitable substrate, and silvery minnow entrainment.

Reclamation, BIA, and BA Partners have committed to several Conservation Measures (Table 1) to minimize the adverse effects of the Proposed Action on silvery minnow and silvery minnow critical habitat PCEs. Reclamation will implement the Silvery Minnow SRS. The Silvery Minnow SRS includes: 1) adaptive management of water operations within the MRG through the RIO to increase May and June flows to aid in providing spawning conditions and July through October flows to maintain wetted river for survival of silvery minnows; 2) fish rescue efforts to relocate fish from drying river reaches to wetted areas within upstream reaches; 3) installation of fish passages at the three diversion dams which will add approximately 32 km (20 mi) of wetted river during the summer and will to allow fish to move from drying areas to wetted areas and maintain genetic connectivity; 4) implementation of large-scale river restoration within the lower reaches of the MRG to improve the hydrology and geomorphology, create additional spawning and rearing habitat, and improve silvery minnow survival by providing wetted river in silvery minnow habitat that has previously dried; and 5) the establishment of Conservation Storage capacity of approximately 30,000 to 60,000 acre-ft of water that can be used during very dry years to ensure adequate water is available for spring spawning and rearing, or to maintain wetted river for survival. In addition, Reclamation will implement BMPs to minimize injury or death of silvery minnows related to water pumping, entrainment, localized disturbances, and monitoring activities.

Based on the production and survival goals in the Silvery Minnow SRS, as well as goals identified in the silvery minnow Recovery Plan, silvery minnow densities must be greater than or equal to 1.0 fish per 100 m^2 to maintain a self-sustaining silvery minnow population within the MRG. In addition, densities must be greater than or equal to 0.3 fish per 100 m^2 to maintain genetic diversity within the population. With the Proposed Action and implementation of the Conservation Measures (as described in the sections above), we anticipate that the population within the MRG will be self-sustaining (Service 2007a, 2010a; Archdeacon 2013a). A self-sustaining population is a recovery goal (Service 2010a, Recovery Criterion 3-A-1).

The proposed Conservation Measures will improve the current conditions for silvery minnow within the Action Area by ensuring adequate spawning conditions are present in May and June and increasing the amount of wetted river through the summer to improve survival of newly spawned silvery minnows and fish from prior years. With implementation of the Silvery Minnow SRS, and the Conservation Measures in Table 1, we anticipate that fall densities of silvery minnow for the duration of this BiOp will not be less than 1.0 fish per 100 m^2 for more than 5 years, and will not be less than 0.3 fish per 100 m^2 for more than 2 years. Therefore, we have determined that implementation of the Silvery Minnow SRS, along with the Conservation Measures committed to in Table 1, will minimize adverse impacts to silvery minnow and designated critical habitat. In addition the Proposed Action will not preclude recovery of the silvery minnow, and will maintain or improve its status within the Action Area.

Southwestern Willow Flycatcher

Hydrology

Hydrology refers to the magnitude, timing, and duration of flows within the Action Area. Based on the Service's review and analysis of the Proposed Action as summarized in the MRSI (Appendix C), the following Proposed Action activities are anticipated to negatively affect river hydrology:

- Water storage (amount and timing)
- Agricultural demand (diversion and depletion)
- LFCC
- State's new water rights permits

The Proposed Action decreases the frequency and amount of water in the channel and overbank flows. Overbank flows are critical for maintaining sediment composition, leaching salts and accumulation of duff from the floodplain. Without overbank flows, soil salinity increases, duff accumulates preventing new riparian growth and regeneration, and prey becomes less abundant. Overbank flows are also important for attracting flycatchers to nesting areas, supporting the required microclimate, creating dynamic riparian systems, and creating conditions for an adequate prey base (see Status of Species and Environmental Baseline sections for additional details and citations). As a result of reduced overbank flows, flycatchers may alter their behavior, have increased energy requirements, experience physiological stress, or move to more suitable habitat.

In an effort to determine the frequency of overbank flows, the Service used data provided by Bui 2016 to estimate the percentage of time under very wet or very dry conditions where overbank flows would occur. Flows are anticipated to reach or exceed 3,500 cfs, 4 percent *less* often during very wet years (10 percent sequence, very wet). During very dry years (90 percent sequence, very dry), and as a result of the Proposed Action, flows would reach 3,500 cfs 2.9 percent *more* often (Bui 2016). In dry years, there is more water available compared to baseline conditions during May and June. This is the time when water is most critical for attracting flycatchers and for improving riparian vegetation health.

In a separate effort to determine the area subjected to overbank flows, the Service used Reclamation's 2016 model (Bui 2016) in conjunction with aerial imagery, and estimated the area of overbank flows in the main channel with or without the Proposed Action. We used aerial imagery to identify floodplain and channel width at ten gage locations from Albuquerque to San Marcial to represent an approximate area of available floodplain habitat. We compared the estimated flows and floodplain area subject to overbanking under the action and pre-action conditions for very wet and very dry years (after Bui 2016). In very dry years, the Proposed Action would decrease overbanking by 7 ha (18 acres), and in very wet years, decrease overbanking by 95 ha (235 acres).

The decrease in overbanking areas as a result of the Proposed Action by as much as 95 ha (235 acres) would negatively impact vegetation and the possibility for natural regeneration of vegetation. Less water availability for riparian vegetation would result in stressed vegetation, producing less foliage and thereby less canopy cover. Less canopy cover would result in flycatchers and nestlings being more susceptible to the elements (heat, storms, etc.), as well as having less concealment from predators. Depending on the extent of the decrease in canopy cover and drying conditions, the area between the riparian floor and riparian canopy may experience higher temperatures and decreases in prey base which would cause increased energetic demands for flycatchers (Service 2002). By decreasing the overbanking area then habitat suitability may decrease.

Hydrology Conservation Measures

Reclamation is implementing Conservation Measures that will minimize the effects of their actions on flycatchers (Table 1).

Implementation of the RIO will increase overbanking conditions necessary to support flycatcher within the Action Area. The MRG Water Managers will meet annually to evaluate the hydrologic conditions within the MRG and to determine if there is a need for modified operations at El Vado Dam/Reservoir, or other operations. Modified operations at El Vado will include: using supplemental SJC water to increase flow, continue adjusting the timing of water storage and storage and releases during runoff or when the River becomes critically dry. Vegetation within flycatcher habitat will benefit from sustained summer water releases (Conservation Measure 1) by keeping depth to groundwater more stable.

In addition, the maintenance of the Delta Channel will allow river breaches to occur and berms will not be repaired until fall/winter months, thereby providing overbanking conditions during the breeding season for the flycatcher (Conservation Measures 58-60). It is anticipated that the Delta Channel maintenance would result in an addition of 99 ha (245 acres) of overbanking habitat. The Delta Channel area supports roughly 25 flycatcher territories (Moore and Ahlers 2016), and also supports approximately 99 ha (245 acres) of suitable or moderately suitable flycatcher habitat in areas where historical Delta Channel breaches have occurred (Siegle et al. 2013). Maintenance and habitat restoration in the Delta Channel area, and the associated benefits to flycatcher habitat, will continue as part of the Proposed Action (Conservation Measures 29, 80-82). In an effort to determine the frequency of flows that would allow for breaches in Delta Channel, the Service used data from Bui (2016) to estimate the percentage of time under very wet or very dry conditions where overbank flows would occur. Breaches typically occur in select areas along the Delta Channel at 1,000 cfs (Reclamation 2014). As a result of the Proposed Action, flows would reach or exceed 1,000 cfs 2 percent more often during wet years (10 percent sequence, very wet). During dry years, and as a result of the Proposed Action, flows would exceed 1,000 cfs roughly 28.9 percent of the time from May and June versus 54.9 percent of the time without the proposed action (90 percent sequence, very dry). The net effect of the hydrology impacts are found in the flycatcher summary section below.

Geomorphology

Geomorphology refers to the physical properties of the river channel (i.e., width, depth, whether it is channelized or meanders). Based on the Service's review and analysis of the Proposed Action as summarized in the MRSI (Appendix C), the following Proposed Action activities are anticipated to affect MRG geomorphology:

- Storage and release of water
- Agricultural demand (diversion and depletion)
- Maintenance activities at river facilities, dams, and levees including the LFCC
- Delta Channel maintenance
- River maintenance projects

Geomorphic alterations to the River, associated with the actions listed above, will occur within the Action Area as a result of the hydrological changes and mechanical alterations to the channel. These geomorphic changes are anticipated to contribute towards the narrowing and incision of the river channel wherever these occur in the MRG. When this narrowing and incision process occurs, the depth to groundwater for existing vegetation increases and opportunities for the River to meander, overbank, or realign the channel decreases. Less water availability for riparian vegetation would result in stressed vegetation, producing less foliage and thereby less canopy cover (Horton et al. 2001; Parametrix 2008; Caplan et al. 2012) (Table 10).

Less canopy cover would result in flycatchers and nestlings being more susceptible to the elements (heat, storms, etc.), as well as having less concealment from predators. Depending on the extent of the decrease in canopy cover and drying conditions, the area between the riparian floor and riparian canopy may experience higher temperatures and decreases in prey base which would cause increased energetic demands for flycatchers (Service 2002).

Additionally, the slow increase of sediment deposition and increased elevation of terraces in the floodplain is anticipated to occur below Highway 380 (USACE 2012a, 2102b) due to the lateral confinement of floods. This is an important area for breeding flycatchers. In 2015, 15 flycatcher territories (Moore and Ahlers 2016) were located in the area identified to be most impacted by the sediment deposition. Maintenance of the spoil bank levee and Proposed Action activities that similarly trap and build sediment in the floodplain will negatively impact flycatcher habitat because sediment has been estimated to accumulate 2 to 3 m (7 to10 ft) in the area occupied by flycatchers over a 50-year period (USACE 2012a, 2012b). These accumulations, coupled with reservoir levels or high flows that would scour aggraded sediments in the channel, would ultimately deepen the channel compared to the aggraded bank. This process would increase the depth to groundwater for vegetation, causing stress to the vegetation within this reach (Service 2016b, Environmental Baseline section). As identified in both the 2013 and 2016 consultations with the USACE (Service 2013b, 2016b), there is much uncertainty associated with aggradation as well as the total amount attributable to natural conditions, the pre-existing spoil bank, the new engineered levee, the future maintenance associated with the spoil bank or levee, in channel maintenance and incision, and reservoir water surface elevations. In both consultations (Service

2013b, 2016b), estimates on aggradation amounts due to natural circumstances and other factors were also estimated and subtracted from the total aggradation amount as originally estimated by the USACE 2012a). Until more certainty can be established, the Service estimated up to 105 ha (260 acres) of suitable or moderately suitable flycatcher habitat will be negatively impacted by sediment accumulations over the next 15 years which continue due to various river maintenance and water management practices.

Geomorphology Conservation Measures

Several Proposed Action activities will minimize geomorphology effects to flycatchers. For example, Reclamation's River Infrastructure Maintenance and Restoration Program will implement Conservation Measures described below that will address sediment management, promote elevation stability, and increase available floodplain area, which would reverse or at least minimize the current trend of the narrowing and incising the channel and address specific geomorphology issues per reach (Reclamation 2015, Part III, Appendix B). To address the geomorphology issues in the San Acacia Reach specifically, Reclamation has been planning with multiple agencies to engineer a 13-km (8-mi) channel realignment at BDANWR (Conservation Measure 70). This realignment will widen the channel, provide areas for overbanking, and reverse the narrowing and incising conditions in the most populated flycatcher area within this Reach. Reclamation has committed to completing planning for the realignment in 1.5 years, with an estimated construction start date in 2021 to 2022 (Reclamation 2016a). Implementation of this realignment will address the sediment plugging conditions, which have historically been remedied by dredging a pilot channel through the plugged portion of the channel. The goal of the realignment is to increase wetted habitat and decrease the frequency of sediment plugging (Reclamation 2016a). It is anticipated that the BDANWR realignment will result in the addition of approximately 59 ha (146 acres) of flycatcher habitat. This acreage was calculated using an estimated 46 m (150 ft) width of bank vegetation extending the length of the 13 km (8 mi) realignment.

In addition to Reclamation's River Infrastructure Maintenance and Restoration Program, Conservation Measures 73 and 78 propose 73 ha (180 acres) of habitat restoration projects to improve floodplain connectivity by 2017. Conservation Measures 73 and 78 will provide benefits for the flycatcher because the projects involve channel widening, lowering terraces, creating backwaters or ephemeral channels, or similar actions that would allow for more areas to receive overbank flows that support riparian vegetation and provide an environment suitable for insect prey base. It is anticipated that habitat restoration activities will result in the addition of approximately 73 ha (180 acres) of flycatcher habitat. The net effect of the geomorphological impacts can be found in the flycatcher summary section below.

Riparian Vegetation Dynamics

Based on the Service's review and analysis of the Proposed Action as summarized in the MRSI (Appendix C), the following activities are anticipated to negatively affect riparian vegetation dynamics and therefore flycatcher habitat:

- Agricultural demand (diversion and depletion)
- Maintenance activities in the River and at dams and levees including the LFCC
- Water storage
- Delta Channel maintenance
- River maintenance projects

Riparian vegetation dynamics change as a result of hydrology and geomorphic conditions, and involve a process where riparian habitat is created and destroyed by the availability of surface and groundwater and high flow events. Generally, as streams reach lower elevations, their gradients typically flatten and surrounding terrain opens into broader floodplains (Service 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; Service 2002, 2014a). Allowing the Rio Grande to flow over the width of the floodplain, when overbank flooding occurs, is integral to allowing 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 development of the vegetation that provides flycatcher habitat and microhabitat conditions (Service 2002, 2014a).

Riparian Vegetation Dynamics Conservation Measures

There is uncertainty associated with the LFCC project (Conservation Measure 68) because plans have not been completely developed. One potential outcome would be to decommission or reroute the LFCC to the river above RM 60, which would result in dewatering a substantial amount of cuckoo and flycatcher habitat. Water provided to flycatcher habitat from the LFCC currently supports approximately 178 flycatcher breeding territories (or 45 percent of the population in the MRG) (Figure 12). Should this scenario take place, 573 ha (1,416 acres) of occupied flycatcher habitat may no longer receive LFCC overbank flows, and be negatively impacted (Siegle et al. 2013). However, if the river is realigned to create a single channel located at the LFCC outfall, this may provide additional overbank habitat, and thus may benefit flycatchers long term by expanding the currently occupied habitat.

Proposed BMP’s for river channel maintenance activities will minimize the effects of the Proposed Action on riparian vegetation. For example, MRGCD will conduct vegetation control from August 15 to April 15, which is outside of the breeding season and when flycatchers are not present within the Action Area. Presence/absence surveys will also be completed to determine locations of breeding flycatchers. If flycatchers are detected in an area where an action would occur, then vegetation removal will only occur beyond 0.4 km (0.25 mi) of an active nest. Replanting of woody species (mainly cottonwood or willow) will occur to replace removed native vegetation at a ratio of 10 new plants to each 1 removed. We expect this ratio to offset early mortality and temporal loss and therefore fully replace any native vegetation loss. It is anticipated that vegetation replacement will result in the addition of approximately 65 ha (160 acres) of flycatcher habitat. This estimate is derived from the river maintenance and habitat restoration activities impacting 65 ha (160 acres) of suitable or moderately suitable flycatcher habitat impacting over the 15-year BiOp period (Reclamation 2015, Part III), and replaced (but with younger aged classes of native vegetation) as proposed at the 10 to 1 ratio.

Conservation Measure 70 (BDANWR realignment) will add 13 km (8 mi) of widened channel, an increased number of meanders, and a new area for riparian vegetation to develop. This would create additional opportunities for overbank flows, which would provide an environment for natural regeneration of vegetation, and thus, an environment composed of young (and adjacent mature) successional age classes of vegetation for flycatchers (see Status of Species section for further detail). It is anticipated that the BDANWR realignment will result in the addition of approximately 59 ha (146 acres) of flycatcher habitat.

Other minimization measures would include modified operations at El Vado Dam (Conservation Measure 3), which will increase opportunities for overbanking conditions. Keeping an additional 16 km (10 mi) of channel wet during the breeding season will ensure the depth to groundwater would not decline.

Some Conservation Measures, such as 50 and 71 (e.g., infrastructure changes), could cause long-term negative impacts for flycatchers. Plans for these projects have not been finalized. Therefore, separate consultations will be necessary in the future. The net effect of riparian vegetation dynamics impacts are summarized in the flycatcher summary section below.

Other (Localized Disturbance Projects)

Based on the Service's review and analysis of the Proposed Action as summarized in the MRSI (Appendix C), the following activities are anticipated to have impacts in addition to those described above, but on a short-term and localized level:

- Infrastructure construction and maintenance activities in the River and at dams and levees, including the LFCC
- River channel maintenance projects
- Delta channel maintenance

The following are minimization measures for impacts to flycatcher that may also have localized impacts:

- Maintain habitat restoration projects from the past and for 15 years post-construction for future projects (Conservation Measure 23)

- BMP's (Conservation Measures 51-52, 54-55, 58-59, 61, 64, and 80)

These activities are characterized by small project areas and localized impacts related to small-scale construction or maintenance projects. The purpose of these projects is to maintain and improve water conveyance, storage, recapture, delivery or protection of existing infrastructure. In other words, several actions would not result in the loss of acreage, but rather, the loss of trees in locations along the road or existing infrastructure (transitional and migratory habitat). These lost trees will be replaced. Reductions in trees due to the Proposed Action are expected to adversely affect adults, and recently fledged juveniles. Conservation Measures 51-52, 54-55, 58-59, 61, and 64, address loss of native vegetation (typically cottonwood), which will be replaced at a ratio of 10 new plants to each 1 removed. We expect this ratio to offset early mortality and temporal loss of trees.

Specifically, river maintenance activities that would directly remove or mow vegetation would reduce habitat available for migrating or foraging activities. However, negative effects from mowing and removal of vegetation would be offset by maintaining a distance of at least 0.4 km (0.25 mi) from a breeding territory, or be coordinated with the Service (Conservation Measures 51, 54-55, 58-59, 61, 64, and 80).

About 65 ha (160 acres) of suitable or moderately suitable habitat (utilized for flycatcher nesting activity) may also be negatively impacted by river maintenance activities over the 15-year BiOp period (Reclamation 2015, Part III). The negative effects to this habitat are anticipated to be offset by the BMP that will result in the replacement of lost mature native vegetation at a 10 to 1 ratio and with young native vegetation. In addition, Reclamation's river maintenance program includes habitat restoration features, such as terrace lowering, which also offsets lost vegetation by providing more favorable conditions for overbanking and natural regeneration of vegetation (Reclamation 2012).

Construction activities may also create noise disturbances for flycatchers which could decrease nest success, decrease opportunities for attracting or communicating with a mate, or cause flycatchers to avoid areas with noise disturbance all together (Habib et al. 2007; Goodwin and Shriver 2010). Conservation Measures 51, 54-55, 58-59, 61, and 64 compensate for noise disturbances by locating nests and ceasing construction in areas with breeding flycatchers located within 0.4 km (0.25 mi) during the breeding season. Should construction be required within 0.4 km (0.25 mi) of a nesting flycatcher, a separate consultation would be required and tiered off this BiOp.

Effects of the Action on Flycatcher Designated Critical Habitat

The Action Area supports 22,576 ha (55,786 acres) of designated flycatcher critical habitat within the MRG and Upper Rio Grande Management Units. As described in the Status of the Species section of this BiOp, the two PCEs of designated flycatcher critical habitat are: 1) riparian habitat along a dynamic river or similar successional environment that is comprised of dense trees and shrubs; and 2) insect prey populations adjacent to moist environments.

Designated flycatcher critical habitat will be adversely affected by the Proposed Action due to reduced overbank flooding, increased depth to groundwater, increased river drying, and vegetation removal. These habitat alterations will result in a loss of breeding and foraging habitat, as well as a loss in prey base, as described in the sections above. We anticipate that the Proposed Action will result in permanent and temporary impacts to 838 ha (2,071 acres) of designated flycatcher critical habitat as follows:

- Temporary loss of 95 ha (235 acres) due to loss of overbank flooding areas (mixed suitability)

- Permanent loss of 573 ha (1,416 acres) due to lack of LFCC water within occupied habitat from RM 62 to 54 (suitable or moderately suitable habitat)

- Temporary loss of 65 ha (160 acres) due to river maintenance projects (suitable or moderately suitable habitat)

- Permanent loss of 105 ha (260 acres) due to increased sedimentation within the floodplain (mixed suitability)

The temporary and permanent loss of 838 ha (2,071 acres) of flycatcher critical habitat is approximately 3.7 percent of the 22,576 ha (55,786 acres) of designated critical habitat within the MRG and Upper Rio Grande Management Units, and approximately 1.0 percent of the total designated critical habitat [84,568 ha (208,973 acres)]. Within the designated critical habitat in the MRG and Upper Rio Grande Management Units, habitat suitable for nesting activity ("suitable" or "moderately" suitable habitat) is estimated to be 3,795 ha (9,378 acres) [calculated from data in Reclamation (2015 Part III), and Siegle et al. (2013)]. Subtracting the project impacted habitat acreage [838 ha (2,071 acres)] from the suitable or moderately suitable habitat available [3,795 ha (9,378 acres)] results in approximately 2,957 ha (7,306 acres) of designated flycatcher critical habitat with PCEs remaining within the Action Area after project impacts. Given flycatchers use an average patch size of roughly 2.2 ha (5.4 acres) (Service 2002), that would be enough habitat remaining to support 1,344 flycatcher territories. The Recovery Goal for the MRG Management Unit is 100 territories and 75 territories for the Upper Rio Grande Management Unit. An estimated 400 flycatcher territories were located within the Action Area from 2015 survey data, and recovery goals have been surpassed in the MRG since 2003. In addition, several Conservation Measures will be implemented that will improve the quality of designated flycatcher critical habitat within the Action Area as described below. Therefore, the loss of 838 ha (2,071 acres) of designated flycatcher critical habitat as a result of the Proposed Action will not appreciably diminish the value of designated critical habitat or preclude recovery.

Flycatcher Designated Critical Habitat Conservation Measures

Although the Proposed Action will result in adverse effects to designated flycatcher critical habitat, several measures will be implemented to minimize the impacts of the Proposed Action (Tables 1).

Implementation of adaptive management through the RIO will increase the frequency of spring peak flows which will enhance overbank flooding conditions that are necessary to support designated flycatcher critical habitat PCEs within the Action Area. The MRG Water Managers will meet annually to evaluate the hydrologic conditions and to determine if there is a need for modified operations at El Vado Dam, or other operations. Modified operations at El Vado will include: using supplemental SJC water to increase flow volumes, continue adjusting the timing of water storage and storage and releases during runoff or when the channel becomes critically dry. Sustained post runoff releases (Conservation Measures 1 through 44) will ensure that the depth to groundwater will not deepen as quickly as it would without the sustained post runoff releases, and therefore will benefit vegetation within flycatcher critical habitat areas. In addition, the maintenance of the Delta Channel will allow river breaches to occur, berms will not be repaired until fall/winter months, thereby providing overbanking conditions during the breeding season within designated flycatcher critical habitat (Conservation Measures 58-60). These Conservation Measures address PCE 1 and 2 by providing flows that result in increased habitat diversity.

To further minimize impacts to flycatcher designed critical habitat, Reclamation will implement a large-scale habitat restoration project in the Isleta and San Acacia Reaches. The Service anticipates that Reclamation will take up to 1.5 years to develop a lower river restoration and enhancement plan (Lower Reach Plan). This Plan will be reviewed and approved by the Service prior to implementation. This Plan will outline project opportunities, costs, timeframes, responsible parties, and an implementation schedule. Once completed, this Plan will be active for the life of this BiOp. The goal of this Plan is to reverse the ongoing adverse effects through habitat restoration that will increase floodplain inundation, and increase the wetted river length. These Conservation Measures address PCE 1 and 2 by providing flows that result in increased habitat diversity.

We anticipate that the Proposed Action will result in 296 ha (731 acres) of habitat improvements as follows:

- Habitat restoration projects [73 ha (180 acres)], (Conservation Measures 73 and 78)
- BDANWR realignment [59 ha (146 acres)] (Conservation Measure 70)
- Delta Channel maintenance [99 ha (245 acres)] (Conservation Measures 29, 58-60, 80-82)
- Replanting (Conservation Measure 51-52, 55, 58, and 61) 65 ha (160 acres) of flycatcher habitat

Summary of Effects on Flycatcher

Flycatchers within the Action Area require dense patches of riparian habitat, comprised of trees and shrubs, as well as an adequate prey base adjacent to riparian floodplains or moist environments. Maintaining adequate hydrology to provide adequate amounts of surface and groundwater is essential to maintaining the flycatcher habitat requirements.

As a result of project-related alterations to hydrology, geomorphology, and riparian vegetation dynamics, as well as localized disturbances, within the Action Area, we anticipate that flycatchers and flycatcher designated critical habitat will be adversely affected by the temporary loss of approximately 160 ha (395 acres) and the permanent loss of 678 ha (1,676 acres) of suitable flycatcher habitat. The loss of flycatcher habitat will result from the following: 1) increased depletions of water from the channel resulting in reduced velocities and overbank flows; 2) geomorphological changes to the channel including channel incision and sediment plugging resulting in the increased depth to groundwater; 3) riparian vegetation dynamic changes due to changes in the availability of surface and groundwater resulting from hydrology and geomorphology alterations; and 4) localized disturbances including vegetation removal and noise.

Reclamation, BIA, and the BA Partners have committed to several Conservation Measures (Table 1) to minimize the adverse effects of the Proposed Action on flycatchers and flycatcher designated critical habitat within the Action Area. These measures include: 1) adaptive management of water operations within the MRG through the RIO to increase May and June flows to increase overbanking conditions and maintain depth to groundwater levels necessary to support flycatcher habitat; 2) maintenance of the Delta Channel to allow river breaches to occur and increase overbanking habitat, which will add an additional 99 ha (245 acres) of suitable flycatcher habitat; 3) river realignment at BDANWR to add 13 km (8 mi) of widened channel, increased meanders, and approximately 59 ha (146 acres) of suitable flycatcher habitat; 4) implementation of large-scale habitat restoration in the Isleta and San Acacia Reaches to increase overbanking conditions and the amount of wetted river, which will add approximately 73 ha (180 acres) of suitable flycatcher habitat; and 5) replanting of riparian vegetation in areas where vegetation is removed for localized projects or maintenance, which will add approximately 65 ha (160 acres) of suitable flycatcher habitat. In addition, Reclamation will implement BMPs to related to localized disturbances, and monitoring activities and will avoid impacts to flycatchers as a result of noise disturbances by locating nests and ceasing construction in areas with breeding flycatchers.

The Service anticipates the loss of approximately 838 ha (2,071 acres) of suitable flycatcher habitat that will be adversely impacted over the 15 year duration of the Proposed Action. This habitat loss is calculated as follows:

- Temporary loss of 95 ha (235 acres) due to loss of overbank flooding areas (mixed suitability)

- Permanent loss of 573 ha (1,416 acres) due to lack of LFCC water within occupied habitat from RM 62 to 54 (suitable or moderately suitable habitat)

- Temporary loss of 65 ha (160 acres) due to river maintenance projects (suitable or moderately suitable habitat)

- Permanent loss of 105 ha (260 acres) due to increased sedimentation within the floodplain (mixed suitability)

We anticipate that the Proposed Action will result in 296 ha (731 acres) of habitat improvements from the following actions:

- Habitat restoration projects totaling 73 ha (180 acres), (Conservation Measures 73 and 78)
- BDANWR realignment totaling 59 ha (146 acres) (Conservation Measure 70)
- Delta Channel maintenance totaling 99 ha (245 acres) (Conservation Measures 29, 58-60, 80-82)
- Replanting 65 ha (160 acres) of flycatcher habitat (Conservation Measure 51-52, 55, 58, and 61)

There is a deficit of 542 ha (1,340 acres) in adversely impacted versus improved acreage that is largely due to the permanent loss of 573 ha (1,416 acres) associated with the LFCC water within occupied habitat from RM 62 to 54. However, this loss of habitat will not result in the adverse modification of critical habitat because approximately 2,957 ha (7,306 acres) of designated flycatcher critical habitat with PCEs (i.e., suitable or moderately suitable habitat for nesting activity) will remain after project impacts. This habitat could support an estimated 1,344 flycatcher territories.

The recovery goal for the MRG Unit is 100 territories and for the Upper Rio Grande Management Unit 75 territories. These recovery goals have been surpassed since 2003. An estimated 400 flycatcher territories were found within the Action Area in 2015. The Proposed Action will result in impacts (temporary and permanent) to 838 ha (2,071 acres) of flycatcher habitat, which could impact up to 26 territories annually. The Service anticipates that the above measures will minimize the impacts to the species through the addition of 296 ha (731 acres) of flycatcher habitat. This could support 135 flycatcher territories. Therefore, we anticipate that recovery goals for the MRG and Upper Rio Grande Management Units will continue to be surpassed.

Yellow-billed Cuckoo

Hydrology

Hydrology refers to the magnitude, timing, and duration of flows within the Action Area. Based on the Service's review and analysis of the Proposed Action activities as summarized in the MRSI (Appendix C), the following activities are anticipated to negatively affect river hydrology:

- Water storage (amount and timing)
- Agricultural demand (diversion and depletion)
- LFCC
- State's new water rights permits.

Proposed Action activities above decrease the amount of water in the channel. Water diversions (in addition to geomorphology changes as discussed below) make overbank flows increasingly less achievable along the MRG and throughout the project area. Identical to the flycatcher hydrology effects section, once flows reach or exceed 3,500 cfs, substantially more overbank flooding occurs [1,610 ha (4,000 acres) of overbank flows at or above 3,500 cfs versus 243 ha (600 acres) below 3,500 cfs]. Flows are anticipated to reach or exceed 3,500 cfs, 4 percent *less* often during very wet years (Bui 2016). During very dry years, and as a result of the Proposed Action, flows would reach 3,500 cfs 2.9 percent *more* often (Bui 2016). The impacts to vegetation are considered to be similar for the flycatcher and cuckoo since they occupy similar habitat and their proposed or designated critical habitats overlap. The main difference in habitat use between flycatchers and cuckoos is that cuckoos occupy substantially larger home ranges (Service 2002; Halterman et al. 2016). While both species occupy dense riparian, mainly native, vegetation with successional age classes of vegetation, cuckoos will use taller or more mature age classes of vegetation (typically tree willow and cottonwood trees).

In very dry years, overbanking will decrease by 7 ha (18 acres) due to the Proposed Action, and in very wet years, overbanking will decrease by 95 ha (235 acres) (as described in the flycatcher Hydrology section). The decrease in overbanking areas as a result of the Proposed Action by as much as 95 ha (235 acres) would negatively impact vegetation and the possibility for natural regeneration of vegetation. Less water availability for riparian vegetation would result in stressed vegetation, producing less foliage and thereby less canopy cover. Less canopy cover would result in cuckoos and nestlings being more susceptible to the elements (heat, storms, etc.), as well as having less concealment from predators. Depending on the extent of the decrease in canopy cover and drying conditions, the area between the riparian floor and riparian canopy may experience higher temperatures and decreases in prey base which would cause increased energetic demands for cuckoos.

Hydrology Conservation Measures

Reclamation is implementing Conservation Measures that will minimize the effects of their actions on cuckoos (Table 1).

Implementation of the RIO will increase overbank flooding conditions necessary to support cuckoo within the Action Area. The MRG Water Managers will meet annually to evaluate the hydrologic conditions within the MRG and to determine if there is a need for modified operations at El Vado Dam/Reservoir, or other operations. Modified operations at El Vado will include: using supplemental SJC water to increase flow volumes, continue adjusting the timing of water storage and storage and releases during runoff or when the channel becomes critically dry. Vegetation within cuckoo habitat will benefit from sustained summer water releases (Conservation Measure 1) by ensuring that the depth to groundwater will not increase.

In addition, the maintenance of the Delta Channel will allow river breaches to occur, berms will not be repaired until fall/winter months, thereby providing overbanking conditions during the breeding season for the cuckoo (Conservation Measures 58-60). The Delta Channel supports approximately 99 ha (245 acres) of suitable or moderately suitable cuckoo habitat (Siegle et al. 2013) that have developed from historical breaches. Maintenance and habitat restoration in the Delta Channel area, and the associated benefits to cuckoo habitat, will continue as part of the

Proposed Action (Conservation Measures 29, 80-82). In an effort to determine the frequency of flows that would allow for breaches in Delta Channel, the Service used data from Bui (2016) to estimate the percentage of time under very wet or very dry conditions where overbank flows would occur. Breaches typically occur in select areas along the Delta Channel at 1,000 cfs (Reclamation 2014). As a result of the Proposed Action, flows would reach or exceed 1,000 cfs 2 percent more often during wet years (10 percent sequence, very wet). During dry years, and as a result of the Proposed Action, flows would exceed 1,000 cfs roughly 28.9 percent of the time from May and June versus 54.9 percent of the time without the proposed action (90 percent sequence, very dry). The net effect of the hydrology impacts are found in the cuckoo summary section below.

Geomorphology

Geomorphology refers to the physical properties of the river channel (i.e., width, depth, whether it is channelized or meanders). Based on the Service's review and analysis of the Proposed Action activities as summarized in the MRSI (Appendix C), the following Proposed Action activities are anticipated to affect MRG geomorphology:

- Storage and release of water
- Agricultural demand (diversion and depletion)
- Maintenance activities at river facilities, dams, and levees including the LFCC
- Delta Channel maintenance
- River maintenance projects

Geomorphic alterations to the River, associated with the actions listed above, will occur within the Action Area as a result of the hydrological changes and mechanical alterations to the channel. These geomorphic changes are anticipated to contribute towards the narrowing and incision of the river channel wherever these occur in the MRG. When this narrowing and incision process occurs, the depth to groundwater for existing vegetation increases and opportunities for the River to meander, overbank, or realign the channel decreases. Less water availability for riparian vegetation would result in stress, producing less foliage and thereby less canopy cover (Horton et al. 2001; Parametrix 2008; Caplan et al. 2012) (Table 10).

The effects listed in the Geomorphology section for flycatchers are identical for cuckoos because the aggradation of sediments and trend of river deepening and narrowing impacts cuckoo habitat in the same way it does for flycatchers (Service 2016a). Both flycatchers and cuckoos occupy habitat composed of various willows and cottonwoods (see Status of Species section for additional detail), which become stressed when depth to groundwater increases. Increased depth to groundwater for native vegetation, which occurs as a result of the geomorphology changes, take place partially due to the Proposed Action (primarily river maintenance activities). The same amount of sediment accumulation acreage [up to 105 ha (260 acres) as identified in the flycatcher Geomorphology effects section], would be attributable to the Proposed Action and negatively impact cuckoo habitat.

Geomorphology Conservation Measures

The Conservation Measures listed in the flycatcher Geomorphology effects section that will result in 73 ha (180 acres) of conservation that would also apply to cuckoo habitat because they provide conditions that will widen the River, lower terraces, create backwaters or ephemeral channels, or similar actions that would allow for more areas to receive overbank flows. All conditions that provide more area of overbank flows and connect the channel to the floodplain at a gradual slope will support riparian vegetation and provide an environment suitable for insect prey base. Habitat restoration activities associated with Reclamation's river infrastructure maintenance and restoration program is anticipated to result in the addition of approximately 59 ha (146 acres) of cuckoo habitat. The net effect of the geomorphological impacts can be found in the cuckoo summary section below.

Riparian Vegetation Dynamics

Riparian vegetation dynamics change as a result of hydrology and geomorphic conditions which change due to several activities in the Proposed Action (listed in the Riparian Vegetation Dynamics effects section for flycatcher). Cuckoos occupy habitat similar to flycatchers in vegetation composition and density (see Status of Species cuckoo section for further details). Cuckoos depend on vegetation being created and destroyed in the same type of dynamic riverine environment that was described in Environmental Baseline and Riparian Vegetation Dynamics effects section for flycatcher. The same amount of suitable or moderately suitable cuckoo habitat that would be impacted by decreased flows in the LFCC as a potential result of Conservation Measure 68 is 573 ha (1,416 acres). However, due to the uncertainty associated with how Conservation Measure 68 will be implemented, there is potential for expanding on the existing occupied habitat if the river is realigned to create a single channel located at the LFCC outfall. This area is particularly important because it supports approximately 10 cuckoo territories (11 percent of the population in the MRG).

Riparian Vegetation Dynamics Conservation Measures

Proposed BMP's for river maintenance activities will minimize a portion of the effects to the dynamic nature of riparian vegetation. One example is to conduct vegetation control activities only from September 1 to April 15 which is outside the cuckoo breeding season and when cuckoos are not present within the Action Area. Presence/absence surveys would also be completed to determine locations of breeding cuckoos. If cuckoos are present, then vegetation removal will only occur beyond 3.2 km (2 mi) of an active nest. Replanting of woody species (mainly cottonwood or willow) will occur to replace native vegetation at a ratio of 10 new plants to each 1 removed. We expect this ratio to offset early mortality and temporal loss and therefore fully replace any native vegetation loss. It is anticipated that vegetation replacement will result in the addition of approximately 65 ha (160 acres) of cuckoo habitat. This estimate is derived from the river maintenance and habitat restoration activities impacting suitable or moderately suitable flycatcher habitat over the 15-year BiOp period (Reclamation 2015, Part III-142), and replaced (but with younger aged classes of native vegetation) at the 10 to 1 ratio.

Refer to flycatcher Riparian Vegetation Dynamics effects section for additional minimization measures, as well as Conservation Measures that would require separate consultation. The net effect of riparian vegetation dynamics impacts are summarized in the cuckoo summary section below.

Other (Localized Disturbance Projects)

Based on the Service's review and analysis of the Proposed Action activities as summarized in the MRSI (Appendix C), the following Proposed Action activities are anticipated to have impacts in addition to those described above, but on a short-term and localized level:

- Infrastructure construction and maintenance activities in the River and at dams and levees, including the LFCC
- River channel maintenance projects
- Delta channel maintenance

The following are offset measures for impacts to cuckoo that may also have localized impacts:

- Maintain habitat restoration projects from the past and for 15 years post-construction for future projects (Conservation Measure 23)
- BMP's (Conservation Measures 51-52, 54-55, 58-59, 61, 64, and 80)

Effects of river maintenance activities and habitat restoration have localized effects on the cuckoo. The localized noise disturbances and activities that directly mow or otherwise remove vegetation would impact cuckoos in the same way as described in the flycatcher Other (Localized Disturbance Projects) effects section. Reclamation proposed BMP's to minimize or mitigate impacts as listed in Conservation Measures 51, 54-55, 58-59, 61, 64, and 80. Conservation Measures 51-52, 54-55, 58-59, 61, 64 offset noise disturbances by locating nests and ceasing construction in areas with breeding cuckoos located within 0.4 km (0.25 mi) during the breeding season. Should construction be required within 0.4 km (0.25 mi) of a nesting cuckoo, a separate consultation would be required and tiered off this BiOp.

Effects of the Action on Cuckoo Proposed Critical Habitat

The Action Area supports 26,289 ha (64,962 acres) of proposed cuckoo critical habitat within the MRG and Upper Rio Grande Management Units. As described in the Status of the Species section of this BiOp, the three PCEs of proposed cuckoo critical habitat are: 1) riparian woodlands; 2) adequate prey base; and 3) dynamic riverine processes

Proposed cuckoo critical habitat will be adversely affected by the Proposed Action due to reduced overbank flooding, increased depth to groundwater, increased river drying, and vegetation removal. These habitat alterations will result in a loss of breeding and foraging habitat, as well as a loss in prey base, as described in the sections above. We anticipate that the Proposed Action will result in permanent and temporary impacts to 838 ha (2,071 acres) of proposed cuckoo critical habitat as follows:

- Temporary loss of 95 ha (235 acres) due to loss of overbank flooding areas (mixed suitability)
- Permanent loss of 573 ha (1,416 acres) due to lack of LFCC water within occupied habitat from RM 62 to 54 (suitable or moderately suitable habitat)
- Temporary loss of 65 ha (160 acres) due to river maintenance projects (suitable or moderately suitable habitat)
- Permanent loss of 105 ha (260 acres) due to increased sedimentation within the floodplain (mixed suitability)

The temporary and permanent loss of 838 ha (2,071 acres) of cuckoo critical habitat is approximately 3.1 percent of the 26,289 ha (64,962 acres) of proposed critical habitat within the MRG and Upper Rio Grande Management Units, and approximately 0.3 percent of the total proposed critical habitat [221,094 ha (546,335 acres)]. Within the proposed critical habitat in the MRG and Upper Rio Grande Management Units, habitat suitable for nesting activity ("suitable" or "moderately" suitable habitat) is estimated to be 3,795 ha (9,378 acres) [calculated using flycatcher habitat as a surrogate from data within Reclamation (2015 Part III), and Siegle et al. (2013)]. Subtracting the project impacted habitat acreage [838 ha (2,071 acres)] from the suitable or moderately suitable habitat available (3,795 ha (9,378 acres)) results in approximately 2,957 ha (7,306 acres) of proposed cuckoo critical habitat with PCEs remaining within the Action Area after project impacts. Some impacted area is temporary and anticipated to regrow once construction is complete or hydrology conditions improve, the cuckoo proposed critical habitat remaining estimate is likely an underestimate. Given cuckoos use a "core" nesting patch size of roughly 5 ha (12 acres) (Halterman et al. 2016), there would be enough nesting habitat remaining to support 591 cuckoo territories (which would be enough to support the entire rangewide population of cuckoos as estimated in 2013 (350-495 territories) (territory data summarized from Service 2014b). There is no recovery plan or recovery goals for the cuckoo in the MRG. In 2015, 110 territories were estimated within the Action Area (Ahlers et al. 2016). In addition, several Conservation Measures will be implemented that will improve the quality of proposed critical habitat within the Action Area as described below. Therefore, the loss of 838 ha (2,071 acres) of proposed critical habitat as a result of the Proposed Action will not appreciably diminish the value of proposed critical habitat because the remaining habitat within the Action Area provides room for population expansion.

Cuckoo Proposed Critical Habitat Conservation Measures

Although the Proposed Action will result in adverse effects to proposed cuckoo critical habitat, several measures will be implemented to minimize the impacts of the activities in the Proposed Action (Table 1).

Implementation of adaptive management through the RIO will increase the frequency of spring peak flows which will result in overbank flooding conditions that are necessary to support cuckoo proposed critical habitat PCEs within the Action Area. The MRG Water Managers will meet annually to evaluate the hydrologic conditions and to determine if there is a need for modified operations at El Vado Dam, or other operations. Modified operations at El Vado will include: using supplemental SJC water to increase flow, continue adjusting the timing of water storage and storage and releases during runoff or when the channel becomes critically dry. Sustained post runoff releases (Conservation Measures 1 through 44) will ensure that the depth to groundwater will not deepen as quickly as it would without the sustained post runoff releases, and therefore will benefit vegetation within cuckoo proposed critical habitat areas. In addition, the maintenance of the Delta Channel will allow river breaches to occur, berms will not be repaired until fall/winter months, thereby providing overbanking conditions during the breeding season within cuckoo proposed critical habitat (Conservation Measures 58-60). These Conservation Measures address PCEs 1 through 3 by providing flows that result in increased habitat diversity.

To further minimize impacts to cuckoo proposed critical habitat, Reclamation will implement a large-scale habitat restoration project in the Isleta and San Acacia reaches of the MRG. The Service anticipates that Reclamation will take up to 1.5 years to develop a lower river restoration and enhancement plan (Lower Reach Plan). This Plan will be reviewed and approved by the Service prior to implementation. This Plan will outline project opportunities, costs, timeframes, responsible parties, and an implementation schedule. Once completed, this Plan will be active for the life of this BiOp. The goal of this Plan is to reverse the ongoing adverse effects through habitat restoration that will increase floodplain inundation, and increase the wetted river length. These Conservation Measures address PCEs 1 through 3 by enhancing habitat and providing flows that result in increased habitat diversity.

We anticipate that the Proposed Action will result in 296 ha (731 acres) of habitat improvements as follows:

- Habitat restoration projects (73 ha (180 acres)) (Conservation Measures 73 and 78)
- BDANWR realignment (59 ha (146 acres)) (Conservation Measure 70)
- Delta Channel maintenance (99 ha (245 acres)) (Conservation Measures 29, 58-60, 80-82)
- Replanting of flycatcher habitat 65 ha (160 acres) (Conservation Measure 51-52, 55, 58, and 61)

Summary of Effects on Cuckoo

Cuckoos within the Action Area require riparian woodlands, as well as an adequate prey base adjacent to dynamic riparian floodplains or moist environments. Maintaining adequate hydrology to provide adequate amounts of surface and groundwater, as well as encourage sediment movement and deposition, is essential to maintaining cuckoo habitat.

As a result of project-related alterations to hydrology, geomorphology, and riparian vegetation dynamics, as well as localized disturbances, within the Action Area, we anticipate that cuckoo and cuckoo proposed critical habitat will be adversely affected by the temporary loss of approximately 160 ha (395 acres) and the permanent loss of 678 ha (1,676 acres) of suitable cuckoo habitat. The loss of cuckoo habitat will result from the following: 1) increased depletions of water from the channel resulting in reduced flow velocities and reduced overbank flows each year; 2) geomorphological changes to the channel including channel incision and sediment plugging resulting in the increased depth to groundwater; 3) riparian vegetation dynamic changes due to changes in the availability of surface and groundwater resulting from hydrology and geomorphology alterations; and 4) localized disturbances including vegetation removal and noise.

Reclamation, BIA, and BA Partners have committed to several Conservation Measures (Table 1) to minimize the adverse effects of the Proposed Action on cuckoo and cuckoo proposed critical habitat within the Action Area. These measures include: 1) adaptive management of water operations within the MRG through the RIO to increase May and June flows to increase overbanking conditions and maintain depth to groundwater levels necessary to support cuckoo habitat; 2) maintenance of the Delta Channel to allow river breaches to occur and increase overbanking habitat, which will add an additional 99 ha (245 acres) of suitable cuckoo habitat; 3) river realignment at BDANWR to add 13 km (8 mi) of widened channel, increased meanders, and approximately 59 ha (146 acres) of suitable cuckoo habitat; 4) implementation of large-scale habitat restoration in the Isleta and San Acacia reaches to increase overbanking conditions and the amount of wetted river, which will add approximately 73 ha (180 acres) of suitable cuckoo habitat; and 5) replanting of riparian vegetation in areas where vegetation is removed for localized projects or maintenance, which will add approximately 65 ha (160 acres) of suitable cuckoo habitat. In addition, Reclamation will implement BMPs to related to localized disturbances, and monitoring activities and will avoid impacts to cuckoo as a result of noise disturbances by locating nests and ceasing construction in areas with breeding cuckoos.

In summary, habitat losses are:

- Temporary loss of 95 ha (235 acres) due to loss of overbank flooding areas (mixed suitability)
- Permanent loss of 573 ha (1,416 acres) due to lack of LFCC water within occupied habitat from RM 62 to 54 (suitable or moderately suitable habitat)
- Temporary loss of 65 ha (160 acres) due to river maintenance projects (suitable or moderately suitable habitat).
- Permanent loss of 105 ha (260 acres) due to increased sedimentation within the floodplain (mixed suitability).

And habitat improvements include 296 ha (731 acres):

- Habitat restoration projects totaling 73 ha (180 acres), (Conservation Measures 73 and 78)
- BDANWR realignment totaling 59 ha (146 acres) (Conservation Measure 70)
- Delta Channel maintenance totaling 99 ha (245 acres) (Conservation Measures 29, 58-60, 80-82)
- Replanting 65 ha (160 acres) of cuckoo habitat (Conservation Measure 51-52, 55, 58, and 61)

There is a deficit in adversely impacted versus improvements that is largely due to the permanent loss of 573 ha (1,416 acres) associated with the LFCC water within occupied habitat from RM 62 to 54.

The cuckoo does not have a recovery plan or recovery goals. An estimated 110 territories were found within the Action Area in 2015 (Ahlers et al. 2016). The Proposed Action will result in impacts (temporary and permanent) to 838 ha (2,071 acres) of cuckoo habitat, which could impact up to six territories annually. Approximately 2,957 ha (7,306 acres) of proposed cuckoo critical habitat with PCEs (i.e., suitable or moderately suitable habitat for nesting activity using flycatcher habitat as a surrogate) will remain after project impacts. This habitat could support an estimated 591 cuckoo territories. The Service anticipates that the above measures will minimize the impacts to the species through the addition of 296 ha (731 acres) of cuckoo habitat. This could support 59 cuckoo territories.

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 considered in this BiOp (50 FR 402.02). 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.

In this consultation, Reclamation elected to include non-Federal actions on behalf of MRGCD and the State of New Mexico. As such, effects of those non-Federal actions that carry on into the future are already assessed as part of the Proposed Action and are not considered in cumulative effects. If there will be future non-Federal water management-related actions that are not currently contemplated that may affect Federally-listed species, it is expected that those actions will be proposed by a Federal agency on behalf of the non-Federal entity and may tier from the current consultation or would require separate consultation pursuant to section 7 of the ESA.

The future exercise of Federal Indian water rights by the 18 federally-recognized Indian Pueblos within the Action Area is reasonably certain to occur and therefore is considered in cumulative effects. Nothing in this BiOp precludes any new depletion that results from the exercise of senior Native American water rights within the Action Area and Reclamation, BIA, and BA Partners assume the risk that the future development of these water rights may result in increased depletions and/or shortages of water to junior users.

Climate Change

We evaluated the impacts of climate change by recognizing whether, and to what degree, climate change may affect the species and their habitats for the duration of the Proposed Action. Service policy (Service 2010b) on how to view an action’s contribution to climate change is through evaluation of greenhouse gas emissions associated with a Proposed Action, when added to the environmental baseline, along with cumulative state and private impacts that will likely contribute at least some gasses that augment tropospheric warming, and at some later time, contribute to habitat changes that may adversely affect listed species in the Action Area.

The Intergovernmental Panel on Climate Change (IPCC) used 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; Solomon et al. 2007). The IPCC concluded: 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 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 in extreme weather events will occur in the areas affected by droughts (Christensen et al. 2007; Prinn et al. 2011). Global climate models were downscaled to provide higher-resolution projections that are more relevant to the Action Area (see Glick et al. 2011).

Since 2011, Reclamation has funded and conducted climate studies in the Rio Grande Basin (Reclamation 2013b, 2016c). Several climate projections containing temperature and precipitation data were developed and downscaled into a set of hydrologic projections that capture the variability of the Rio Grande Basin (Llewellyn and Hastings 2015; Reclamation 2013b, 2016c). For evaluation of climate change impacts to the silvery minnow, flycatcher, and cuckoo, we used the following downscaled projections and various summaries (Garfin et al. 2013; Maurer et al. 2014; Llewellyn and Hastings 2015; Dettinger et al. 2015; Mearns et al. 2015; Reclamation 2013b, 2016c).

A review of climatic models indicates that an increase in drying of the southwestern U.S. and northwestern Mexico will likely occur throughout this century (Seager and Vecchi 2010). Long-term climatic patterns in the southwestern U.S. regularly cause periodic droughts, but the effects of greenhouse gases will compound these events and increase their intensity (Seager and Vecchi 2010). As much as 60 percent of this drying trend in the southwestern U.S. can be attributed to anthropogenic effects (Barnett et al. 2008). One outcome is that more mountain precipitation in the winter now occurs as rain instead of snow (Barnett et al. 2008). This is causing earlier spring runoffs and shorter runoff periods from reduced snowpack (Reclamation 2013b).

Average global surface air temperature is increasing and will continue for many decades (e.g., Meehl, et al. 2007; Ruhl 2008; Church et al. 2010; Gillett et al. 2011). The overall projected air temperature trend in the Rio Grande Basin is one of increased warming compared to current conditions (Meehl et al. 2007; Glick et al. 2011; Prinn et al. 2011; Garfin et al. 2013; Pinson 2013; Reclamation 2013b, 2016c).

The Service examined the potential consequences to the listed species and their habitats that arise from changes in environmental conditions associated with various aspects of climate change. For example, climate-related changes to habitat quantity or qualities, predator-prey relationships, disease and disease vectors, or conditions that exceed the physiological tolerances of a species, occurring individually or in combination, may affect the status of a species or the environmental baseline.

NMOSE (2006), listed the following impacts of climate change in New Mexico:

- Warming trends in the southwest are expected to continue to be greater than global averages by about 50 percent;
- Modeling suggests that even moderate increases in precipitation would not offset the negative impacts to the water supply caused by increased temperature;
- Increased temperatures will increase growing seasons, resulting in increased plant and human use of decreasing water supplies;
- There will likely be alterations in the arrival of snow, acceleration of spring snow melt, increased variation in the proportion of rain, all contributing to rapid and earlier seasonal runoff events; and
- The intensity, frequency, and duration of drought may increase.

In summary, climate change predicts major effects on the silvery minnow. They include: 1) increased water temperature over the long term; 2) a change in peak runoff timing, 3) an overall decrease in the magnitude and duration of runoff; and, 4) an increased occurrence of extreme events (e.g., fire, drought, and floods).

Water Temperature

Water temperature of a river is the product of heat energy exchange between the river and its environment (e.g., atmosphere and ground). There is a strong correlation between air temperatures and water temperatures measured in the MRG (USACE et al. 2007). Air temperature are expected to increase approximately 1.0 °C (3.2°F) by 2050 and 3.5 °C (6.3 °F) by 2100 (Pinson 2013).

Overall, water temperature increases from north to south in the MRG. The highest water temperatures occurred during summer months in the lower (southern) reaches and the lowest water temperatures were recorded in upper reaches during winter months. Using an air-to-water correlation, a potential increase in air temperatures of 5 °C (9 °F) by 2030 could result in an increase in water temperatures as high as 3.5 °C (6.3 °F) (Bui 2011).

Small changes in water temperature are known to have effects on freshwater fishes (Morgan et al. 2001; Carveth et al. 2006). Warm-water fish species in the southwestern U.S. might not be able to tolerate water temperature increases above certain levels that could be lethal or favor nonnative species (Archer and Predick 2008). The shallow waters of the inundated floodplain have a higher water temperature than the river channel. These warmer water temperatures may lead to conditions unfavorable to the silvery minnow.

Droughts

Droughts cause low snowpack and reduced monsoonal rains resulting in low river flow. Droughts are cyclical returning on average to the MRG every 15 years (Pinson 2013). Wallace (2014) described significant correlations between drought cycles and the Otowi Gage flow. Based on the last 20 years drier conditions could prevail through 2024 (Wallace 2014).

Based on past frequency, extreme droughts (Palmer Drought Severity Index less than 4) should not exceed 1.8 years in duration on the MRG (Pinson 2013). Low flow conditions as would be expected would leave the MRG in an intermittent condition with more than 77 km (48 mi) that would not support silvery minnow and could also impact flycatcher and cuckoo breeding success. Low flow conditions do not allow aquifer recharge leading to lower groundwater levels that affects flycatcher and cuckoo habitat.

Precipitation and Snowmelt Runoff

The MRG basin receives less than 25 cm (10 in) of precipitation per year (Reclamation 2016c). Most of the flow in the MRG results from snowmelt runoff above the Action Area and summer monsoonal rains (Reclamation 2011, 2016c; Pinson 2013). Climate change models project that precipitation in the MRG Basin will remain unchanged or will decline slightly (Pinson 2013).

Increased winter temperatures can cause more precipitation to fall as rain instead of snow resulting in earlier spring peak flow (Regonda et al. 2005). The timing of spring streamflow in the MRG has advanced arriving 7 to 30 days earlier, resulting in less flow in the summer (Stewart et al. 2004; Bui 2011; Krabbenhoft 2012). By 2080, peak runoff is expected to advance 15 to 25 days (Stewart et al. 2004). Earlier peak runoff can have significant impacts on the silvery minnow.

The silvery minnow takes advantage of the predictable high spring flows for spawning. Krabbenhoft (2012) suggested that there should be strong selective pressures aimed at matching the timing of presence of silvery minnow larvae with necessary food resources. Changes in peak flow timing will likely adversely affect the reproductive success of the silvery minnow (Platania and Hoagstrom 1996; Magana 2009; Krabbenhoft et al. 2014).

Using the relationship between water temperature in May and silvery minnow hatching rate, a 5-day advance in peak runoff would potentially reduce hatching by 2.1 percent. A 15-day advance of peak runoff would result in 6.4 percent reduction in egg hatch. Silvery minnow may not be able to adapt to this great a change in peak runoff timing (Krabbenhoft 2012).

Flow Volume

Flow volume is expected to decline under climate change scenarios. We estimated the flow volume at the Albuquerque Gage under a range of scenarios. Based on these analyses, we anticipate that the reduction in spring (May and June) runoff volume at the Albuquerque Gage would be approximately 6,580 acre-ft in 15 years. The frequency of reduced (below current average) spring runoff volumes during May and June will increase from two to four occurrences during the next 15 years due solely to the anticipated effects of climate change. The spring runoff volume at the Albuquerque Gage will be reduced by as much as 43,000 acre-ft by 2050.

Similarly, we anticipate that the reduction in low flow (July through October) volumes at the Albuquerque Gage will be approximately 7,026 acre-ft in 15 years. These changes in flow volume will have negative impacts to silvery minnow, cuckoo, and flycatcher.

Other Impacts

Other secondary impacts could occur as a result of climate change including increases in wildfire frequency, and landscape-level changes to vegetation (Pinson 2013). More arid conditions could favor an increase in nonnative riparian vegetation (Stromberg et al. 2009). This would have negative impacts to silvery minnow, cuckoo, and flycatcher through channel stabilization, and replacement of preferred habitat.

Overall, climate change is expected to result in continued degradation of silvery minnow, flycatcher, and cuckoo habitat, resulting in reductions of density and distribution.

Population Growth and Urban Development

With a projected growth rate of 15 percent per decade, the human population will have difficulty in meeting the demand for water from the MRG. By 2040 the MRG is expected to have a 50 percent increase in population with the greatest increase in the greater Albuquerque area (Mid-Region Council of Governments 2004). Further south Socorro and Sierra Counties are projected to increase in population to over 60,000 by 2040.

Total water use in the major population centers (Santa Fe, Bernalillo, and Valencia Counties) has exceeded renewable supplies by 55,000 acre-ft per year (Mid-Region Council of Governments 2004), and is projected to reach a 150,000 acre-ft per year deficit by 2050 (Reclamation 2015: I-236).

With the proposed enhancement of the current levees to engineered levees (Service 2013b, 2016b) we expect further encroachment upon the historical floodplain outside the levees as the flood risk is reduced. Conversion of agricultural land to residential housing developments will further impact remaining riparian habitat that is used by cuckoo and flycatcher. For development that is not connected to municipal water systems we can expect further groundwater depletion from residential wells that will impact river flows and riparian habitat.

Urban areas require transportation systems that include bridges and roads that can be detrimental to water quality and riparian habitat (Marshall and Stoleson 2000). Some communities may desire to remove riparian vegetation to reduce fire risk. Urbanization can favor domestic cat predation as well as other predators or competitors of flycatchers and cuckoos (e.g., cowbirds, blackbirds).

Urban Water Discharges

Urban development can concentrate pollutants in aquatic and riparian habitats through stormwater runoff and wastewater discharges. Pollutants come from commercial and industrial sites, dairies, and agricultural fields. Existing aquatic habitats and riparian vegetation that support cuckoo, flycatcher, and silvery minnow habitat can also be sustained by urban stormwater and wastewater (Service 2014d).

Stormwater discharges contribute to low DO conditions in the MRG that can harm silvery minnow (Service 2014d). Increased urban stormwater runoff can increase nitrates and phosphates in the River (Moore and Anderholm 2002). In addition, organic chemicals, heavy metals, and pesticides have been documented in stormwater flowing into the River (Storms et al. 2015). Urban population growth will increase pollutants in stormwater runoff.

Urban growth causes increased wastewater discharge (USACE 2013b). WWTP discharge can be a major source of recharging water for the River, but also affects water quality (USACE 2013b). While increased pollution from urban sources is considered a major threat to the silvery minnow (Service 2010a), it is not considered to be as critical an issue as is the reduction and duration of flows in the River.

Recreation

As developed areas and human populations grow, recreational activities will increase. Use of the Bosque (riparian area) is encouraged by the City of Albuquerque and other municipalities and counties in the Action Area. Recreational activities require additional infrastructure such as pedestrian and vehicle access, commercial and educational structures that reduce riparian vegetation and fragment the habitat.

Aquatic recreational activities that may transfer organisms may result in the introduction of nonnative invasive species. The Asian clam (*Corbicula fluminea*), an invasive bivalve, currently occurs below Elephant Butte Reservoir (Foster et al. 2012). It occurs in both still and running water habitat, and if it invaded the MRG it could have negative impacts to the silvery minnow through changes in water quality and food availability (Sousa et al. 2008). Invasion by other nonnative species can be expected over time that will have negative impacts to the silvery minnow.

Fire

Human-caused wildfire and wildfire suppression in riparian areas may have an adverse effect on flycatchers and cuckoos. The Bosque is not a fire dependent system. As such wildfires can have a devastating effect on riparian habitat. The early vegetation succession state caused by wildfires is not suitable for cuckoo and flycatchers. Wildfire frequency will increase as current vegetation succeeds to an overgrown state that is more fire prone and more people use the Bosque reducing suitable habitat for cuckoo and flycatcher.

In addition, large upper watershed fires can contribute runoff that may have adverse effects on silvery minnow through water quality degradation. These types of fires are also projected to increase over time due to climate change (Westerling et al. 2006).

The Service anticipates a continued and expanded degradation of silvery minnow, flycatcher, and cuckoo habitat as a result of cumulative effects.

CONCLUSION

In accordance with policy and regulation, the jeopardy analysis in this BiOp relies on four components: 1) the Status of the Species, which evaluates the silvery minnow, flycatcher, and cuckoo rangewide condition, the factors responsible for that condition, and their survival and recovery needs; 2) the Environmental Baseline, which evaluates the condition of the silvery minnow, flycatcher, and cuckoo in the Action Area, the factors responsible for that condition, and the relationship of the to the survival and recovery of the silvery minnow, flycatcher, and cuckoo; 3) the Effects of the Action, which determines the direct and indirect impacts of the proposed Federal action and the effects of any interrelated or interdependent activities on the silvery minnow, flycatcher, and cuckoo; and 4) Cumulative Effects, which evaluates the effects of future, non-Federal activities in the Action Area on the silvery minnow, flycatcher, and cuckoo.

The jeopardy determination is made by evaluating the effects of the proposed Federal action in the context of the silvery minnow, flycatcher, and cuckoo current status, taking into account any cumulative effects, to determine if implementation of the Proposed Action is likely to cause an appreciable reduction in the likelihood of both the survival and recovery of the silvery minnow, flycatcher, and cuckoo in the wild.

The jeopardy analysis in this BiOp considers the rangewide survival and recovery needs of the silvery minnow, flycatcher, and cuckoo, and the role of the Action Area in the survival and recovery of the silvery minnow, flycatcher, and cuckoo as the context for evaluating the significance of the effects of the proposed Federal action, taken together with cumulative effects, for purposes of making the jeopardy determination.

The Service and the National Marine Fisheries Service published a final rule in 2016 (81 FR 7214), revising the definition for destruction or adverse modification of critical habitat in the Act’s implementing regulations at 50 CFR 402.02. The final regulatory definition is: “Destruction or adverse modification means a direct or indirect alteration that appreciably diminishes the value of critical habitat for the conservation of a listed species. Such alterations may include, but are not limited to, those that alter the physical or biological features essential to the conservation of a species or that preclude or significantly delay development of such features.” This BiOp analyzed the effects of the action and its relationship to the function and conservation role of silvery minnow and flycatcher designated critical habitat, and cuckoo proposed critical habitat, to determine whether the current proposal destroys or adversely modifies critical habitat for these species.

Rio Grande Silvery Minnow

In 2003, we made a jeopardy opinion for the silvery minnow. Since that time, improvements in river operations, conservation measures, and decreased agricultural diversions have been implemented. However, basic conditions in the Action Area have not changed. For example, the Action Area is still subject to drought and variable water supply, and geomorphic degradation. The status of the minnow continues to not meet the recovery goals. Population monitoring during 2013 through 2015 estimated fall densities of 0.03, 0.00, and 0.16 fish per 100

m^2 respectively. These low population levels are a result of poor spring flows, hydrograph modification, and adverse trends in river geomorphology, habitat fragmentation, diversions and consumption of water. In addition, annual river drying has resulted in reduced minnow survival and loss of genetic diversity.

Recovery goals in the Action Area include a density of at least 5 fish per 100 m^2 for 5 consecutive years. The Recovery Plan actions include restoring, protecting, and altering habitats to reduce or ameliorate threats, ensure survival, and the use of adaptive management. The Proposed Action will prevent extinction, stabilize or improve the population abundance, and increase survival of silvery minnow through implementation of the Silvery Minnow SRS, such that recovery is not precluded as described in the Effects on Silvery Minnow Recovery section above.

The Service has analyzed and described adverse effects to the silvery minnow from the Proposed Action, which are in addition to effects attributable to the environmental baseline. The effects of the Proposed Action include changes in river hydrology and geomorphology, water quality, riparian vegetation dynamics, and other localized disturbances (Appendix C). An action agency may not take an action that further imperils a critically endangered species or exacerbates an already degraded environmental baseline such that extinction is likely. The impacts of the Proposed Action along with the Conservation Measures were analyzed to determine the effects of the Proposed Action on reproduction, abundance, and distribution of silvery minnows in the Action Area.

Although ecological conditions and ongoing actions are similar to 2003, Reclamation, BIA, and the BA Partners have proposed significant new conservation actions that will improve river hydrology and geomorphology, water quality, riparian vegetation dynamics, and minimize other localized disturbances. Therefore, we find that implementation of the Proposed Action with the Conservation Measures will not appreciably reduce the likelihood of both survival and recovery of the silvery minnow because:

- Conducting modified spring flow operations at El Vado Dam will augment silvery minnow reproduction and abundance.
- Implementing fish passage at San Acacia, Isleta, and Angostura Diversion Dams will increase silvery minnow distribution.
- Implementing the Lower Reach Plan will increase silvery minnow spawning, survival, and distribution.
- Implementing the Lower Reach Plan will improve the PCEs of silvery minnow critical habitat.
- Implementing river maintenance as proposed will improve the PCEs of silvery minnow critical habitat.
- Continuing Reclamation’s use of supplemental water will increase silvery minnow survival and distribution.
- Pumping water from the Low Flow Conveyance Channel at strategic locations will increase silvery minnow survival and distribution.
- Continuing to use irrigation infrastructure (drains, wasteways, and outfalls) to deliver water to the river will support silvery minnow survival.

- Implementing fish rescue will increase silvery minnow survival and distribution.
- Implementing genetic management and captive propagation will improve silvery minnow abundance and survival.
- Continuing to adjust the timing of water storage in upstream reservoirs prior to spring runoff will minimize its effect on silvery minnow spawning and abundance.
- Implementing water management through the RIO will improve the abundance and survival of silvery minnow.
- Coordinating development of conservation storage in upstream reservoirs will provide water management options to increase silvery minnow abundance and survival.

We conclude that the Proposed Action with the conservation measures will reduce harm and increase silvery minnow survival and therefore, enhances the probability of attaining a self-sustaining silvery minnow population in the MRG. Therefore the Proposed Action is not likely to jeopardize the continued existence of the silvery minnow or result in the destruction or adverse modification of designated critical habitat.

Southwestern Willow Flycatcher

The flycatcher population in the MRG consists of 400 flycatcher territories and greatly exceeds the recovery goal of 175 total for the MRG and Upper Rio Grande Management Units. The population within the Action Area is largely a result of the low surface water elevations in Elephant Butte Reservoir which provide vast expanses of newly created habitat as well as the LFCC Outfall providing water to occupied habitat. To attain recovery of the species, at least 1,950 territories maintained over a 5-year period must be met rangewide, and each Management Unit must meet and hold at least 80 percent of its minimum population target (Service 2002). Rangewide, the population is estimated to be 1,299 territories as of 2007 (Service 2014a).

The Service has analyzed and described adverse effects to the flycatcher from the Proposed Action that are in addition to those effects that are attributable to the environmental baseline due to changes in river hydrology and geomorphology, riparian vegetation dynamics, and other localized disturbances (Appendix C). An action agency may not take an action that further imperils a critically endangered species or exacerbates an already degraded environmental baseline such that extinction is likely. The impacts and conservation measures were analyzed to determine the effects of the Proposed Action on reproduction, abundance, and distribution of flycatchers in the Action Area.

We find that implementation of the Proposed Action with conservation measures will not appreciably reduce the likelihood of both survival and recovery of the flycatcher, and will not destroy or adversely modify designated critical habitat because:

- Implementing water management through the RIO will improve the PCEs of flycatcher designated critical habitat.
- Continuing to use irrigation infrastructure (i.e., wasteways and outfalls) to deliver water to the River will improve the PCEs of flycatcher designated critical habitat.
- Continuing the use of supplemental water will improve the PCEs of flycatcher designated critical habitat.
- Implementing the Lower Reach Plan will improve the PCEs of flycatcher designated critical habitat.
- Implementing river maintenance as proposed will improve the PCEs of flycatcher designated critical habitat.
- Implementing river maintenance as proposed will increase flycatcher abundance and survival.

We found that the Proposed Action will result in a short term decrease in available flycatcher habitat while providing long-term benefits through substantial habitat restoration. Planned habitat restoration activities will address both the dynamic nature of flycatcher habitat as well as reverse the negative effects of ongoing adverse geomorphic trends. The Service concludes that the Proposed Action, with the conservation measures, will reduce harm and increase survival, and enhances the probability of supporting the large population (a population that currently exceeds recovery goals) of flycatchers in the MRG. Therefore, the Proposed Action is not likely to jeopardize the continued existence of the flycatcher or result in the destruction or adverse modification of designated critical habitat.

Yellow-billed Cuckoo

The cuckoo population in the MRG consists of 110 cuckoo territories and is one of the largest populations rangewide. The population within the Action Area is largely a result of the low surface water elevations in Elephant Butte Reservoir which provide vast expanses of newly created habitat as well as the LFCC Outfall providing water to occupied habitat. Rangewide the population is estimated to be 680 to 1025 territories (Service 2013a), and the largest populations are located in Northwestern Mexico, Arizona, and New Mexico.

The Service has analyzed and described adverse effects to the cuckoo from the Proposed Action that are in addition to those effects that are attributable to the environmental baseline due to changes in river hydrology and geomorphology, riparian vegetation dynamics, and other localized disturbances (Appendix C). An action agency may not take an action that further imperils a critically endangered species or exacerbates an already degraded environmental baseline such that extinction is likely. The impacts and conservation measures were analyzed to determine the effects of the Proposed Action on reproduction, abundance, and distribution of cuckoos in the Action Area.

We find that implementation of the Proposed Action with conservation measures will not appreciably reduce the likelihood of both survival and recovery of the cuckoo, and will not destroy or adversely modify proposed critical habitat because:

- Implementing water management through the RIO will improve the primary constituent elements of cuckoo critical habitat.
- Continuing to use irrigation infrastructure (i.e., wasteways and outfalls) to deliver water to the River will improve the PCEs of cuckoo proposed critical habitat.
- Continuing the use of supplemental water will improve the PCEs of cuckoo proposed critical habitat.
- Implementing the Lower Reach Plan will improve the PCEs of cuckoo proposed critical habitat.
- Implementing river maintenance as proposed will improve the PCEs of cuckoo proposed critical habitat.
- Implementing river maintenance as proposed will increase cuckoo abundance and survival.

We found that the Proposed Action will result in a short term decrease in available cuckoo habitat while providing long-term benefits through substantial habitat restoration. Planned habitat restoration activities will address both the dynamic nature of cuckoo habitat as well as reverse the negative effects of ongoing adverse geomorphic trends. The Service concludes that the Proposed Action with the conservation measures will reduce harm and increase survival, and enhances the probability of supporting the large population of cuckoos in the MRG. Therefore, the Proposed Action is not likely to jeopardize the continued existence of the cuckoo or result in the destruction or adverse modification of proposed critical habitat.

INCIDENTAL TAKE STATEMENT

Section 9 of the ESA and Federal regulations 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 (50 CFR 17.3) 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 (50 CFR 17.3) 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 Reclamation, BIA, and other participants in that they become binding conditions of any grant or permit issued to the MRGCD and the State, as appropriate, for the exemption in section 7(o)(2) to apply. Reclamation and BIA have a continuing duty to regulate the activity covered by this incidental take statement. If Reclamation, BIA, or any of their partners 1) fails to assume and implement the terms and conditions, or 2) fails to require the (applicant) to adhere 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, Reclamation and BIA 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

Rio Grande Silvery Minnow

The Service finds it will be impractical to express a numerical measure of take for silvery minnows for the following reasons: the species is relatively small and lives in flowing water; therefore, finding a dead or impaired specimen is unlikely; the number of silvery minnows present in the Action Area at any time is based upon the success of the spring spawn and therefore highly variable; and losses may be masked by seasonal fluctuations in numbers or other causes (e.g., oxygen depletions).

We chose silvery minnow densities as a surrogate for the number of fish that die due to the Proposed Action because October densities incorporate and reflect mortalities that occurred throughout the year. As discussed in the effects section of the BiOp, the Proposed Action will alter spring and summer flows. Silvery minnow densities (fish per 100 m^2) in October are related to spring and summer flows. Therefore, rather than quantifying the number of individuals that are taken by the Proposed Action, we will use the October densities of the

Silvery Minnow PMP as a surrogate for the take of all age classes of silvery minnows. Then using these results we can estimate the density of silvery minnow in the spring and fall each year in the Action Area. The difference in these densities most accurately reflects the number of fish lost annually.

Incidental take of silvery minnows is authorized for the Proposed Action if:

- October density is greater than or equal to 1.0 fish per 100 m^2 for 10 of 15 years; and
- October density is less than 1.0 per 100 m^2 for no more than 5 of 15 years; and
- October density is less than 0.3 fish per 100 m^2 for no more than 2 of the 15 years.

Incidental take will be considered exceeded if these densities are not met as a result of the Proposed Action.

Southwestern Willow Flycatcher

The Service finds it will be impractical to express a numerical measure of take for flycatchers for the following reasons: the species may fail to nest, it may be detrimental to monitor egg or nestling mortality, nest sites may be abandoned, individuals may be difficult to detect, and the species is mobile. It is difficult to detect this species in dense riparian habitat; therefore, finding a dead or impaired specimen is unlikely, or losses may be masked by other causes.

The Service chose acres of suitable habitat (using Siegle et al. 2013) and average patch size as a surrogate for incidental take. Due to habitat loss resulting from the Proposed Action, flycatchers may abandon nesting sites, experience nesting failures, or shift their territories. Based on an average flycatcher patch size of 2.2 ha (5.4 acres) we anticipate that adverse impacts to 838 ha (2,071 acres) may result in the displacement of 26 flycatcher territories annually and up to 384 territories over the 15-year BiOp duration. Incidental take of flycatcher will be considered exceeded if more than 26 flycatcher territories are displaced in any year as a result of the Proposed Action, or if more than 838 ha (2,071 acres) of suitable flycatcher habitat are impacted as a result of the Proposed Action over the 15-year BiOp duration.

The Service anticipates the loss of approximately 838 ha (2,071 acres) of suitable flycatcher habitat will be adversely impacted over the 15-year duration of the BiOp. This habitat loss is calculated as follows:

- Temporary loss of 95 ha (235 acres) due to loss of overbank flooding areas (mixed suitability)
- Permanent loss of 573 ha (1,416 acres) due to lack of LFCC water within occupied habitat from RM 62 to 54 (suitable or moderately suitable habitat)
- Temporary loss of 65 ha (160 acres) due to river maintenance projects (suitable or moderately suitable habitat)
- Permanent loss of 105 ha (260 acres) due to increased sedimentation within the floodplain (mixed suitability)

Yellow-billed Cuckoo

The Service finds it will be impractical to express a numerical measure of take for cuckoos for the following reasons: the species may fail to nest, it may be detrimental to monitor egg or nestling mortality, nest sites may be abandoned, individuals may be difficult to detect, and the species is mobile. It is difficult to detect this species in dense riparian habitat; therefore, finding a dead or impaired specimen is unlikely, or losses may be masked by other causes.

The Service chose acres of suitable habitat (using Siegle et al. 2013) and average patch size as a surrogate for incidental take. Due to habitat loss resulting from the Proposed Action, cuckoos may abandon nesting sites, experience nesting failures, or shift their territories. Based on a "core" nesting patch size of roughly 5 ha (12 acres) (Halterman et al 2016), we anticipate that adverse impacts to 838 ha (2,071 acres) may result in the displacement of 11 cuckoo territories annually and up to 172 territories over the 15-year BiOp duration. Incidental take of cuckoos will be considered exceeded if more than 11 cuckoo territories are displaced in any year as a result of the Proposed Action or if more than 838 ha (2,071 acres) of suitable cuckoo habitat are impacted as a result of the Proposed Action over the 15-year BiOp duration.

The Service anticipates the loss of approximately 838 ha (2,071 acres) of suitable cuckoo habitat will be adversely impacted over the 15-year BiOp duration. This habitat loss is calculated as follows:

- Temporary loss of 95 ha (235 acres) due to loss of overbank flooding areas (mixed suitability)
- Permanent loss of 573 ha (1,416 acres) due to lack of LFCC water within occupied habitat from RM 62 to 54 (suitable or moderately suitable habitat)
- Temporary loss of 65 ha (160 acres) due to river maintenance projects (suitable or moderately suitable habitat)
- Permanent loss of 105 ha (260 acres) due to increased sedimentation within the floodplain (mixed suitability).

EFFECT OF THE TAKE

In this BiOp, the Service determined that these levels of anticipated take are not likely to result in jeopardy to the species or destruction or adverse modification of critical habitats.

REASONABLE AND PRUDENT MEASURES

The Service finds the following RPMs are necessary and appropriate to minimize impacts of incidental takes of silvery minnows, flycatchers, and cuckoos from the Proposed Action:

1. Reclamation will use the RIO to optimize the management of spring runoff in May and June to increase silvery minnow spawning and survival as monitored in the fall;

2. Reclamation will develop a model on and use information about the elevations of ground, surface water, and groundwater levels, to increase overbanking;

3. Reclamation will minimize take of silvery minnow due to river intermittency and drying by using the RIO to assist with implementing fish passage at the Angostura Diversion Dam within 10 years, Isleta Diversion Dam within 6 years, and San Acacia Diversion Dam within 5 years.

4. Reclamation will work with the Service to minimize take of silvery minnows by using the fish rescue service and by actively managing recession;

5. Reclamation will standardize, fund, and implement an active captive propagation and population augmentation program;

6. Reclamation will maintain, and foster regular interactions with, staffs of BIA, the six MRG Pueblos, State of New Mexico (NMISC and NMOSE), MRGCD, and the Service (NMESFO) as part of adaptive management and habitat restoration project planning, and water management through the RIO;

7. Reclamation will monitor, and report on the populations of the silvery minnow, flycatcher, cuckoo and their habitats in the Action Area;

8. Reclamation will standardize and implement all BMPs that minimize effects to listed species;

9. Reclamation will minimize take of silvery minnow, flycatchers, and cuckoos due to proposed water operations, maintenance, and habitat restoration activities;

10. Reclamation will integrate and share all data collected for the Proposed Action through the RIO; and

11. Reclamation will annually report to the Service on implementation of the Proposed Action, the annual ITS summary, the RPMs, and their implementing terms and conditions.

The Service recognizes that any RPM that involves access to or use of Indian Pueblo or Tribal lands or other trust resources requires the consent of the affected Indian Pueblo or Tribe and that the Federal agencies are obligated by the Federal trust responsibility to consult with the affected

Pueblo or Tribe in coordination with BIA. The Service further recognizes that nothing in the RPMs shall adversely affect or otherwise modify the obligations to store, release, and deliver water to the six MRG Pueblos to meet their statutorily recognized rights.

TERMS AND CONDITIONS

In order to be exempt from the prohibitions of section 9 of the ESA, the agencies must comply with the following terms and conditions. These terms and conditions implement the RPMs described above and outline required reporting and monitoring requirements. These terms and conditions are non-discretionary.

The Service recognizes that any Term and Condition that involves access to or use of Indian Pueblo or Tribal lands or other trust resources requires the consent of the affected Indian Pueblo or Tribe and that the Federal agencies are obligated by the Federal trust responsibility to consult with the affected Pueblo or Tribe in coordination with BIA. The Service recognizes that nothing in the Terms and Conditions shall adversely affect or otherwise modify the obligations to store, release, and deliver water to the six MRG Pueblos to meet their statutorily recognized rights.

<u>To implement RPM 1:</u>

1.1 In advance of spring runoff Reclamation shall collaborate with the Service and, if necessary, devise a managed spring runoff to maximize the benefits of the magnitude, timing, and duration for silvery minnow spawning and recruitment.

1.2 Reclamation will use the RIO to maximize spawning and survival of silvery minnow by management of spring runoff during May and June.

1.3 Reclamation, BIA, and the BA Partners shall involve, coordinate and consult directly with the Service on their discretionary actions covered by this BiOp to attempt to manage spring runoff in the MRG for the benefit of the listed species.

1.4 If appropriate and necessary during non-debit Compact years, Reclamation, the State of New Mexico, and MRGCD shall work with the Service to request that the USACE consider temporary deviation operations at Cochiti Dam.

1.5 Reclamation shall coordinate with MRGCD to minimize diversions or depletions during spring runoff.

1.6 Whenever discretionary water management options exist, Reclamation, BIA, and the BA partners shall use these options as appropriate to improve the magnitude, duration, or timing of spring runoff. This is expected to result in increased floodplain inundation, spawning and recruitment of silvery minnows.

   a. Such discretionary water management options shall be used to attain a self-sustaining population (1.0 fish per 100 m^2), or when opportunities exist, of meeting recovery goals (5.0 fish per 100 m^2).
   b. Reclamation and BIA shall coordinate with MRGCD on diversions in order to enhance spawning and recruitment and minimize entrainment of eggs and larvae during May and June.

To implement RPM 2:

2.1 When actions are proposed that involve habitat restoration and modeling of the listed MRG species habitats, Reclamation shall coordinate with the Service and use the appropriate modeling and site information to identify, describe, report, and utilize information about the lateral, longitudinal, vertical, and temporal relationships of surface water levels or groundwater levels to the ground surface elevations for the five 10-year hydrologic scenarios and within 6 to 13 km (4 to 8 mi) of any proposed restoration actions within the MRG.

2.2 Reclamation shall use current elevation plans to maximize the benefits of habitat restoration activities such that the design or range of design flows create optimal conditions described by the five 10-year hydrologic scenarios, which shall create optimal conditions of inundation depth, velocity, and proximity to surface water or groundwater for the listed species.

2.3 Reclamation shall include elevation plans in all consultations including actions involving sediment management planning, spring runoff channel inundation and floodplain overbanking planning, low flow channel inundation or refugia planning. Estimates of native riparian vegetation survival in relation to the proximity of groundwater, or elevation accurate modeling of river connectivity projects for the listed MRG species shall be monitored.

2.4 Where appropriate for water, sediment, and habitat management, Reclamation shall develop elevation plans cooperatively with agencies involved in projects.

To implement RPM 3:

3.1 Reclamation shall from the issuance of this BiOp construct fish passage through the San Acacia Diversion Dam by the 5th year of the Proposed Action, the Isleta Diversion Dam by the 6th year of the Proposed Action, and Angostura Diversion Dam by the 10th year of the Proposed Action.

3.2 Reclamation shall manage low flow conditions during July through October to minimize the take described in the ITS.

3.3 Reclamation shall ensure that river bed incision will be minimized to the extent possible when implementing fish passage at San Acacia Diversion Dam.

3.4 Reclamation shall establish monitoring of silvery minnows in the Cochiti Reach, pending approval from Pueblos, after the Angostura fish passage construction is completed. Monitoring results shall be incorporated into the Silvery Minnow PMP.

To implement RPM 4:

4.1 Reclamation shall work with the Service's NMFWCO to standardize, fund, and implement fish rescue.

4.2 Reclamation and BIA shall work with the six MRG Pueblos to standardize and fund their voluntary implementation of fish rescue on tribal lands.

4.3 Reclamation shall work with the Service to develop standard protocols, procedures, goals, and responsibilities for fish rescue. All fish rescue shall be coordinated with the Service and may be implemented by the staffs of Reclamation, BIA, the six MRG Pueblos, MRGCD, and the State of New Mexico under a memorandum of agreement, and appropriate permitting only.

4.4 If adaptive management or other research finds that there is an optimal rate of recession appropriate for minimizing the effects on silvery minnows, including prioritization of fish rescue opportunities, then the rates of recession may vary and may be deployed in coordination with fish rescue services, as modified by adaptive management.

To implement RPM 5:

5.1 Reclamation shall work with the Service to fund, improve, and implement the Captive Propagation and Population Augmentation Program including regularly reviewing and updating genetics management activities.

5.2 Reclamation shall continue to fund and implement regular and routine monitoring of appropriate metrics of the genetic diversity and integrity of captive broodstock and silvery minnows in the wild.

5.3 Reclamation shall support the development and implementation of additional tools and techniques to improve and optimize the genetic diversity in fish broodstock and verify that the captive propagation and population augmentation program efforts will not deleteriously affect genetic integrity of the silvery minnow population of MRG in the wild.

To implement RPM 6:

6.1 Engage quarterly to discuss science, monitoring, adaptive management, water, sediment, and habitat project planning efforts, reporting, and executive coordination.

6.2 Use the development of the Annual Operating Plan to describe the spring runoff and low flow condition management expectations and outcomes with the Service.

To implement RPM 7:

7.1 Reclamation shall fund and implement the Silvery Minnow PMP using the current protocols, procedures, analytic methods and reporting without any gaps, especially in the fall, of its implementation along the MRG. The Silvery Minnow PMP may be modified and adjusted through the adaptive management, provided there is appropriate overlap in monitoring prior to the implementation of any newly modified Silvery Minnow PMP. Results shall be used to inform the adaptive management process in the RIO.

7.2. Reclamation shall monitor the habitat use and movement of silvery minnows in association with Proposed Action projects, including fish passage projects. Results shall be used to inform the adaptive management process in the RIO.

7.3 Reclamation, BIA, and BA partners shall ensure silvery minnow surveys are performed by biologists that possess a Section 10(a)(1)(A) permit.

7.4. Reclamation shall conduct flycatcher and cuckoo protocol surveys annually throughout the Action Area.

7.5 Reclamation shall continue to monitor nests for flycatchers annually to determine nest success and the relationship to modeling of habitat utilization, hydrology, and geomorphology.

7.6 Reclamation shall develop a habitat suitability model specific to the cuckoo to quantify the amount of suitable or moderately suitable habitat available to the species.

7.7 Using habitat characteristics agreed to in coordination with the Service, Reclamation shall map and monitor all suitable and potential flycatcher and cuckoo habitat within the Action Area at least once every 5 years. Reclamation shall implement mapping and monitoring of the floodplain from the southern boundary of Isleta Pueblo to Elephant Butte Dam. MRGCD shall implement mapping in areas within MRGCD-administered land that contain potential or suitable flycatcher or cuckoo habitat.

7.8 Reclamation will initiate or continue studies to better understand cuckoo habitat utilization, core nesting areas/size, overall territory size, site fidelity, and seasonal occupancy dates.

7.9 Reclamation, BIA, and BA partners shall ensure flycatcher and cuckoo protocol surveys and nest monitoring are performed by biologists that possess a Section 10(a)(1)(A) permit.

To implement RPM 8:

8.1 Reclamation shall standardize and implement all BMPs that pertain to equipment and operations, staging and access, project timing, water quality, dust abatement, exclusion, silt fence installation, and others for their Proposed Action.

8.2 Reclamation and BIA shall request that the six MRG Pueblos and MRGCD review, consider, and implement the BMPs in their activities and on their lands and waters.

8.3 Reclamation, BIA, and the BA Partners shall seek to minimize their activities, noise, and disturbances within the seasonal and geographic buffer areas associated with flycatcher and cuckoo nesting/territorial/feeding behaviors. Specifically, all parties shall adhere to the seasonal and geographic avoidance of vegetation clearing activities during the breeding season (April 15-September 1), or coordinate with the Service (NMESFO) when seasonal or geographic restrictions cannot be implemented as proposed.

8.4 Habitat restoration and maintenance projects shall minimize native plant disturbance to the extent possible or replace native plants at the ratio specified within Reclamation's BMPs. Invasive species removed shall be replaced with native species.

8.5 Reclamation and BIA shall ensure that all Conservation Measures and BMPs described in the BA and the BiOp are implemented.

To implement RPM 9:

9.1 During droughts or low flow periods, Reclamation shall continue to work with MRGCD to coordinate operations so as to support and enhance habitat availability and related species benefits.

9.2 Reclamation shall coordinate water diversions from the LFCC during droughts or low flow periods to minimize impacts to flycatcher breeding territories from RM 67 to 54. The Lower Reach Plan shall include coordination with BDANWR as well as the Service (NMESFO) to minimize effects on the species with potentially competing water needs (silvery minnow, flycatcher, and cuckoo).

9.3 Reclamation shall coordinate with the Service (NMESFO) throughout the planning process for the conservation measures for which impacts and effects cannot currently be estimated (e.g., North Boundary BDANWR Infrastructure Changes, Connectivity Project) prior to any separate consultations.

9.4 Reclamation shall coordinate with the Service (NMESFO) on modification or improvements of the LFCC. Reclamation will assist the Service to quantify impacts to habitat. If the LFCC modification/improvement project provides additional water to benefit the 573 ha (1,416 acres) of flycatcher and cuckoo habitat, Reclamation shall use the surplus of habitat restoration acreage [estimated to be 31 ha (77 acres)] to minimize impacts associated with other actions.

9.5 Reclamation shall coordinate with the USACE to develop an elevation plan for sediment management purposes as part of the Lower Reach Plan.

9.6 Reclamation shall take up to 1.5 years to develop the Lower Reach Plan. This Plan shall be reviewed and approved by the Service.

To implement RPM 10:

10.1 Reclamation shall coordinate in the development of a comprehensive database for species and habitat information.

To implement RPM 11:

11.1 Reclamation shall coordinate the appropriate reporting of the listed species and their habitat monitoring data and all associated management actions that affect these species or their habitats on an annual basis, as well as integrated and synthesized reports every 5th year.

11.2 All agencies shall report to the Service in accordance with 10(a)(1)(A) permits.

11.3 Reclamation shall report by March 1st, of each year, and provide electronic copies of reports and plans to the Service on implementation of all RPMs their associated Terms and Conditions.

11.4 Reclamation shall report to the Service any spills of hazardous chemicals in toxic amounts associated with the Proposed Action activities that occur in the floodplain fuels, hydraulic fluids, and other hazardous materials.

11.5 Annual reports shall reference the appropriate consultation number 02ENNM00-2013-F-0033, and should be delivered electronically to email address nmesfo@fws.gov.

Disposition of Dead or Injured Listed Species

Upon locating a dead, injured, or sick listed species initial notification must be made to the Service's Law Enforcement Office P.O. Box 1306, Albuquerque, NM 87103-1306, telephone 505-248-7889 within 3 working days of its finding. Written notification must be made within 5 calendar days and include the date, time, and location of the animal, a photograph if possible, and any other pertinent information. The notification shall be sent to the Law Enforcement Office with a copy to this office via email at nmesfo@fws.gov. Care must be taken in handling sick or injured animals to ensure effective treatment and care, and in handling dead specimens to preserve the biological material in the best possible state.

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 conservation recommendations identified below may be implemented by Reclamation and BIA. Conservation recommendations may be recovery actions that are not currently being undertaken.

The Service recognizes that any Conservation Recommendations that involves access to or use of Indian Pueblo or Tribal lands or other trust resources requires the consent of the affected Indian Pueblo or Tribe and that the Federal agencies are obligated by the Federal trust responsibility to consult with the affected Pueblo or Tribe in coordination with BIA. The Service further recognizes that nothing in the Conservation Recommendations shall adversely affect or otherwise modify the obligations to store, release, and deliver water to the six MRG Pueblos to meet their statutorily recognized rights.

1. Determine how water savings from water conservation and water use efficiency improvements or water acquired through purchase or lease can be used directly for instream flow and other direct benefits to the species. Implement in-streamflow as a beneficial use and use water savings to improve the MRG for its native species.

2. Monitor fluctuations of groundwater, and water levels in canals/drains, the LFCC and in the main channel to better understand and mitigate losses of water.

3. Develop and implement an agricultural leasing program that will provide additional supplemental water to be used for the conservation of the silvery minnow, flycatcher, and cuckoo.

4. Reclamation, NMISC, and MRGCD should work with the State of Colorado to develop options for enhancing silvery minnow spawning flows in May and June.

5. NMOSE, in cooperation with water management agencies (Reclamation, NMISC and MRGCD), should account for and take measures to prevent unauthorized use of water within the Rio Chama and MRG watersheds, also including the use of water intended to directly or indirectly benefit endangered species.

6. Conduct studies to determine the areas of mixing zones associated with construction actions and effects of such disturbances, including noise, on silvery minnow behavior.

7. Follow BMPs to reduce the annual risks of catastrophic hazardous material or petroleum spills.

8. Develop a wildfire prevention and restoration plan for flycatcher and cuckoo habitat.

9. Develop new technologies and equipment that can be more effective at rapidly destabilizing and restoring aquatic habitats along the shoreline or channel banks.

10. Sponsor voluntary citizen monitoring programs of habitat and water quality in the MRG.

11. Work with landowners to promote environmental stewardship and conservation of the flycatcher, cuckoo, and their habitats.

12. Implement additional ecosystem restoration activities on broad scale.

13. Research silvery minnow predation and competition relationships.

14. Inform partners and the public about saltcedar beetle issues. Continue to improve an understanding about saltcedar issues using the latest science.

15. Control feral hogs as needed.

16. Selectively remove jetty jacks.

17. Coordinate management of livestock grazing to minimize impacts to flycatchers, cuckoos, and their habitats.

18. Coordinate with fire management agencies to prepare for and reduce bosque loss to fires.

19. BIA should work with the Pueblos and the Service to develop Safe Harbor Agreements where appropriate.

20. NMISC should continue operations of the Los Lunas Silvery Minnow Refugium to provide additional augmentation and research of silvery minnow.

21. Reclamation and the BA Partners should work with the Service to conduct annual tours of the MRG to assess progress in implementing activities described in this BiOp.

22. The City of Albuquerque should continue operations at the BioPark to provide silvery minnow propagation, augmentation, and public education.

In order for the Service to be kept informed of actions minimizing or avoiding adverse effects or benefiting listed species or their habitats, the Service requests notification of the implementation of any conservation recommendations.

REINITIATION NOTICE

This concludes formal consultation on the action(s) outlined in the request. As provided in 50 CFR 402.16, reinitiation 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 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 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 operations causing such take must cease pending reinitiation.

Through formal conferencing, the Service has determined the Proposed Action is "not likely to destroy or adversely modify" cuckoo proposed critical habitat. Upon designation of critical habitat, you may request the Service to confirm the conference opinion as a BiOp issued through this formal consultation. Such a request must be in writing, and if the Service reviews the Proposed Action and finds no significant changes in the Proposed Action or the information used during this conference, the Service will confirm the conference opinion as the BiOp, and no further section 7 consultation will be necessary.

The Service appreciates Reclamation's and BIA's efforts to identify and minimize effects to listed species from this project. For further information please contact David Campbell at 505-761-4745, david_campbell@fws.gov, or myself at 505-761-4781, wally_murphy@fws.gov. Please refer to the consultation number 02ENNM00-2013-F-0033, in future correspondence concerning this project.

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Table 1. Summary of Conservation Measures that were included by Reclamation, BIA, and the BA partners as part of the Proposed Action (from Reclamation 2015, Tables IV-1 and IV-2 except where noted).

Table 1 **Action Category**[1]	**Conservation Measure(s)**[2*]	**Benefits**[3]
Hydrology		
El Vado Reservoir Operations – Store native water at the request of MRGCD or MRG Pueblos' Prior and Paramount water at request of BIA, or store allocated credit relinquished water **(Reclamation, BIA, MRGCD)**	Proposed Minimization Measures 1. Supplemental SJC water will be used for the highest need, such as spring peak flows or summer water, as guided through Adaptive Management, RIO, and the Minnow Action Team (MAT). **(Reclamation)** 2. Coordinate to develop Conservation Storage (30,000-60,000 acre-ft) in upstream reservoirs. (Include working with ABCWUA). **(Reclamation, MRGCD, State)**	1. This Measure minimizes the negative impact to May and June and July through October flows in the MRG caused by storing water in the spring through augments to flows during low water periods. This will assist in meeting the Hydrobiological Objectives. 2. This Measure will help to meet the Silvery Minnow SRS through establishing the Conservation Storage, which would provide water during low flow years. This will require cooperation between Reclamation, MRGCD, State, and ABCWUA to provide storage behind existing dams, acquire legal authorities for conservation storage, agreements on water sources, and agreements on the conservation use of the water. This Measure will assist in improving the

[1]The Action Category column contains general categories of the proposed action that have adverse effects on the listed species. These are described in more detail in the Proposed Action section of this document, on page 9.

[2] The Conservation Measures listed in this column are those that were proposed to minimize the effects of the Proposed Action on listed species in BA Table IV-1 (referred to in this table as Proposed Minimization Measures) and those that were proposed to improve the conservation of the listed species beyond the minimization required to offset the impact of the Proposed Action in BA Table IV-2 (referred to in this table as Proposed Additional Conservation) (Reclamation 2015).

[3] The Benefits column contains a summary of the beneficial effects of the Proposed Actions in the Conservation Measure column identified by number, and discussed in the Effects of the Action section of this document, on page 52.

* The Service recognizes that Conservation Measures that involve access to or use of Indian Pueblo or Tribal lands or other trust resources requires the consent of the affected Indian Pueblo or Tribe and that Reclamation and BIA are obligated by the Federal trust responsibility to consult with the affected Pueblo or Tribe. In addition, the Service recognizes that BIA should be involved with any Conservation Measures that involve access to or use of Indian Pueblo or Tribal lands or other trust resources. The Service further recognizes that nothing in the Conservation Measures shall adversely affect or otherwise modify the obligations to store, release, and deliver water to the six MRG Pueblos to meet their statutorily-recognized rights.

Table 1 Action Category[1]	Conservation Measure(s)[2*]	Benefits[3]
El Vado Reservoir Operations (continued)		conservation security of all listed species in the MRG that are reliant on river flows. Supported by Conservation Measures 39-40.
	3. Annually evaluate the need for modified reservoir operations within current authorities at El Vado, to better meet the needs of the species, e.g., (Reclamation 2016a; RGCC 2016) modification of operations at El Vado Reservoir. **(Reclamation, State, MRGCD)**	3. This Measure is the implementation of an Adaptive Management strategy through the RIO at the beginning of the water year to determine how to meet the Hydrobiological Objectives. This process will determine if adequate water is available to follow the Production Strategy or Survival Strategy and how an El Vado deviation may be used to ensure the success of the Production and Survival Strategies.
	4. Adjust timing of storage during spring peak flows. For example, storing early to minimize the impact on peak spring flows. **(MRGCD and Reclamation)**	4. The adjusting of the timing of the water storage from January to April, will reduce the negative impact of storage on the spring peak flow and the negative impacts to spawning caused by storing water during silvery minnow spawning season.
	5. Utilize diversion structures to aid in providing spawning conditions. **(MRGCD)**	5. This Measure will help to minimize the negative impacts of water storage and depletions from the Proposed Action by assisting in the delivery of water to occupied river reaches by contributing to the Production Strategy will be achieved.
	Proposed Additional Conservation 6. Pursue exchanges of SJC water from downstream to upstream to aid in addressing impacts during spawning period. **(MRGCD and Reclamation)**	6. The exchanges of water will make water available to benefit silvery minnow during the spawning and rearing period. This would help minimize the impact of water storage and depletion on silvery minnow by exchanging water in the system for SJC water that can be used to augment flows through alteration of the timing and location of diversion. These flows would aid in overbanking and backwaters during the May and June flow period. The extent of the of habitat that will be made available will depend on water already in the system,

Table 1 **Action Category**[1]	**Conservation Measure(s)**[2*]	**Benefits**[3]
		and habitat improvements that create overbanking at lower flows, such as described in Conservation Measure 75.
Operate Diversions – Divert water, for delivery to and consumption by agricultural users, at Cochiti, and Angostura, Isleta, San Acacia diversion dams. See Appendix H in BA for additional detail. **(MRGCD)**	Proposed Minimization Measures During high-flow and low-flow periods**:** 7. MRGCD will conduct management to closely match diversion to actual agricultural demand. MRGCD will use a Decision Support System, and irrigation scheduling to manage irrigation diversion rates. **(MRGCD)**	7. While this Measure will not reduce the agricultural demands or deliveries in the MRG, it will more closely match water releases to those demands. This Measure will minimize the total volume released to meet water user demands and result in more water remaining in storage and to meet needs.
	8. Use MRGCD diversions and conveyance system to deliver Supplemental Water to specific habitat areas in the River, minimizing naturally occurring losses to supplemental water. **(MRGCD)**	8. Reduce impacts of water withdrawal to silvery minnow by using MRGCD diversion and conveyance system to move water to occupied silvery minnow habitat to improve survival.
	9. Exchange the supplemental water for Rio Grande water, allowing use of supplemental water for environment purposes, while remaining in compliance with the Compact and SJC Project regulations. **(MRGCD)**	9. The exchange of supplemental water for native water will increase water delivery to the Isleta and San Acacia Reaches by allowing native water to be used to prevent river channel drying in support of the Hydrobiological Objectives Survival Strategy. This native water can then be replaced by Supplemental Water to fulfill Compact water deliveries and stay within SJC regulations. In some years, this may also generate credits under the Compact as described below in Conservation Measures 22, 25, 29, and 30.
	10. Construction of gaging stations to monitor diversion rates and deliveries to irrigation laterals, and expanded installation and use of automatic controls at MRGCD diversion structures, canals and wasteways. **(MRGCD)**	10. This Measure should increase accuracy and timing of water releases for delivery to water users. It should also result in less carriage water needed to transfer water through the delivery system. This Measure will minimize the total volume released to meet water user demands and result in more water remaining in storage that can be used to meet future water demands, conservation uses, and conservation storage, similar to Conservation Measure 7.

Table 1 Action Category[1]	Conservation Measure(s)[2*]	Benefits[3]
Operate Diversions (continued)	11. Manage MRGCD facilities, e.g., wasteways and outfalls, from which the MRGCD has historically discharged water at a variable rate, to discharge water more consistently **(MRGCD)**	11. Managing the rate of water discharge back into the river can result in maintaining flow rates in the river channel that will result in reduced stranding and displacement of silvery minnow. This will minimize the impacts of water discharge from wasteways and outfalls into the river channel through improving survival of silvery minnow of all age classes.
	Specific to address low-flow periods: 12. Use MRGCD diversions and conveyance system to manage river recession ("provide a controlled recession") during post spawn and during low-flow periods; and manage return flows in coordination with Reclamation and the Service to assist with silvery minnow rescue efforts. **(MRGCD)**	12. Reducing the rate of river recession (water loss) will result in less stranding of silvery minnow in isolated pools and increased survival of all age classes.
	13. Construction of a surface return flow collection system at MRGCD south boundary at River Mile 84 to aid in managing river recession and deliver return flows to the River. **(MRGCD)** This includes BDANWR Infrastructure and River Realignment changes.	13. This Measure will return water from three MRGCD drains above RM 84. It will result in more water being returned to the river channel in support of the large-scale habitat restoration as part of the Conservation Strategy in the proposed action. This will help minimize the impact on hydrology and geomorphology that result in effects to silvery minnow, flycatcher, and cuckoo by increasing wetted river area in the San Acacia Reach. This Measure is reliant on the habitat restoration to be in place or this Conservation Measure will not otherwise be effective.
	14. Maintain selected MRGCD drain and wasteway outfalls, such as the Peralta Drain, to keep sites viable and productive for targeted species, as well as for overall ecosystem health. This will be managed in a manner consistent with the overall purposes of the MRGCD. **(MRGCD)**	**14.** This Measure will result in more effective collection of waste water, carriage water that is past the delivery point and transferred through wasteways to the River. This will minimize the impact of storage and depletions on silvery minnow by using this water to support up to 16 km (10 mi) of additional wetted area primarily in the Isleta Reach supporting

Table 1 Action Category[1]	Conservation Measure(s)[2*]	Benefits[3]
Operate Diversions (continued)		both the Production and Survival Strategies.
	15. Provide a minimum of $150,000 in annual ESA and science related funding, a portion of which may support San Acacia reach habitat projects, and may include additional funds for specific habitat projects identified as priorities in the Program **(MRGCD)**	15. Annual funding of ESA science related research and monitoring in support of habitat projects for silvery minnow, flycatcher, and cuckoo. Providing funds for habitat restoration and enhancement.
	Specific to address egg entrainment: 16. During peak silvery minnow egg production times, maintain close coordination with the Service and egg monitoring teams, adjusting diversions to minimize entrainment of eggs. **(MRGCD)**	16. This Measure will minimize the effects of diversions on silvery minnow eggs by reducing the conditions that result in them being trapped in MRGCD canals and waterways, and other unfavorable environments. This is in support of the Production Strategy.
	Specific to address river connectivity: 17. Reclamation will implement a program to facilitate fish passage at San Acacia, Isleta and Angostura Diversion Dams, with assistance from BIA, MRGCD and the State, within the first 5 years of the new BiOp (Reclamation 2016b). An initial pilot study will test small-scale modifications, to determine a feasible approach for a simplified full-scale fish passage (NMISC) at San Acacia. Side channel construction options will be explored at Angostura and Isleta Diversion Dams.	17. This Measure will improve connectivity of the river channel for silvery minnow. This will minimize the impacts of drying in the river channel from storage and depletions by allowing the silvery minnow to move to available water. It will also provide access to the Cochiti Reach where there is up to 32 km (20 mi) of unoccupied and designated critical habitat.
	18. MRGCD will implement a program for fish passage at San Acacia that is expected to require in-channel grade control structures, modification of gates and of the apron. This simplified approach will entail the Dam remain unchecked (gates raised) for much of the year. It requires concurrent construction of a siphon near the Rio Puerco confluence to deliver a portion of east side drain returns to Drain Unit 7 and provide an alternate source of water supply for the MRGCD's Socorro Division (San Acacia Reach). Operation of the San Acacia Dam in the checked condition, though necessary	18. This Measure will improve connectivity of the river channel for silvery minnow between the San Acacia and Isleta Reaches. This will minimize the impacts of drying in the lower river by allowing the silvery minnow to move to wetted habitat. It will also reestablish the genetic connection to upstream habitats.

Table 1 Action Category[1]	Conservation Measure(s)[2*]	Benefits[3]
Operate Diversions (continued)	under certain conditions, is expected to be infrequent and short duration. The MRGCD will provide the local cost-share necessary to build these structures, with the expectation of Federal cost-share also being provided. Planning will be in 2016-2017, and construction in 2017-2018 (**MRGCD**).	
Operate Drains and Wasteways – Collect and return water to river **(MRGCD)**	Proposed Minimization Measures 19. Configuration of MRGCD drain outfalls as habitat areas. **(MRGCD)**	19. This Measure will minimize losses of silvery minnow by providing areas of habitat that will act as refugia at existing MRGCD drains during times of extremely low water primarily in the Isleta Reach.
	20. Use of MRGCD drains and wasteways to manage flows and rates of recession. **(MRGCD)**	20. This Measure will minimize the impacts from water storage, delivery, and depletion by water users through reducing the amount of river area that dries, and also providing regulated rate of water recession thereby reducing entrainment of silvery minnows in isolated pools, similar to Conservation Measures 13 and 16.
	21. Use of MRGCD drains and wasteways to convey and deliver Supplemental Water to Rio Grande for environmental purposes. **(MRGCD)**	21. This Measure will minimize the impacts by conveying Supplemental Water transferred through wasteways to outfalls in the river channel. In addition, carriage water in the system will be used to support up to 16 km (10 mi) of additional wetted river primarily in the Isleta Reach supporting both the Production and Survival Strategies.
Administration of Surface water and Groundwater Supplies **(State)**	Proposed Minimization Measures 22. The State will provide up to 250 acre-ft per event (not to exceed a total of 4,500 acre-ft in any 15-year period) of Compact relinquishment credit water for storage and later release at low flow rates when MRGCD is not otherwise releasing stored water.	22. This Measure will assist in minimizing the impacts from storage and depletions on silvery minnow. This Measure will provide water that is associated with Compact relinquishment credits. This water will be used in low flow years (event) when water has not been available, to assist in accomplishing the

Table 1 **Action Category**[1]	**Conservation Measure(s)**[2*]	**Benefits**[3]
Administration of Surface water and Groundwater Supplies (continued)	23. The State will work with its Program partners to maintain existing overbank habitat constructed by the State since 2006 in the Angostura and Isleta Reaches for 15 years, which will result in maintaining habitat availability at a greater range of flows in which spawning, egg incubation, and larval rearing can occur. 24. The State will provide depletion offsets for the USACE MRG Floodway projects in accordance with existing agreements.	Production Strategy, but more likely the Survival Strategy. This is water that has not been historically available for conservation use. 23. This Measure will minimize the impacts of water storage, release, and depletions on the hydrological and geomorphological processes in the River. This Measure will maintain existing overbank silvery minnow habitats in the Angostura and Isleta Reaches for the term of the BiOp. This will keep these habitats available for spawning and rearing of larvae improving survival of young of year. 24. This Measure will reduce the amount of water needed by the USACE to implement their MRG Floodway projects. This water could be used for implementation of Production or Survival Strategies.
Administration of Domestic, Municipal, Livestock and Temporary Uses **(State)**	Proposed Minimization Measures 25. The State will provide up to 150 acre-ft per event (not to exceed a total of 1,500 acre-ft during the 15-year BiOp period) of Compact relinquishment credit for storage and later release at low flow rates when MRGCD is not otherwise releasing stored water.	25. This Measure is similar to Conservation Measure 22, above. It will assist in minimizing the impacts from storage and depletions on silvery minnow. This Measure will provide water that is associated with Compact relinquishment credits, but is from another part of the water budget. This water will be used in low flow years when water is not normally being released to assist in the Production Strategy, but more likely in the Survival Strategy. This water source has not historically been available for conservation use.

Table 1 **Action Category[1]**	**Conservation Measure(s)[2*]**	**Benefits[3]**
RIO Using Adaptive Management- River Operations	Proposed Additional Conservation 26. The MAT will annually use the RIO to evaluate and determine the best use of available water for conservation as well as long-term solutions. Through the RIO, the MAT will evaluate recommended spring flows by testing the Service's Hydrobiological Objectives water management hypotheses within an adaptive management framework the strategic use of river operations is expected to improve species status through the various strategies will be scientifically investigated. Conservation Measures that have a river operations component will be integrated into the RIO to the maximum extent possible. (**Reclamation, MRGCD, and State**) The RIO will also be used to determine the best methodologies for quantification of available habitat over the full range of river conditions during the term of the BiOp.	26. This Measure will result in the MAT evaluating the projected water available in the spring of each year, and determining the best strategy (Production or Survival) for meeting the Hydrobiological Objectives through adaptive management.
RIO Using Adaptive Management - Allocation of existing relinquishment credits	Proposed Additional Conservation 27. The State will provide over 100,000 acre-ft of previously allocated New Mexico Compact Relinquishment Credit for use over the next several years when the Compact Article VII storage restrictions are in effect to meet both MRGCD irrigation demand and BiOp needs. (**State**)	27. This Measure will minimize the impacts of storage and depletions of water on the silvery minnow. Similar to Conservation Measure 22 and 25, above, it will provide water that is part of the water budget that has not been historically available for conservation. This will provide Reclamation, BIA, and the BA partners with water during storage restrictions when Compact Article VII conditions are met. This should assist in both Production and Survival Strategies. We are not able to predict the frequency that these credits would be used, as it will be based upon the snowpack each year (annual water budget) and availability of credits. However, this Conservation Measure will be used when water is scarce.
RIO Using Adaptive Management - Maximize Compact Credit Status	Proposed Additional Conservation 28. MRGCD will cooperate with appropriate entities to maximize New Mexico credit status under the Compact, and increase the opportunities for future credit relinquishment to benefit both ESA needs and MRGCD water supply. **(MRGCD)**	28. This Measure will indirectly assist developing the Conservation Storage. This water could then be used to improve hydrology, geomorphology, water quality issues, and riparian vegetation maintenance and development for all listed species. It is specific to the Silvery Minnow SRS, which will minimize

Table 1 Action Category[1]	Conservation Measure(s)[2*]	Benefits[3]
RIO Using Adaptive Management - Maximize Compact Credit Status (continued)		the impacts of storage, controlled releases and depletion of water on this species. This reserve of water can be used to meet the Hydrobiological Objectives (Production and Survival Strategies) in dry years
RIO Using Adaptive Management - Maintenance of the Delta Channel	Proposed Additional Conservation 29. The State will continue maintenance of the Delta Channel at up to $1 million per year primarily as a means of aiding in Compact compliance but also, potentially, to accrue additional Compact Credit Water that could be relinquished and provide future relinquishment credit allocations. (**State**)	29. This Measure will create additional habitat for silvery minnow and provide more efficient collection and delivery of water to Elephant Butte Reservoir to meet Compact obligations. Depending on the efficiency of delivery, additional Compact credits for water may be generated. These credits can be then be used as described in Conservation Measures 22 and 25, minimizing impacts of the proposed action on silvery minnow through increasing reliable water for implementation of Production and Survival Strategies.
RIO Using Adaptive Management - Efficiency Improvements	Proposed Additional Conservation 30. MRGCD will provide a minimum of $500,000 annually toward improving existing water delivery systems, increasing flexibility in water operations, and managing during drought to improve efficiencies of water deliveries, thereby incrementally reducing diversions, during spawning and recruitment. These funds will be leveraged with Federal and State water conservation and infrastructure programs to accelerate system-wide improvements. (**MRGCD**)	30. This Measure is aimed at minimizing the impacts of water delivery and depletion by water users on silvery minnow by improving efficiency of the water delivery system. Improving the timing of delivery relative to demand, and providing a means to more readily get water to the user with less loss. This would result in less carriage water being needed to ensure water users received their water right. From these efficiencies, there would be additional water available in storage or for the generation of additional Compact Credits to be used as described in Conservation Measures 22 and 25.
RIO Using Adaptive Management - Water Conservation Storage and Timing	Proposed Additional Conservation 31. Pursue modified reservoir operations including those at Heron, El Vado, Abiquiu, and Cochiti *beyond current authorizations.* (**Reclamation, ISC, and MRGCD**) This would include the recent Letter to the Compact requesting a team to evaluate alternatives at El Vado. 32. Coordinate to develop conservation storage in upstream	31-37. These Measures, as well as Conservation Measures 38 and 39, will be part of the process of developing Conservation Storage to minimize the impacts of water storage and depletions by water users on silvery minnow, flycatcher, and cuckoo. These Measures are all part of the process by which Reclamation, BIA, and the BA Partners will develop

Table 1 **Action Category**[1]	**Conservation Measure(s)**[2*]	**Benefits**[3]
RIO Using Adaptive Management - Water Conservation Storage and Timing (continued)	reservoirs *beyond existing authorities.* (**Reclamation, MRGCD, State**) 33. Pursue storage agreement or permit in Abiquiu Reservoir. **(Reclamation and ISC)** 34. MRGCD will expand its opportunity for storage to manage through drought by completion of agreements with ABCWUA to store up to 50,000 acre-ft of water at Abiquiu Reservoir. **(MRGCD)** This is for storage space. This is not a conservation pool but intended to increase operational flexibility. 35. Store excess leased Supplemental SJC water or exchanged water. **(Reclamation)** 36. Purchase/lease pre-1907 water rights. (**Reclamation and MRGCD**)	the authorities, capacities, and identify water for storage to implement the Conservation Storage. The Conservation Storage as described in the proposed action will be used to provide necessary flows for successful spawning (Production Strategy) and recruitment (Survival Strategy) when other water is not available. It may also be used to improve and restore riparian vegetation for flycatcher and cuckoo through providing overbank inundation and maintaining near river groundwater level for native riparian vegetation. Implementation of the Conservation Storage and use of its water will minimize of the effects of water storage, delivery and depletions. While these Measures are not in place today, with the exception of Conservation Measure 35, they will be put into place the framework necessary to secure reliable water sources for the conservation and recovery of listed species.
	37. MRGCD will encourage the development of Federal legislation that reauthorizes Cochiti Dam and Reservoir as a dual-purpose facility for both flood control and for up to 60,000 acre-ft of conservation storage. The MRGCD will work closely with the Federal and State agencies as well as the six MRG Pueblos to coordinate this effort during the 2 to 4 years this may take to get the legislation passed. (**MRGCD**) Proposed draft legislation has been submitted by non-Federal partners to Senator Udall.	37. This measure will be done in coordination with Cochiti Pueblo because Cochiti Dam and Reservoir are located on Cochiti Pueblo land.
	38. Seek opportunities to conduct modified operations at other reservoirs and SJC exchanges that may benefit the species. (**State**)	38. This Measure will pursue options to modify operations at Heron and Abiquiu Reservoirs to achieve the Conservation Storage. The Conservation Storage can be used to meet the Production or Survival Strategies.
RIO Using Adaptive	39. Pursue adjusted timing of storage *beyond current authorizations.* (**Reclamation, State, and MRGCD**)	39. This Measure is similar to those above

Table 1 **Action Category**[1]	**Conservation Measure(s)**[2*]	**Benefits**[3]
Management - Water Conservation Storage and Timing (continued)		(Conservation Measures 31-38) in that it will not directly minimize the impacts of water storage on the silvery minnow, but will work to improve the ability of Reclamation, BIA, and the BA partners to meet the Production and Survival Strategies.
RIO Using Adaptive Management - Flexibility in managed recession	Proposed Additional Conservation 40. The MRGCD will establish a policy whereby during times of floodwater storage and managed recession for silvery minnow MRGCD available natural flow will be determined by the theoretical release from Cochiti Reservoir in the absence of any such managed recession. **(MRGCD)**	40. This Measure will indirectly provide for increases in the amount of available Supplemental Water, which will assist in the long-term survival and recovery of the silvery minnow, as described above for Conservation Measures 29 and 32-41.
RIO Using Adaptive Management - Native Water Acquisition Program	Proposed Additional Conservation 41. Continue pursuit of a Native Water Acquisition Program, which might include Strategic Water Reserve and Water Banking components, with the goal of determining potential benefits for species conservation. (**Reclamation, State, and MRGCD**) Strategic water reserve currently includes water for depletion offsets and temporary deviations.	41. This Measure will indirectly provide for increases in the amount of available Supplemental Water, which will assist in the long-term survival and recovery of the silvery minnow, as described above for Conservation Measures 29 and 32-41.
RIO Using Adaptive Management - LFCC Pumping and Evaluation	Proposed Additional Conservation 42. The pumping from the LFCC to the river channel will continue while an evaluation of the effectiveness of this action occurs. **(Reclamation)**. This evaluation will be part of the Lower Reach Plan and may be linked to BDANWR Realignment Project and north boundary distribution hub.	42. This Measure will minimize the impacts of water storage and depletions by water users on the silvery minnow in the San Acacia Reach. While the Lower Reach Plan is being developed from 2016 to 2018, the pumping of water collected in the LFCC into the river channel will support the Survival Strategy. This will maintain habitat availability in the San Acacia Reach for silvery minnow. The Lower Reach Plan should provide the context for this evaluation and alternatives to pumping.
RIO Using Adaptive Management - Enhanced Measurement and Data	Proposed Additional Conservation 43. The expansion, refinement, operation and maintenance of measurement stations, telemetry equipment, computer processing, and data exchange networks will be pursued to improve the collection and distribution of information on MRGCD water operations. **(MRGCD)** This supports native water acquisition program.	43. This Measure will provide information that can be used to minimize impacts from water delivery and depletions by water users on listed species. This will be through providing better data with which to base the RIO decision process and improving models of the MRG. This will be an ongoing

Table 1 **Action Category**[1]	**Conservation Measure(s)**[2*]	**Benefits**[3]
		process by Reclamation, BIA, and the BA partners, supporting greater efficiency of delivery and the Silvery Minnow SRS.
RIO Using Adaptive Management - Reduction in Angostura diversions during shortage operations	Proposed Additional Conservation 44. During MRGCD shortage/conservation operations and when the ABCWUA has agreed to suspend diversions of native Rio Grande water, MRGCD will, if deemed necessary, reduce diversions at Angostura Diversion Dam to the minimum practical rate of flow required to meet irrigation demand within the MRGCD Albuquerque division (Angostura Reach). **(MRGCD)**	44. This Measure can provide additional flows to meet flow targets at the Albuquerque gage in the river channel through the Angostura Reach during low flow years in support of the Production Strategy. Additionally this Measure could be used to maintain wetted area in this reach under the Survival Strategy. This will support the Hydrobiological Objectives and minimize the effects on silvery minnow of water storage, release and depletion.
RIO Using Adaptive Management - Supplemental Water coverage	Proposed Additional Conservation 45. Under certain conditions, when Reclamation has begun releasing Supplemental Water for conservation purposes, but that water has not yet reached its intended destination, MRGCD will assist Reclamation to achieve intended rates of flow below the Diversion Dams. **(MRGCD)**	45. This Measure enhances the ability of Reclamation to deliver the Supplemental Water to needed locations by reducing the travel time of water, which will reduce losses as carriage water moves within the system to areas of conservation need. This will support the Production and Survival Strategies of the Hydrobiological Objectives, by delivering water to critical areas where drying may occur.
RIO Using Adaptive Management - Operating Plan	Proposed Additional Conservation 46. Annually, the MRGCD will develop an Operating Plan that will coordinate the delivery of irrigation water with assistance in providing spawning, recruitment, and survival habitat needs as determined by using the best available scientific information. **(MRGCD)**	46. This Measure involves providing input to the RIO for applying adaptive management. This measure will be one of the considerations the MAT will use to determine the annual strategy of Production and Survival. This will contribute to working through the RIO and applying Adaptive Management to meet the Hydrobiological Objectives. The Annual Operating Plan will be the document that records which Strategy (Production or Survival) will be pursued. This will minimize the impact of water storage, releases, and depletions on silvery minnow when implemented under Conservation Measures 3, 5, 8, 9, 14, 16, 21, 22, 24-27, 29, 40,44, and 47.

Table 1 **Action Category**[1]	**Conservation Measure(s)**[2*]	**Benefits**[3]
RIO Using Adaptive Management - Increase safe channel capacity in the MRG	Proposed Additional Conservation 47. The State will work with the USACE and Reclamation to identify projects, in addition to the San Acacia Levee and Socorro Levee Projects, that when constructed will allow the USACE to increase its safe channel capacity releases from Cochiti and Jemez Canyon Reservoirs so that higher snowmelt runoff flows can safely be passed through the middle valley. That, in turn, will provide for additional overbanking habitat. (**State**)	47. This Measure provides greater management flexibility in support of the Silvery Minnow SRS, by allowing higher peak flows. The result of this will be improved hydrological and geomorphological conditions through overbanking, sediment transport, and more inundation of spawning and rearing habitats for silvery minnow. It will also support large-scale habitat restoration and localized projects that create backwaters and channels for silvery minnow spawning at high flows, as well as riparian habitat restoration for flycatcher and cuckoo nesting.
River Connectivity- Re-Connectivity for Other Diversions: Angostura and Isleta Diversion Dams	Proposed Additional Conservation 48. By spring 2017, conduct San Acacia Diversion Dam pilot studies that will evaluate alternative design features. Angostura and Isleta Diversion Dams connectivity will be pursued. (**MRGCD, Reclamation, BIA**) See Conservation Measure 65 for more details.	48. This Measure will develop alternative fish passage structures for silvery minnow at the San Acacia Diversion Dam. While the initial structure may not provide unobstructed passage from the San Acacia Reach to the Isleta Reach, it will provide connectivity until permanent structures are in place by the end of 2022. See Conservation Measure 65 for more details.
River Connectivity- Re-Connectivity for Other Diversions: Angostura and Isleta Diversion Dams (continued)	49. Within 6 years implement new standard operating procedures for Isleta Diversion Dam resulting in improved sediment transport and fish passage. **(Reclamation. MRGCD)** The State may assist the MRGCD in planning, designing, testing, and constructing projects designed to better provide fish passage at this structures. **(State)**	49. This Measure will result in minimizing of impacts from water storage, release, and through improving the sediment transport in the river channel, allowing for the development of more diverse silvery minnow habitats. Additionally, the fish passage will provide the silvery minnow the ability to move upstream to the Angostura Reach. This ability to move will allow the silvery minnow to avoid areas of river drying. The connectivity between the reaches should also provide additional benefit in genetic interchange upstream resulting in a reduction in the likelihood of genetic degradation.

Table 1 Action Category[1]	Conservation Measure(s)[2*]	Benefits[3]
Habitat Improvements- Bernardo Siphon	Proposed Additional Conservation 50. MRGCD will pursue construction of the Bernardo siphon, which will create a more reliable water supply at San Acacia Diversion Dam and assist with the management of river connectivity (San Acacia Fish Passage) and downstream refugia. (**MRGCD**)	50. This Measure will reduce the reliance on San Acacia Diversion Dam and assist with fish passage. Under certain conditions will support fish refugia.
Geomorphology		
River Maintenance – Up to eight projects per year (average of four per year); includes State cooperative agreement for MRG Project Area **(Reclamation, State)**	Proposed Minimization Measures 51. General BMPs and Category BMPs**.**	51. This Measure will minimize the effects of localized project activities on silvery minnow, flycatcher, and cuckoo during river channel maintenance. These BMPs will involve sediment control, pre-construction surveys, etc. that will reduce impacts on the listed species. Project specific consultation may be required to determine the anticipated level of incidental take.
	52. Habitat restoration techniques within project footprint, such as bioengineering, revegetation, bank lowering, etc. **(Reclamation, State)**	52. This Measure will minimize the impacts on hydrology and geomorphology from water storage, release and depletions on habitat of listed species. The minimization will occur through creation of overbank flow channels, backwaters, and riparian habitats no longer being created by the natural hydrology and geomorphological processes. Some bioengineered structures may be used to promote more natural processes in silvery minnow habitat and riparian vegetation for flycatcher and cuckoo. This will be accomplished by Reclamation, BIA, and the BA partners on an annual basis.

Table 1 Action Category[1]	Conservation Measure(s)[2*]	Benefits[3]
River Maintenance (continued)	53. Use Adaptive Management for project sites. **(Reclamation, State)**	53. This Measure will provide for continual improvement of design and implementation of the projects in Conservation Measures 51 and 52. This should further reduce impacts to listed species as described above and improve effectiveness of these river channel maintenance projects in meeting their conservation objectives.
River Maintenance – Support activities; includes maintenance of access roads, storage sites, stockpile sites, borrow areas, and quarries. Also covers pumping water for dust abatement and data collection **(Reclamation, State)**	Proposed Minimization Measures 54. Consideration of species impacts during project design, including BMPs to avoid effects.	54. This Measure will minimize impacts on a specific project by project basis for river channel and infrastructure maintenance activities. This will be accomplished through first considering these impacts in the project design, and then through the implementation of BMPs that avoid effects during implementation. This will minimize the effect on all listed species in the project areas from these projects.
	55. General BMPs.	55. This Measure will minimize the effects of localized, projects to silvery minnow, flycatcher, and cuckoo during river channel maintenance. These involve sediment control and pre-construction surveys, etc. Project specific consultation may be required to determine the anticipated level of incidental take.
	56. BMPs for water pumping.	56. This Measure will minimize the impact to silvery minnow by reducing the amount of take associated with pumping water from the River. Screens will prevent silvery minnow mortality. This will be implemented by Reclamation, BIA, and the BA partners at all pumping sites.
	57. Design of data collection minimizes impacts to species.	57. This Measure will minimize incidental injury or death of silvery minnow, flycatcher, and cuckoo related to research and monitoring activities.

Table 1 **Action Category**[1]	**Conservation Measure(s)**[2*]	**Benefits**[3]
River Maintenance – Maintenance of Delta Channel, includes State cooperative agreement **(Reclamation, State)**	Proposed Minimization Measures 58. General BMPs and specific Delta Channel BMPs	58. This Measure will minimize the effects of localized project specific impacts to silvery minnow, flycatcher, and cuckoo during Delta Channel maintenance projects. These will involve sediment control, pre-construction surveys, etc. that will reduce impacts on the listed species. Project specific consultation maybe required to determine the anticipated level of incidental take and provide project specific incidental take authorization.
	59. Maintenance of the Delta Channel to facilitate the development of a natural channel bed allowing greater diversity of hydraulic character (width, depth, and velocity).	59. This Measure will minimize impacts and resulting effects to listed species through the creation of overbank flow channels, backwaters, riparian habitats, and other engineered structures, which would reestablish natural processes within the Delta Channel.
	60. BMPs for water pumping (use of 0.64 cm (0.25-in) mesh screen at intake) and coordination with Service for pumping during low flows.	60. This Measure will minimize the impact to silvery minnow by reducing the amount of take associated with pumping water from the River. Screens will prevent silvery minnow from being sucked into the pumps and dying. This will be implemented by Reclamation, BIA, and the BA Partners at all pumping sites.
Drain Maintenance – Drain and LFCC maintenance; includes State cooperative agreement for MRG Project Area. **(Reclamation, State, MRGCD)**	Proposed Minimization Measures 61. General BMPs**.**	61. This Measure will minimize the effects of localized project to silvery minnow, flycatcher, and cuckoo during Drain and LFCC maintenance. These involve sediment control and pre-construction surveys, etc. Project specific consultation maybe required to determine the anticipated level of incidental take.

Table 1 Action Category[1]	Conservation Measure(s)[2*]	Benefits[3]
Drain Maintenance (continued)	62. Exclusion zones where necessary (seining for silvery minnow and installing temporary migration barriers). 63. Return flows and pumped flows.	62. This Measure is to minimize the effects of localized projects through capturing and relocating individual silvery minnows and installing barriers to their movement. This will reduce the likelihood of death or injury related to Drain and LFCC channel maintenance projects. This will be implemented by Reclamation, BIA, and the BA partners. 63. This Measure will return water to the river channel in support of the Silvery Minnow SRS, i.e., keeping river channel wet, as described in Conservation Measures 14, 18, 20, and 21. The long-term benefit of these flows should offset the short-term loss of individuals at these maintenance sites.
Maintenance of River Facilities – River facilities, dams, and levee maintenance **(MRGCD)**	Proposed Minimization Measures 64. Implement a BMP program for maintenance of MRGCD structures located between the levees.	64. This Measure will minimize the effects of facilities, such as dams and levee maintenance on silvery minnow, flycatcher, and cuckoo similar to Conservation Measures associated with localized projects above. These will involve sediment control, pre-construction surveys, etc. that will reduce impacts on the listed species. Specific facility maintenance projects may require separate consultation to determine the anticipated level of incidental take.
River Connectivity- Pilot Project(s) to Assess River Connectivity at Diversion Structures: San Acacia Diversion Dam	Proposed Additional Conservation 65. Pilot project fish passage concepts will be prepared and tested at the San Acacia Diversion Dam. Plan and construct a pilot project(s) with possible multiple passage configurations (e.g., gradient restoration facilities) to test effectiveness in 2015 to 2018. Conduct approved fish movement studies. (**MRGCD, State, and Reclamation**) MRGCD funding will be made available but is contingent on BiOp completion. Planning and will be in 2016 to 2017, and construction in 2017 to 2018. Collaborative Program could support this effort.	65. This Measure will develop fish passages at the San Acacia Diversion Dam. This will help develop effective designs for passage of the silvery minnow around diversion dams. While the initial structures may not provide unobstructed passage from the San Acacia Reach to the Isleta Reach, it will provide some connectivity which when paired with the interim Measure of Fish Rescue (Conservation Measure 12) should provide connectivity in support of the Conservation Strategy for silvery

Table 1 **Action Category**[1]	**Conservation Measure(s)**[2*]	**Benefits**[3]
River Connectivity (continued)	66. The State will provide up to $25,000 of technical assistance to MRGCD per year for 3 years to design and prepare fish passage concepts at the San Acacia Diversion Dam, set up alternative designs, and test them through Service approved fish movement studies. (**State**) 67. The State will discuss assistance to the MRGCD for construction of the pilot project. (**State**)	minnow until permanent structures are in place by the end of 2022. 66 and 67. These Measures are in support of Conservation Measure 65. These Measures provide no direct minimization of effects, but are part of the necessary process of developing the fish passage at the San Acacia Diversion Dam.
Habitat Improvements- San Acacia Reach (Priority No. 1) *Habitat Improvements*- San	Proposed Additional Conservation 68. Lower Reach (San Acacia) planning efforts will include multiple planned river maintenance and ESA projects that will be coordinated under the lower reach planning effort to provide a cohesive approach for this critical and complex reach of the Action Area. Efforts will include agency and public interactions to establish strategies to engage private landowners. (**Reclamation, State, MRGCD**) 69. Provide a minimum of $150,000 in annual ESA and science related funding, a portion of which may support San Acacia Reach habitat projects, and may include additional funds for specific habitat projects identified as priorities in the Program. **(MRGCD)** 70. BDANWR River Realignment Project will be completed with	68. This Measure commits Reclamation and BA parties to develop a plan within a year of the BiOp being signed that will maintain the San Acacia Reach's ability to deliver water to users and RGC deliveries, while reducing effects to silvery minnow, flycatcher, and cuckoo. These goals will be accomplished through habitat restoration and maintenance, improving water delivery and transport efficiency, and making use of natural hydrology and geomorphology to support these goals. This will minimize the impacts of water storage, delivery, and depletions on river hydrology and geomorphology and resulting effects on listed species. 69. Funds are committed to implement habitat restoration, river channel maintenance, and research studies on listed species. Habitat restoration will minimize the effects of the action by providing riparian habitat restoration projects (Conservation Measures 13, 15, 47, 52, and 65) for silvery minnow, flycatcher, and cuckoo by providing spawning and nesting for these species. River channel maintenance will minimize the effects of the action by including overbank channels and backwaters lost through impaired hydrology

Table 1 **Action Category**[1]	**Conservation Measure(s)**[2*]	**Benefits**[3]
Acacia Reach (continued)	construction estimated to commence by 2018, at which time the NMISC may be requested to provide funding or other support. Stakeholders will be engaged in planning process. (**Reclamation with MRGCD and State**) This is a long-term project with multiple components (e.g., river realignment and LFCC pumping). 71. Fort Craig to RM 60 Restoration includes improving the LFCC for water delivery and construction at the RM 60 site of a structure to allow return flows to the main channel and also provide the ability to control flows into wetlands and silvery minnow designated critical habitat. (**Reclamation, State**) 72. Fund and construct Lower Reach (San Acacia) Habitat Restoration at approximately $1 to 5 million per year as part of River Maintenance and Restoration. (**Reclamation**) 73. Overbank habitat improvements between San Acacia Diversion Dam and RM 100 will begin in 2015 to 2016. The State will provide up to $500,000 to plan and construct approximately 40 ha (100 acres) of backwater and ephemeral channels to be lowered to provide inundation at lower spring runoff flows (1,500 cfs). (**State with Reclamation and MRGCD**)	(Conservation Measures 53 to 57). Research studies will minimize the effects of the action by providing data that will be used in Adaptive Management to improve success of these conservation measures. 70. BDANWR River Realignment Project will realign 11 km (7 mi) of the river channel and design a more natural meander to the channel to promote improved hydrological and geomorphological conditions for silvery minnow, flycatcher, and cuckoo; while improving water delivery for the Compact, MRGCD, and Reclamation. 71. This Measure will provide the ability to deliver more water back to the river channel that will improve the silvery minnow survival by providing up to 13 km (8 mi) of additional wetted river in silvery minnow habitat that has historically dried. 72. Funding has been committed to implement habitat restoration, river channel maintenance, and research studies on listed species within the San Acacia Reach as described in Conservation Measures 68-71 and 73-75. 73. This Measure will minimize the impacts of water storage, delivery, and depletions on geomorphology that would create backwaters and ephemeral channels that would be used by silvery minnow for spawning and rearing. This will be done by the creation of 40 ha (100 acres) of these habitats that will be inundated at lower spring (May and June) flows. This should provide additional habitat and increase the number of Age 0 individuals in low flow years even when a Survival Strategy is being implemented. As such, there is more likely to be a larger young age class recruited into the
Habitat Improvements- San	74. Riverine Refugia. The MRGCD will cooperate and assist with the creation and enhancement of specific habitat areas near MRGCD outfalls to provide a series of refuge areas	

Table 1 **Action Category[1]**	**Conservation Measure(s)[2*]**	**Benefits[3]**
Acacia Reach (continued)	where silvery minnow populations may be maintained during normal periods of low and intermittent flow in the MRG. **(MRGCD)**	reproductive population the following spring, than would be expected without this Measure. 74. This Measure will minimize the impact of water storage, delivery and depletion on river hydrology and resulting effects on silvery minnow survival, from river drying. This Measure will reduce river drying by providing water to occupied silvery minnow habitat.
Habitat Improvements- Isleta Reach - Riverine Refugia (Priority No. 2)	Proposed Additional Conservation 75. The MRGCD will cooperate and assist with the creation and enhancement of specific habitat areas near MRGCD outfalls to provide a series of refuge areas where silvery minnow populations may be maintained during normal periods of low and intermittent flow in the MRG.	75. This Measure is similar to that of Conservation Measure 74 above, but in the Isleta Reach. This measure will provide approximately the same amount of habitat, on average, as those in the San Acacia Reach.
Habitat Improvements- Angostura Reach (Priority No. 3)	Proposed Additional Conservation 76. Rio Rancho Habitat Restoration Phase II will be constructed using State funding of approximately $500,000 for habitat restoration in upper portion of the Angostura Reach by spring 2017. Bankline lowering and floodplain reconnection is planned. (**State**)	76. This Measure will provide funding to implement Conservation Measures 47 and 52, which will provide the minimization and benefits to the species as described above.
Riparian Vegetation Dynamics		
Habitat Improvements- Isleta Reach (Priority No. 2) *Habitat Improvements*-	Proposed Additional Conservation 77. MRGCD will provide a minimum of $150,000 in annual ESA and science related funding, a portion of which may support Isleta Reach habitat projects, and may include additional funds for specific habitat projects identified as priorities in the Program. **(MRGCD)** 78. Sevilleta NWR flycatcher and silvery minnow habitat improvements will be planned and implemented by a consortium of agencies including the BA Partners and the Service. Up to 32 ha (80 acres) of new habitat will be restored from 2015 to 2017. (**State, Reclamation, and MRGCD**) 79. Construction and monitoring of Isleta Reach habitat	77. This Measure will indirectly minimize the impacts of storage and depletions, through funding portions of the habitat restoration projects in the Isleta Reach as described in Conservation Measures 23, 49, 75, 78, and 79. 78. This Measure will minimize the impact of water storage, delivery, and depletions on hydrology and geomorphology; and the resulting effects on silvery minnow, flycatcher, and cuckoo. This will provide 32 ha (80 acres) of additional habitat by the end of 2017. 79. This Measure will minimize the impact of water

Table 1 Action Category[1]	Conservation Measure(s)[2*]	Benefits[3]
Isleta Reach (continued)	restoration using Adaptive Management includes maintenance and monitoring of new habitat restoration and existing habitat restoration near Los Lunas and Belen through assessment and modification of natural and manmade levees on bank attached bars that restrict spring runoff flows and cause large-scale entrapment for silvery minnows. (**Reclamation, State, and MRGCD**)	storage, delivery, and depletions on hydrology and geomorphology; and the resulting effects on silvery minnow, flycatcher, and cuckoo. This will provide additional habitat and perpetually maintain it. The primary goal is to modify levees and bank bars that have cause large-scale entrapment for silvery minnow. The benefit would be reduced mortality and need to salvage silvery minnows.
Water Quality		
Habitat Improvements-System-Wide Solutions for Habitat Improvements	Proposed Additional Conservation 80. Sedimentation management planning will occur and implementation of BMPs during river maintenance will improve the balance of sediment into the River. (**Reclamation**)	80. This Measure will reduce impacts of water storage and diversion on geomorphology of the river channel, specifically on sediment transport. Reduced sediment transport diminishes deposition areas that maintain natural river meander and backwater habitats essential for spawning and rearing of silvery minnow. This reduction also effects the riparian habitat dynamics necessary to provide continued nesting habitats for flycatcher and cuckoo. This Measure will minimize these effects to the listed species by improving the sediment load (balance) in the water column. This Measure combined with previous conservation measures should provide additional habitat for silvery minnow spawning and improved riparian vegetation dynamics to benefit flycatcher and cuckoo nesting.
Habitat Improvements-	81. Habitat Monitoring program will establish a geographical information system (GIS) database to track habitat	81. This Measure will indirectly minimize the impacts of storage and depletions, through informing habitat

Table 1 Action Category[1]	Conservation Measure(s)[2*]	Benefits[3]
System-Wide Solutions for Habitat Improvements (continued)	restoration. (**Reclamation, State, and MRGCD**)	restoration decisions, such as placement of restoration projects and identifying successful techniques that can be used in the Adaptive Management program. This will help minimize the effects to the listed species as described in previous conservation measures.
Other		
Habitat Improvements-Species and Habitat Monitoring	Proposed Additional Conservation 82. Fund portions of hydrology, species and habitat monitoring, in coordination with Reclamation. Riparian habitat monitoring will be funded as part of established river maintenance and restoration protocols. Species and habitat monitoring will inform Adaptive Management. (**Reclamation, MRGCD, and State**) 83. State will provide up to $75,000 for monitoring purposes. (**State**) 84. Revise and refine the population monitoring program as determined through workshops and other forums to provide reliable indices to track the status and trend of the population and to inform management decisions**. (Reclamation, MRGCD, and State)**	82. This Measure will indirectly minimize impacts, through funding portions of riparian habitat monitoring. The minimization of impacts to listed species is described in Conservation Measures 15, 53, 79, and 81. 83. This Measure will indirectly minimize the impacts of storage, depletions, and construction and maintenance projects through funding portions of the monitoring program. The minimization of impacts to listed species is described in Conservation Measures 16, 53, 57, and 84, which will be partially funded through this Measure. 84. This Measure will indirectly minimize the impacts of storage, delivery, and depletions through improving monitoring of silvery minnow, and informing Adaptive Management decisions that will be necessary in Conservation Measures 16, 53, and 57 above.
Habitat Improvements-Species and Habitat Monitoring	85. MRGCD will provide a minimum of $150,000 in annual ESA and science related funding, a portion of which may support this revision and refinement process. **(MRGCD)**	85. This Measure will indirectly minimize the impacts of storage, depletions, and construction and maintenance through funding portions of river

Table 1 Action Category[1]	Conservation Measure(s)[2*]	Benefits[3]
(continued)	86. MRGCD will provide a minimum of $150,000 in annual ESA and science related funding that will include support for seeking experts to contribute to the scientific efforts, including helping to develop and achieve the envisioned Adaptive Management procedures. **(MRGCD)**	channel maintenance and habitat restoration projects. The minimization of impacts to listed species is described in Conservation Measures 29, 43, 52, 53, 57-59, 68, 73, 74, 78, 79, and 81. 86. This Measure will support Adaptive Management used to implement Conservation Measures 1, 3, and 27-46, which will help minimize impacts to the River and provide benefits to the listed species.

Table 2. Estimated rangewide cuckoo territory numbers (Service 2014b).

Area	**Estimated Number of Territories**
Arizona	170-250
California	40-50
Colorado	< 10
Idaho	10-20
Nevada	< 10
New Mexico	100-155
Northwestern Mexico	330-530
Utah	10-20
Western Texas	< 10
Wyoming	< 5
Total	**680-1025**

Table 3. Estimated density of silvery minnow (fish per 100 m^2), spring runoff volume, river length dried, and occupancy based on year in the Middle Rio Grande.

Year	Silvery Minnow Density (fish per $100m^2$) in Fall	Total number of Silver Minnow collected in MRG during the year	Number of Silvery Minnow Captured in Oct			Albuquerque Gage Spring Runoff Volume	Total MRG Area Dried (in Miles)	October occupancy (Total number of sites)
			Angostura	Isleta	San Acacia			
2000	0.43	1,027	0	0	36	119,441	0.0	0.33 (15)
2001	0.90	3,075	3	23	86	220,893	10.0	0.65 (20)
2002	0.08	1,604	9	1	1	82,635	43.2	0.25 (20)
2003	0.03	384	1	1	0	74,418	93.5	0.10 (20)
2004	0.89	3,039	44	4	30	162,208	48.5	0.45 (20)
2005	44.90	30,993	278	2,445	1,299	607,478	43.0	1.00 (20)
2006	1.00	20,450	73	24	69	85,505	24.0	0.90 (20)
2007	13.10	9,631	601	463	102	234,327	33.5	0.80 (20)
2008	10.54	9,550	219	111	538	433,944	3.0	1.00 (20)
2009	14.90	5,470	328	327	1,256	358,140	17.5	0.95 (20)
2010	1.20	13,856	11	30	96	287,169	28.7	0.75 (20)
2011	1.30	2,314	6	22	90	101,292	42.5	0.40 (20)
2012	0.00	834	0	0	0	79,031	51.0	0.00 (20)
2013	0.03	354	66	23	189	69,953	36.5	0.15 (20)
2014	0.00	471	0	0	0	107,572	26.4	0.70 (20)
2015	0.16	1,421	5	8	3	181,494	19.6	0.40 (20)

Table 4. Number of silvery minnow salvaged and released and river miles (RM) salvaged during 2001 to 2015 (Archdeacon and Remshardt 2013; Archdeacon et al. 2016).

Year	RMs Salvaged	Silvery Minnow Salvaged and Released	Silvery Minnow Salvaged per RM*
2001	7.0	380	54
2002	43.2	3,662	84
2003	70.0	713	10
2004	68.0	12,865	189
2005	28.5	603,266 *	21,167
2006	26.0	69,875 *	2,687
2007	30.0	13,953	465
2008	0.8	3,561**	4,748
2009	20.0	17,199	860
2010	28.2	9,667	342
2011	39.8	8,244	207
2012	51.0	4,251	83.4
2013	36.5	1,492	41
2014	24.5	630	26
2015	17.4	1,320	76
Total	490.9	751,078	1530.2

*Included salvage of overbank areas.
**Salvaged during project construction on BDANWR, not from operational river drying.

Table 5. Suitable habitat for the flycatchers in the MRG by reach, year of assessment, and percentage of suitable habitat within the floodplain (values generated using data collected from: Ahlers 2009; Siegle et al. 2013; Reclamation 2015, Part III).

Year of Suitability Assessment	Area or Reach	Suitable or Marginally Suitable Habitat ha (acres)	Floodplain Area Evaluated ha (acres)	Percentage of Available Habitat Considered Suitable or Marginally Suitable
2008	Velarde to Cochiti Area	78 (192)	656 (1,620)	12
2008	Cochiti Reach	66 (164)	558 (1,380)	12
2008	Angostura Reach	118 (292)	996 (2,460)	12
2012	Isleta Reach	794 (1,962)	3,075 (7,599)	26
2012	San Acacia Reach (to RM 38)	2,781 (6,871)	13,635 (33,693)	20

Table 6. Extent of annual river drying in Isleta and San Acacia Reaches and percent of total critical habitat from 2001 to 2015.

	Isleta 85 km (53 mi)		**San Acacia** 94 km (58.5 mi)		**Combined** 174.4 km (111.5 mi)		**Critical Habitat** 252 km (157 mi)
Year	km (mi)	Percent	km (mi)	Percent	km (mi)	Percent	Percent
2001	0.0 (0.0)	0.0	11.3 (7.0)	12.0	11.3 (7.0)	6.3	4.5
2002	29.3 (18.2)	34.3	40.2 (25.0)	42.7	69.5 (43.2)	38.7	27.5
2003	48.3 (30.0)	56.6	64.4 (40.0)	68.4	112.6 (70.0)	62.8	44.6
2004	49.9 (31.0)	58.5	59.5 (37.0)	63.2	109.4 (68.0)	61.0	43.3
2005	6.4 (4.0)	7.5	39.4 (24.5)	41.9	45.9 (28.5)	25.6	18.2
2006	15.3 (9.5)	17.9	26.5 (16.5)	28.2	41.8 (26.0)	23.3	16.6
2007	15.3 (9.5)	17.9	33.0 (20.5)	35.0	48.3 (30.0)	26.9	19.1
2008	0.0 (0.0)	0.0	0.0 (0.0)	0.0	0.0 (0.0)	0.0	0.0
2009	0.0 (0.0)	0.0	32.2 (20.0)	34.2	32.2 (20.0)	17.9	12.7
2010	13.7 (8.5)	16.0	31.7 (19.7)	33.7	45.4 (28.2)	25.3	18.0
2011	20.8 (12.9)	24.3	43.6 (27.1)	46.3	64.4 (40.0)	35.9	25.5
2012	30.9 (19.2)	36.2	51.2 (31.8)	54.4	82.1 (51.0)	45.7	32.5
2013	15.6 (9.7)	18.3	43.1 (26.8)	45.8	58.7 (36.5)	32.7	23.2
2014	5.3 (3.3)	6.2	37.2 (23.1)	39.5	42.5 (26.4)	23.7	16.8
2015	10.3 (6.4)	12.1	21.2 (13.2)	22.6	31.5 (19.6)	17.6	12.5

Table 7. Baseline flows required at specific RMs to initiate overbank flows (values computed using data collected from: Bui 2016, 2014 aerial imagery, Reclamation 2015, Part III).

Gage	**Reach**	**River Mile**	**Elevation to Overbank (feet)**	**Flow required to overbank (cfs)**	**Percentage of Vegetation in Floodplain Inundated**
Alameda Bridge	Angostura	192	4,997	1,240	1
Albuquerque	Angostura	183	4,955	3,084	2
Isleta	Angostura	172	4,902	2,992	1
Bosque Farms	Isleta	166	4,875	4,584	3
Highway 346	Isleta	141	4,769	3,515	63
Bernardo	Isleta	131	4,728	2,945	3
San Acacia	San Acacia	116	4,655	1,068	3
Escondida	San Acacia	104	4,614	3,240	3
Highway 390	San Acacia	88	4,553	2,720	75
San Marcial	San Acacia	68	4,481	Unknown*	Unknown

* unknown but greater than 4,995 cfs.

Table 8. Volumes of water removed from MRG as estimated at the Albuquerque Gage during May and June by the Proposed Action and in the Environmental Baseline for three hydrologic scenarios (see Reclamation 2015 for description of the hydrologic scenarios).

Impact to May and June flow at the Albuquerque Gage	**Volume (acre-ft) during Very WET Years (Scenario 10)**	**Volume (acre-ft) during AVERAGE Years (Scenario 50)**	**Volume (acre-ft) during Very DRY Years (Scenario 90)**
Riparian demand[1]	47,070	47,070	47,070
Evaporative demand[2]	26,100	26,100	26,100
Groundwater demand[3]	11,800	11,800	11,800
Climate-based demand[4]	-7,340	6,580	14,190
Environmental Baseline Impacts to May and June Flows	77,630	91,550	99,160
Diversion for storage[5]	30,180	20,540	2,990
Agricultural demand[6]	87,900	87,900	87,900
LFCC demand[7]	50,330	38,440	20,660
New State demand[8]	1,600	1,600	1,600
Proposed Action Impacts to May and June Flows	**170,010**	**148,480**	**113,150**
Total Impacts to May and June Flows (Baseline and Proposed Action)	247,640	240,030	212,310

[1] Reclamation (2015a, Appendix H, file name "10_ProposedActionMRGCDOps_2015_DRYING.xlsx")
[2] Reclamation (2015a, Appendix H, file name "50_ProposedActionMRGCDOps_2015_DRYING.xlsx")
[3] Hathaway and MacClune (2007, page 44, average groundwater depletions or May and June)
[4] Reclamation (2016c, Appendix C, URGWOM Hde Flow Output of median May and June volumes for various climate scenarios Observed minus Warm and Wet, Observed minus Central Tendency, and Observed minus Hot and Dry during the 2020s)
[5] Gensler (2016b, file name RevisedPotentialCorrectionsToFWSDepletionEstimates.xlsx)
[6] Reclamation (2015, rows 142-202, file "30%ProposedActionMRGCDOps_2015_DRYING.xlsx")
[7] Average May and June volume at USGS Gage 08358300 for the various hydrologic scenarios
[8] Reclamation (2015) - average volume of the State's new permit demand during May and June

Table 9. Volumes of water removed from MRG as estimated at the Albuquerque Gage during July to October by the Proposed Action and in the Environmental Baseline for three hydrologic scenarios (see Reclamation 2015 for description of the hydrologic scenarios).

Impact to July to October flow at Albuquerque Gage	**Volume (acre-ft) during Very WET Years (Scenario 10)**	**Volume (acre-ft) during AVERAGE Years (Scenario 50)**	**Volume (acre-ft) during Very DRY Years (Scenario 90)**
Riparian demand[1]	84,100	84,100	84,100
Evaporative demand[2]	34,900	25,600	26,600
Groundwater demand[3]	23,700	23,700	23,700
Climate-based demand[4]	-1,700	7,030	10,050
Environmental Baseline Impacts to July to October Flows	141,000	140,430	144,450
Return credit for storage[5]	-30,180	-20,540	-2,990
Agricultural demand[6]	90,780	90,780	90,780
LFCC demand[7]	79,960	50,830	36,190
New State demand[8]	3,300	3,300	3,300
Supplemental Water Progam[9]	-19,470	-15,390	-22,720
Proposed Action Impacts to July to October Flows	**124,390**	**108,980**	**104,560**
Total Impacts to July to October Flows (Baseline and Proposed Action)	265,390	249,410	249,010

[1] Reclamation (2015a, Appendix H, file name "10_ProposedActionMRGCDOps_2015_DRYING.xlsx")
[2] Reclamation (2015a, Appendix H, file name "90_ProposedActionMRGCDOps_2015_DRYING.xlsx")
[3] Hathaway and MacClune (2007, page 44, average groundwater depletions for July to October)
[4] Reclamation (2016c, Appendix C, URGWOM Hde Flow Output of median July-October volumes for various climate scenarios Observed minus Warm and Wet, Observed minus Central Tendency, and Observed minus Hot and Dry during the 2020s)
[5] Gensler (2016b, file name RevisedPotentialCorrectionsToFWSDepletionEstimates.xlsx)
[6] Reclamation (2015, rows 203-325, file "30%ProposedActionMRGCDOps_2015_DRYING.xlsx")
[7] Average July-October volume at USGS Gage 08358300 for the various hydrologic scenarios
[8] Reclamation (2015) - average volume of the State's new permit demand during July-October
[9] Reclamation (2015, Table I-18, average annual volume with only the minimum Albuquerque lease)

Table 10. The effect of depth to groundwater on health of native and nonnative riparian vegetation in the Middle Rio Grande (Horton et al. 2001; Parametrix 2008; Caplan et al. 2012).

Riparian Vegetation	Healthy m (ft)	Stressed m (ft)	Crown dieback m (ft)	Mortality m (ft)
Cottonwood	< 2.3 (7.4)	2.3 – 3.0 (7.5 – 9.8)	3.0 – 5.0 (9.9 – 16.4)	> 5.0 (> 16)
Saltcedar	< 2.3 (7.4)	2.3 – 2.5 (7.5 – 8.2)	> 2.5 (> 8.2)	> 30 (> 100)
Willow	< 2.0 (6.5)	2.0 – 2.3 (6.6 – 7.4)	2.3 – 3.0 (7.5 – 9.8)	> 3.0 (> 10)

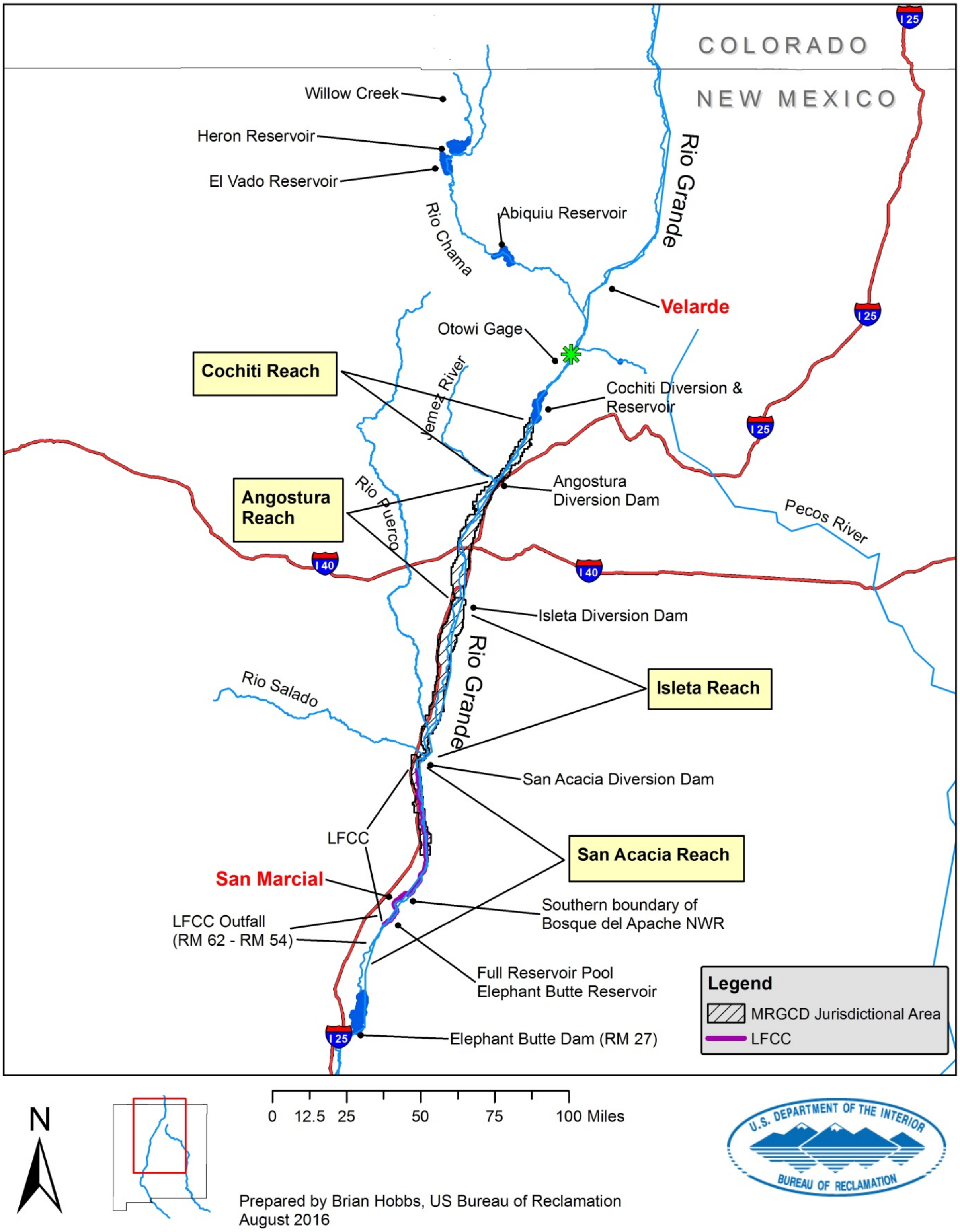

Figure 1. The Middle Rio Grande Action Area with major locations mentioned in the text.

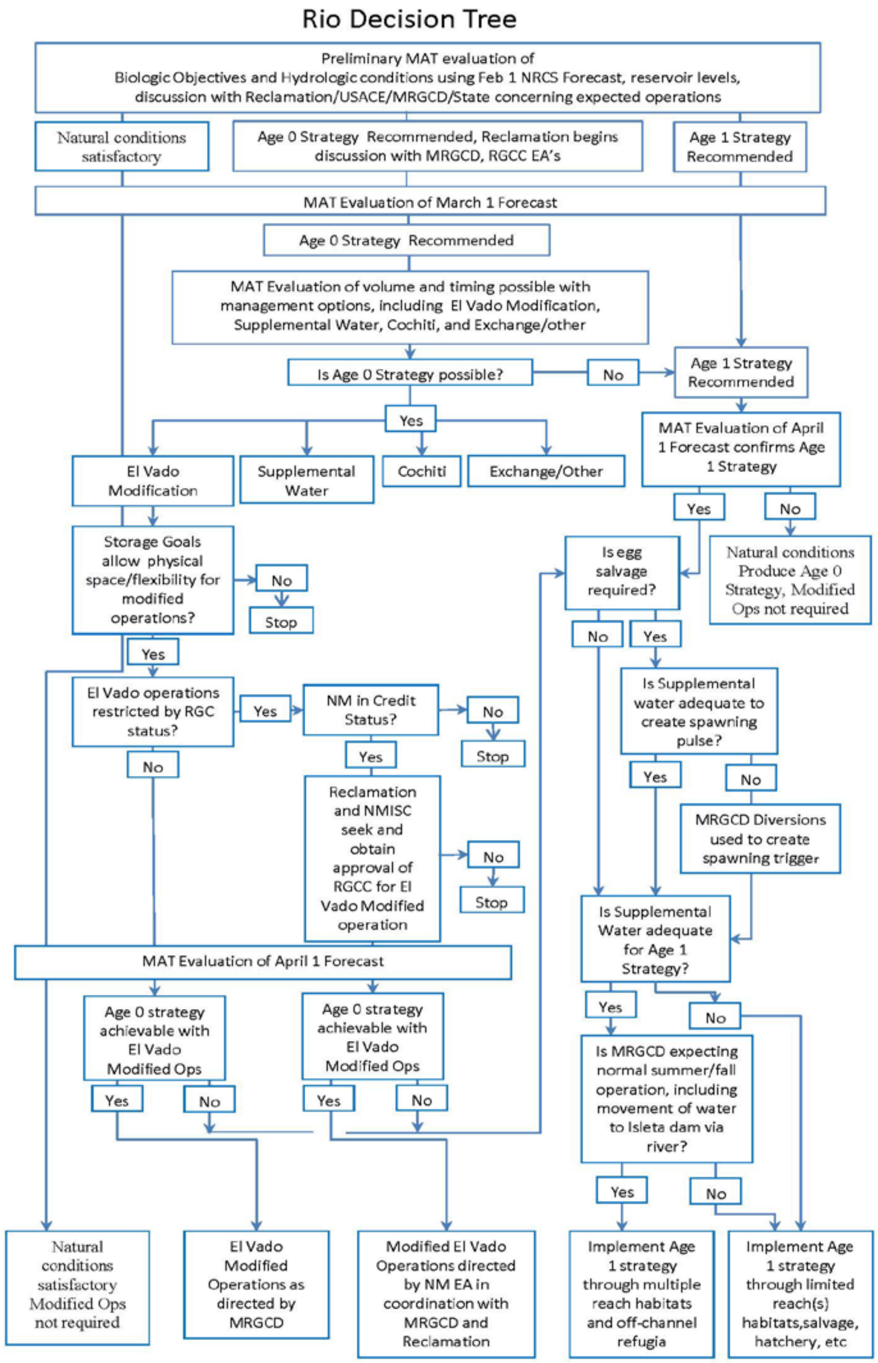

Figure 2. Draft RIO Decision Tree*.
*The Service recognizes that access to or use of Indian Pueblo or Tribal lands or other trust resources requires the consent of the affected Indian Pueblo or Tribe and that the Federal agencies are obligated by the federal trust responsibility to consult with the affected Pueblo or Tribe. The Service recognizes that nothing in this draft RIO Decision Tree shall adversely affect or otherwise modify the obligations to store, release, and deliver water to the six MRG Pueblos to meet their statutorily recognizedrights.

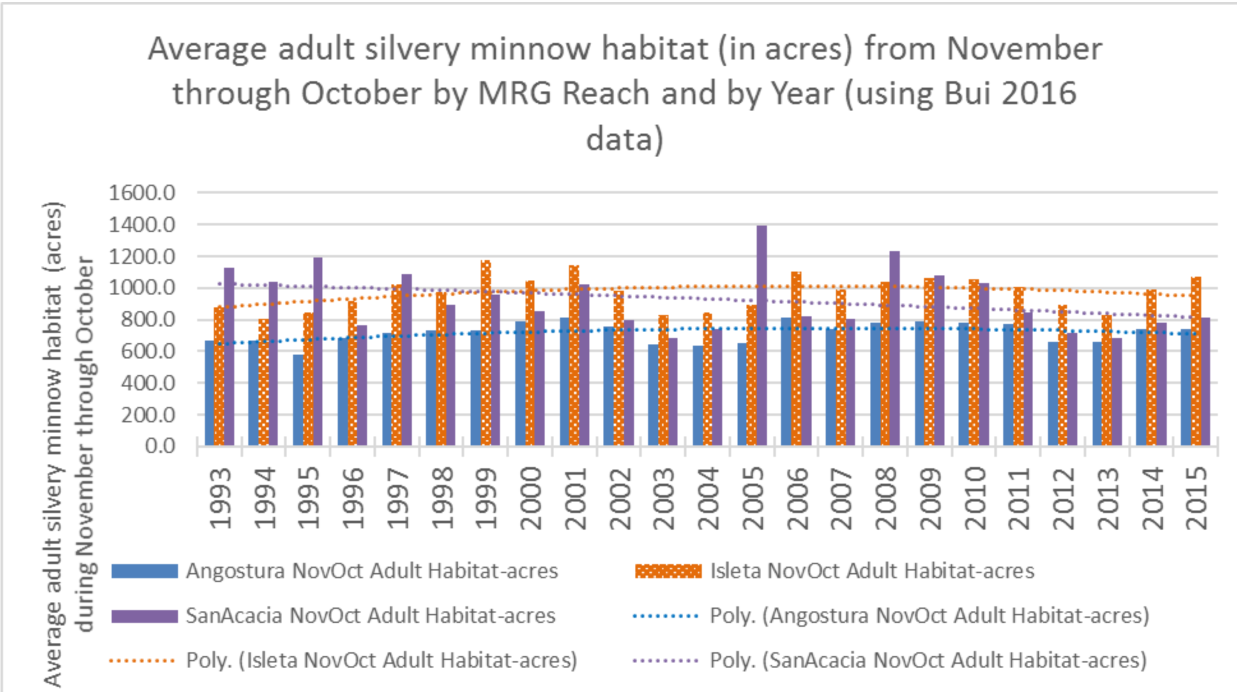

Figure 3. Changes in annual adult silvery minnow habitat by river reach and year.

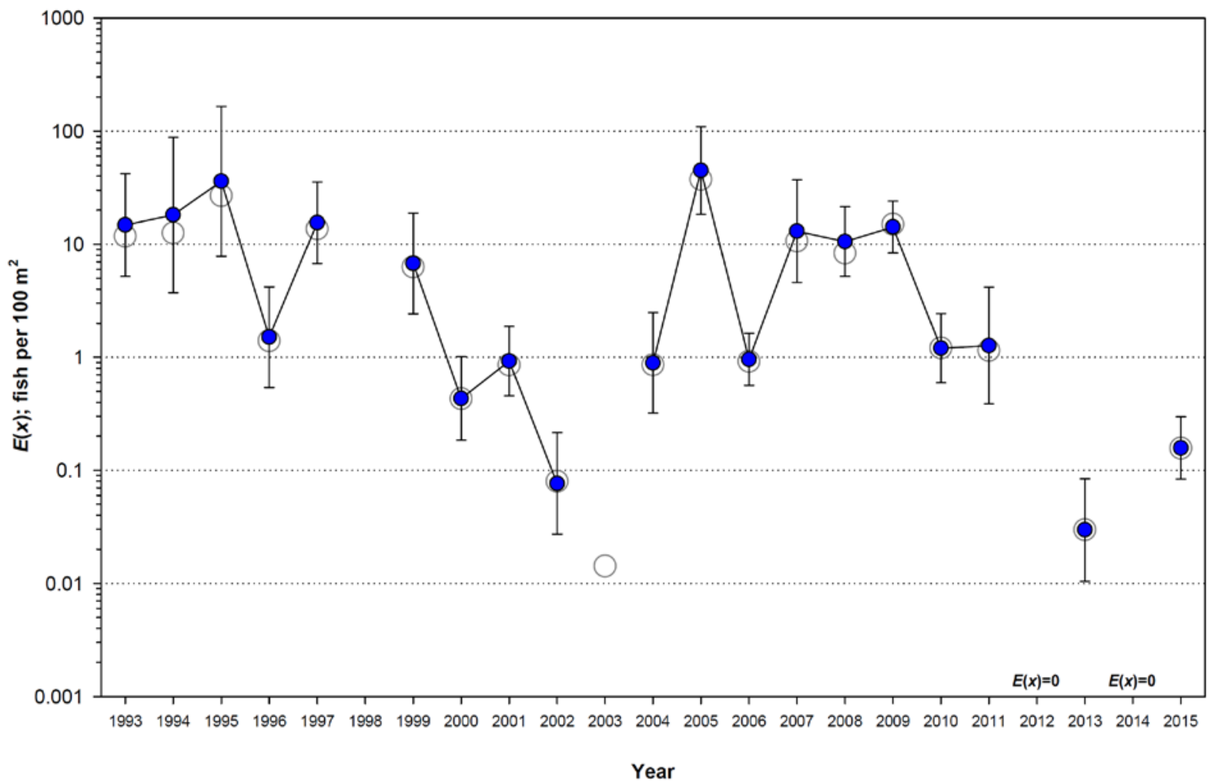

Figure 4. Density of silvery minnow (fish per 100 m^2) in the MRG from 1993 to 2015 (from Dudley et al. 2016).

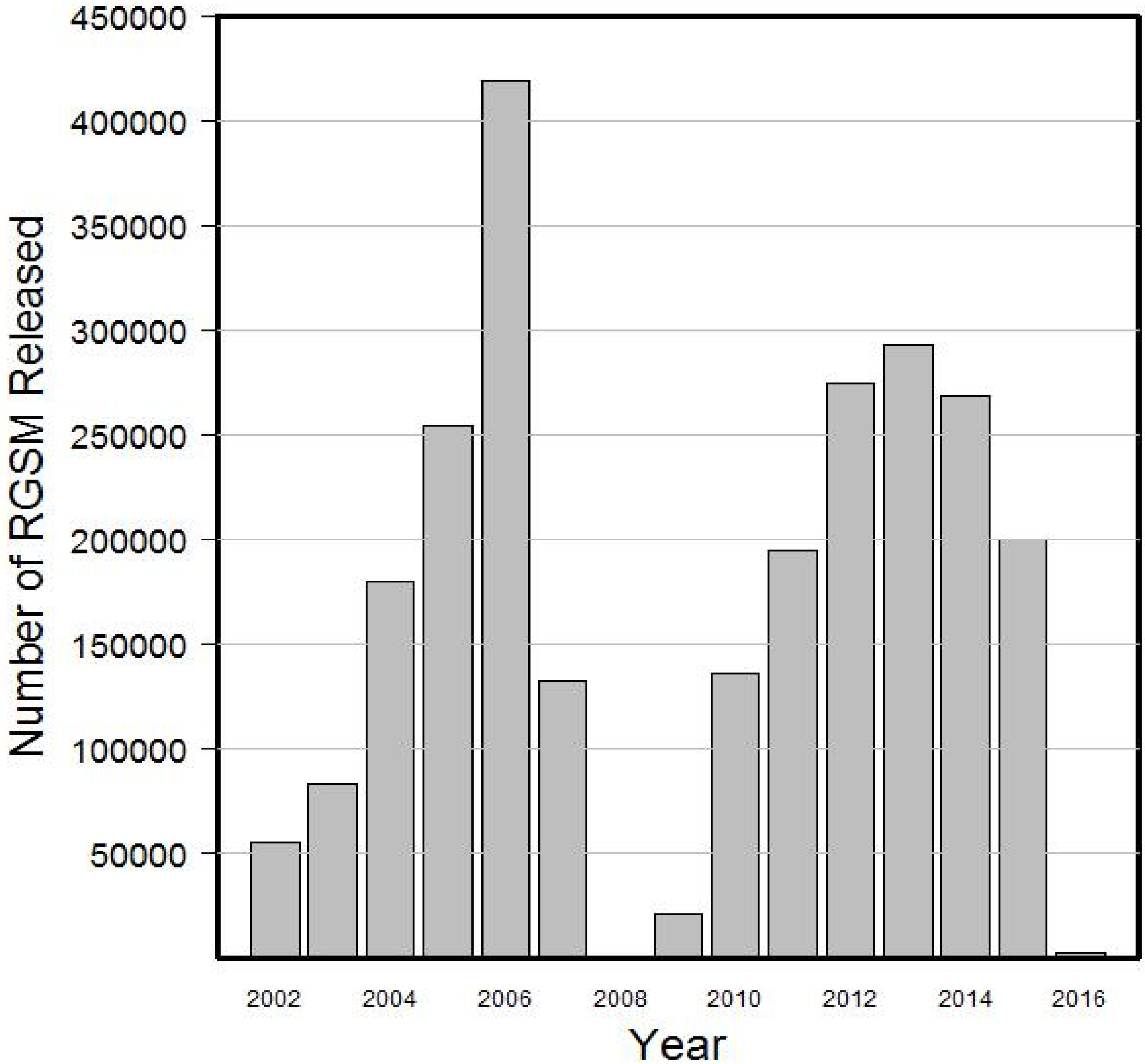

Figure 5. Number of silvery minnow (RGSM) released into the MRG from 2002 to 2016 (Archdeacon et al. 2016).

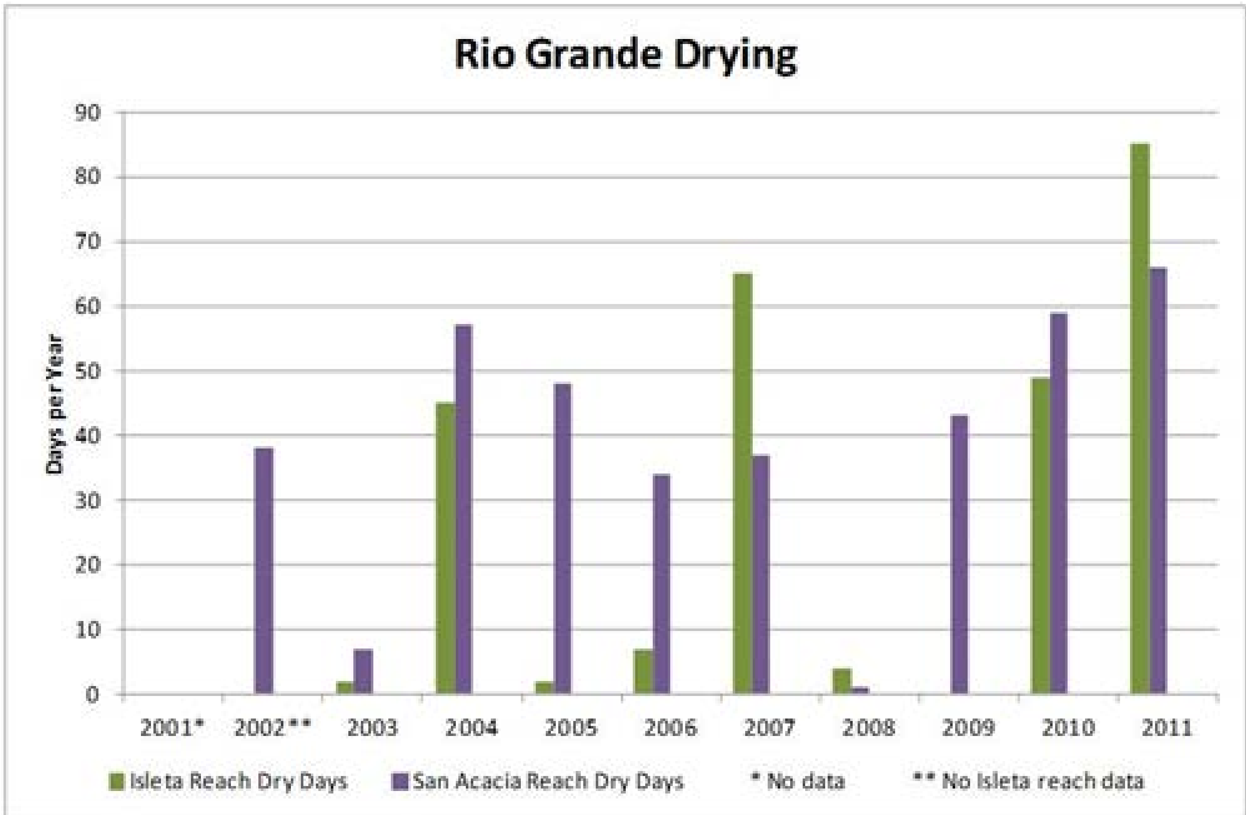

Figure 6. Number of days per year of river drying in the Isleta and San Acacia Reaches from 2001 to 2011 (from Reclamation 2015).

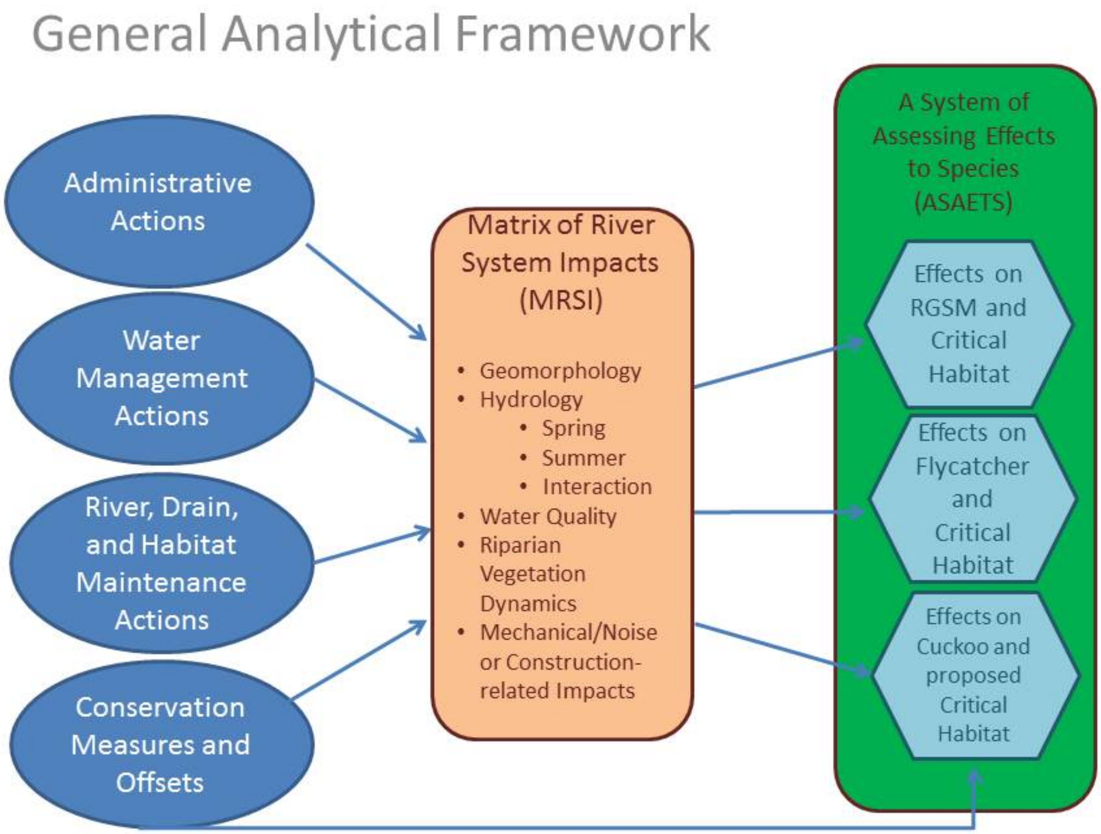

Figure 7. General analytical framework for the Matrix of River System Impacts and System of Assessing Effects to a Species.

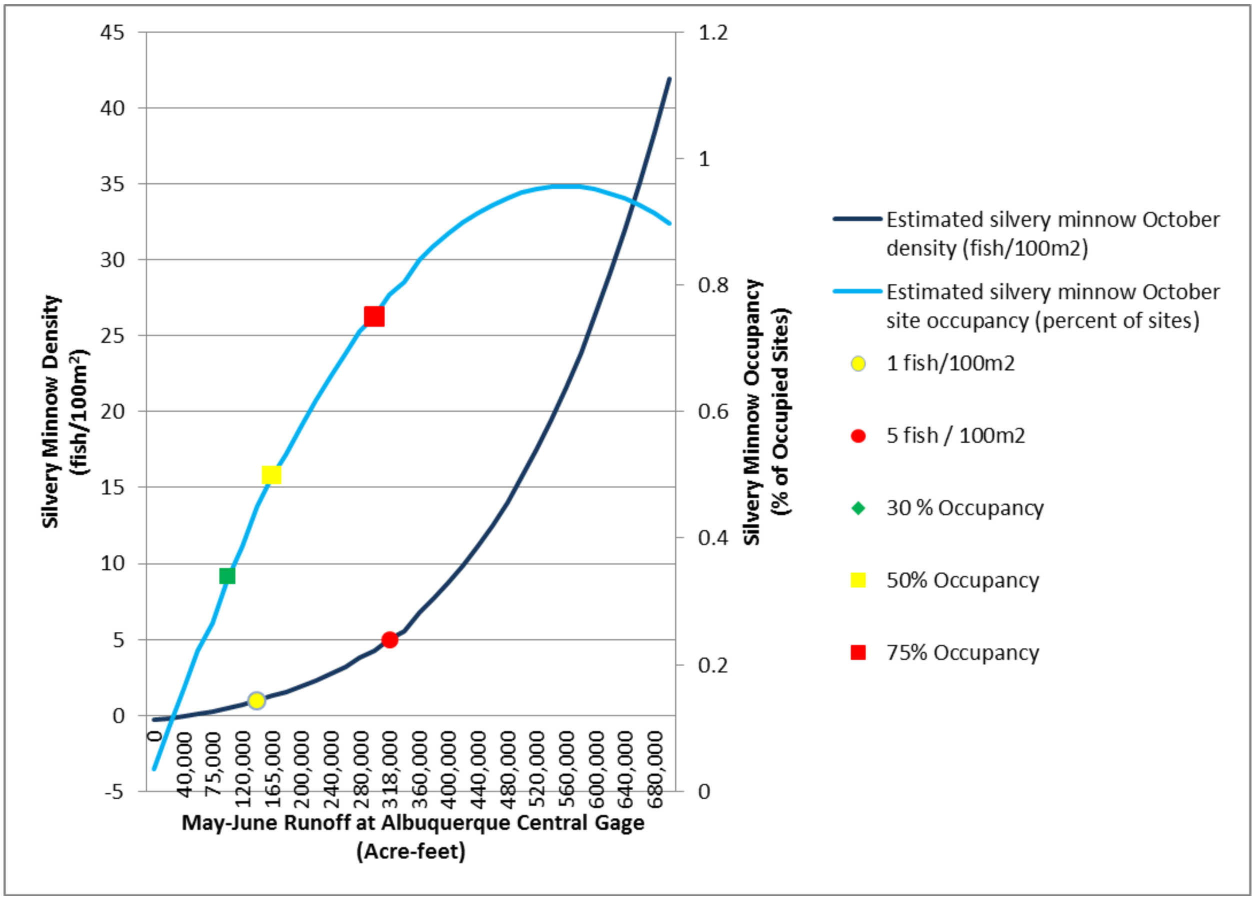

Figure 8. Estimated fall densities of silvery minnow (fish per 100 m^2) and percent occupancy based on alterations to flow at the Albuquerque Gage during May and June (see Table 8).

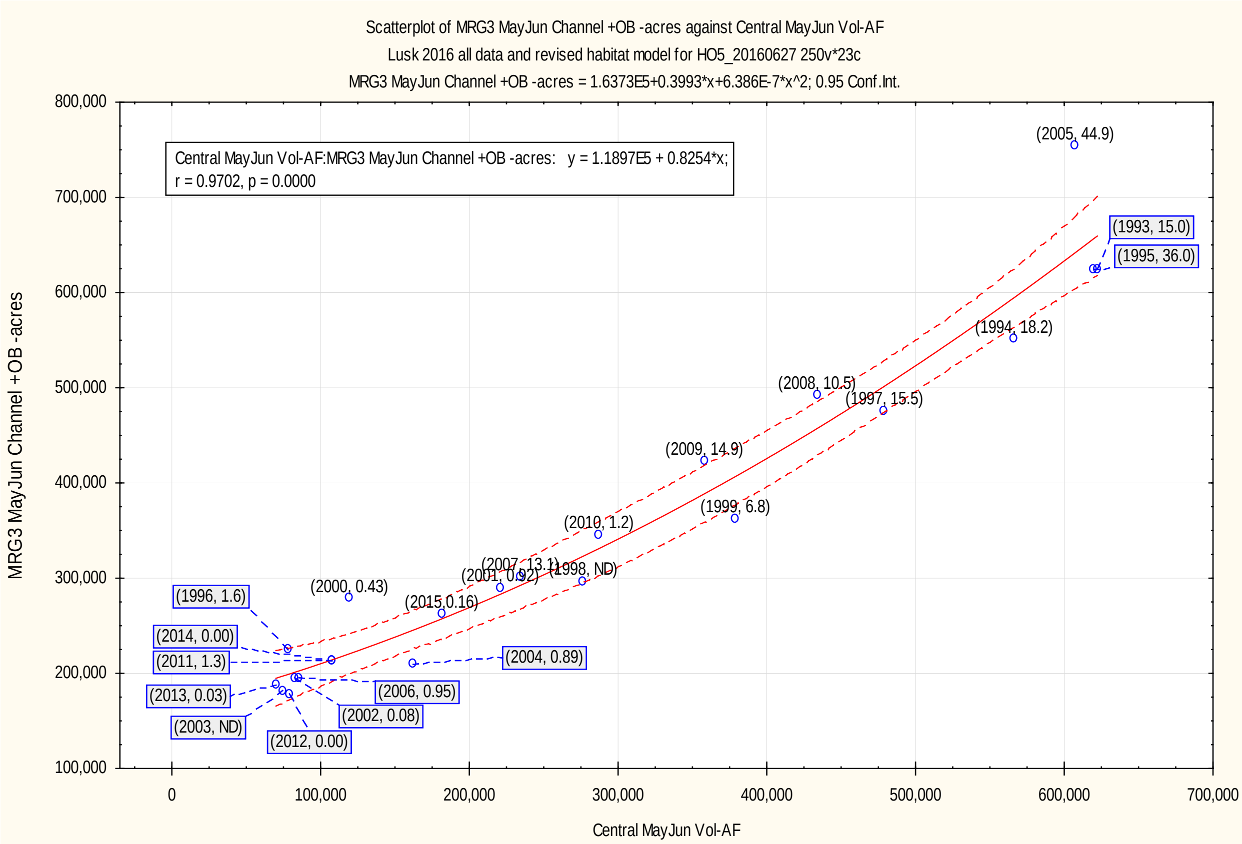

Figure 9. Relationship between volume (acre-ft) at the Albuquerque Gage and the area of inundated channel and floodplain during the spring.

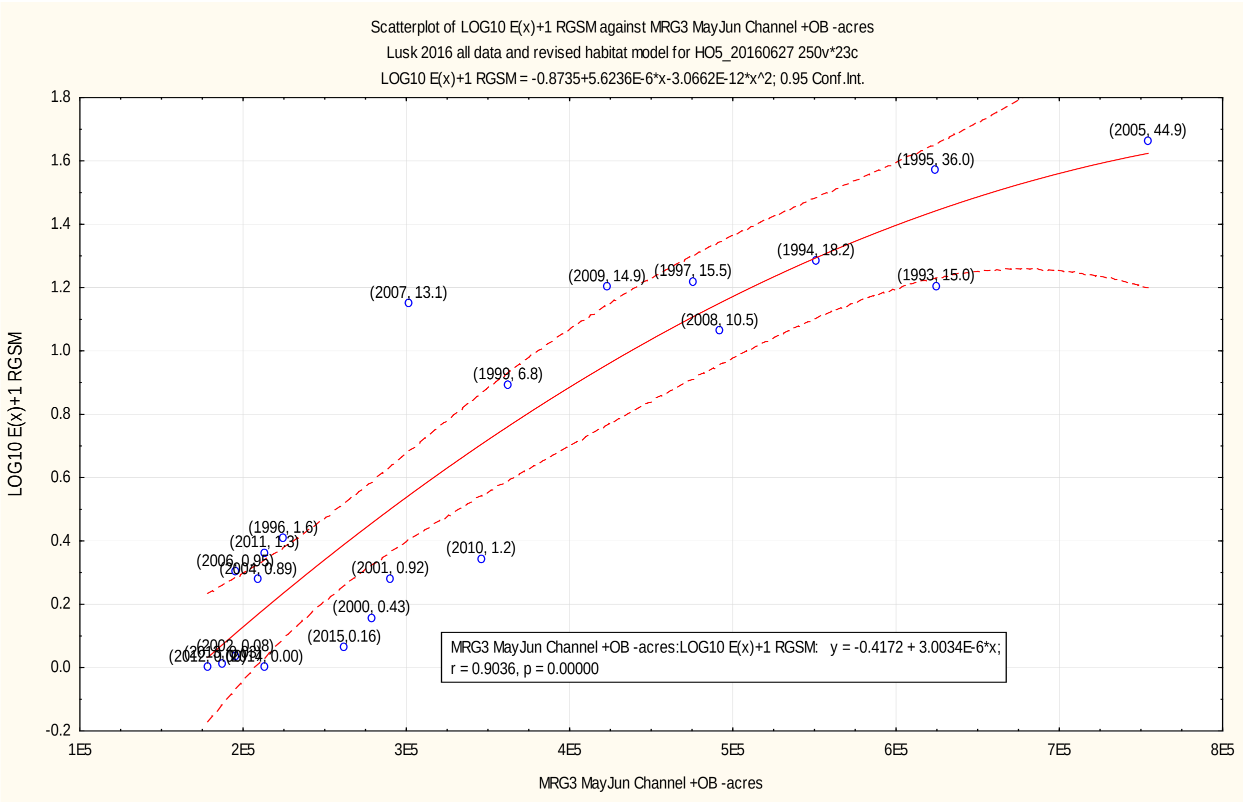

Figure 10. Relationship between inundated channel and floodplain area and silvery minnow abundance (fish per 100 m^2) in the fall.

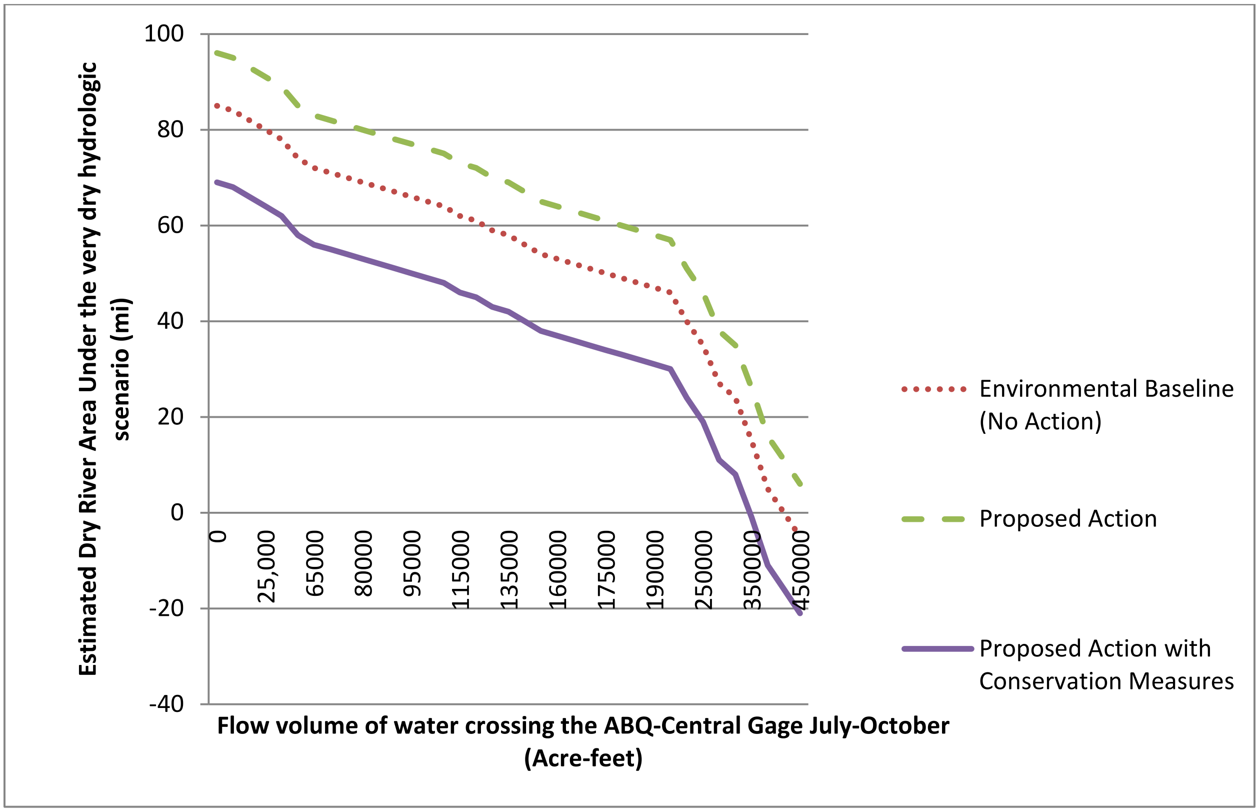

Figure 11. Estimated dry river area within the MRG under the very dry scenario (see Reclamation 2015 for description of the hydrologic scenarios).

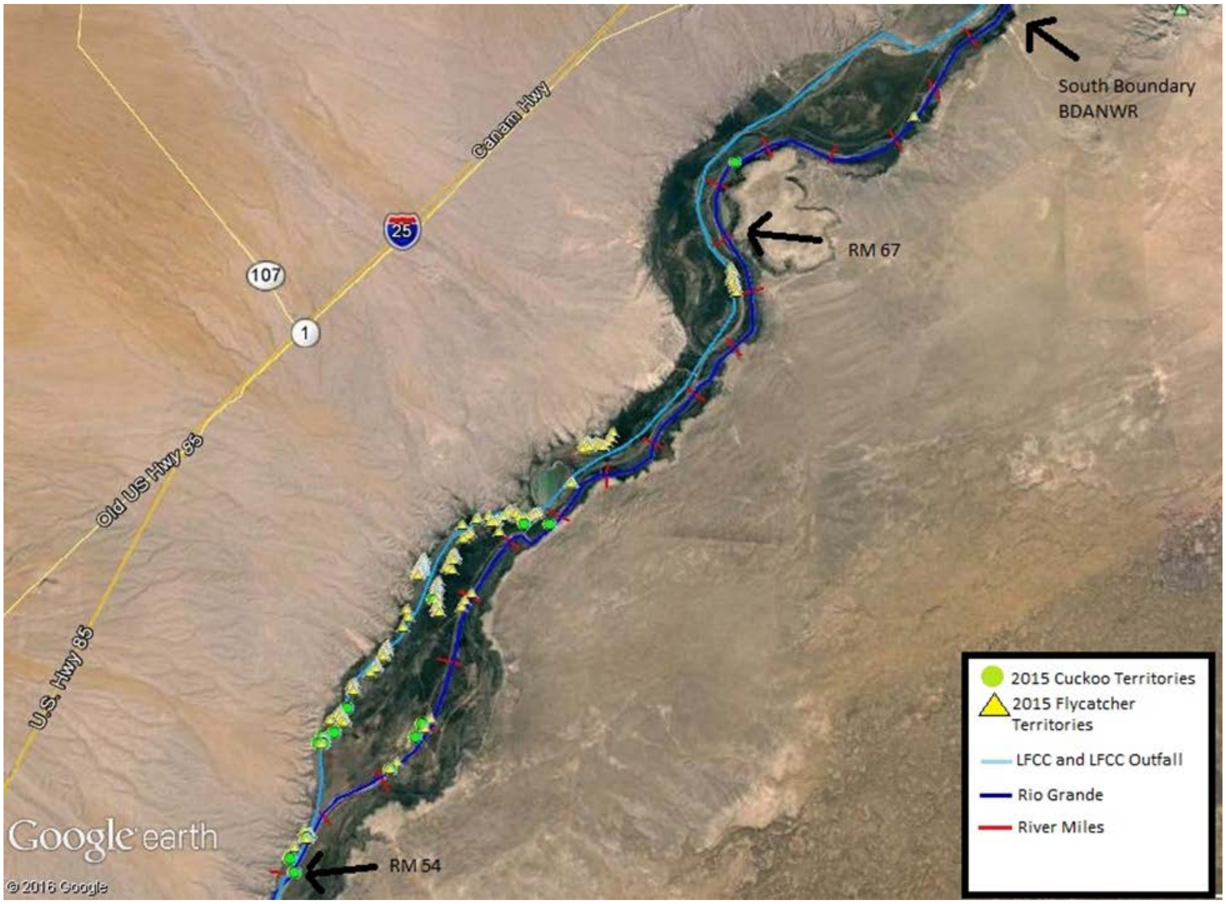

Figure 12. Flycatcher and cuckoo locations in 2015 from the south boundary of BDANWR (RM 67) to the Low Flow Conveyance Channel (LFCC) and Rio Grande confluence (RM 54).